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A TEXT-BOOK

OF

ZOOLOGY,

FOR SCHOOLS.

BY PHILIP HENRY GOSSE, A.L.S.

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ZOOLOGY.

SUB-KINGDOM I. ACRITA.*

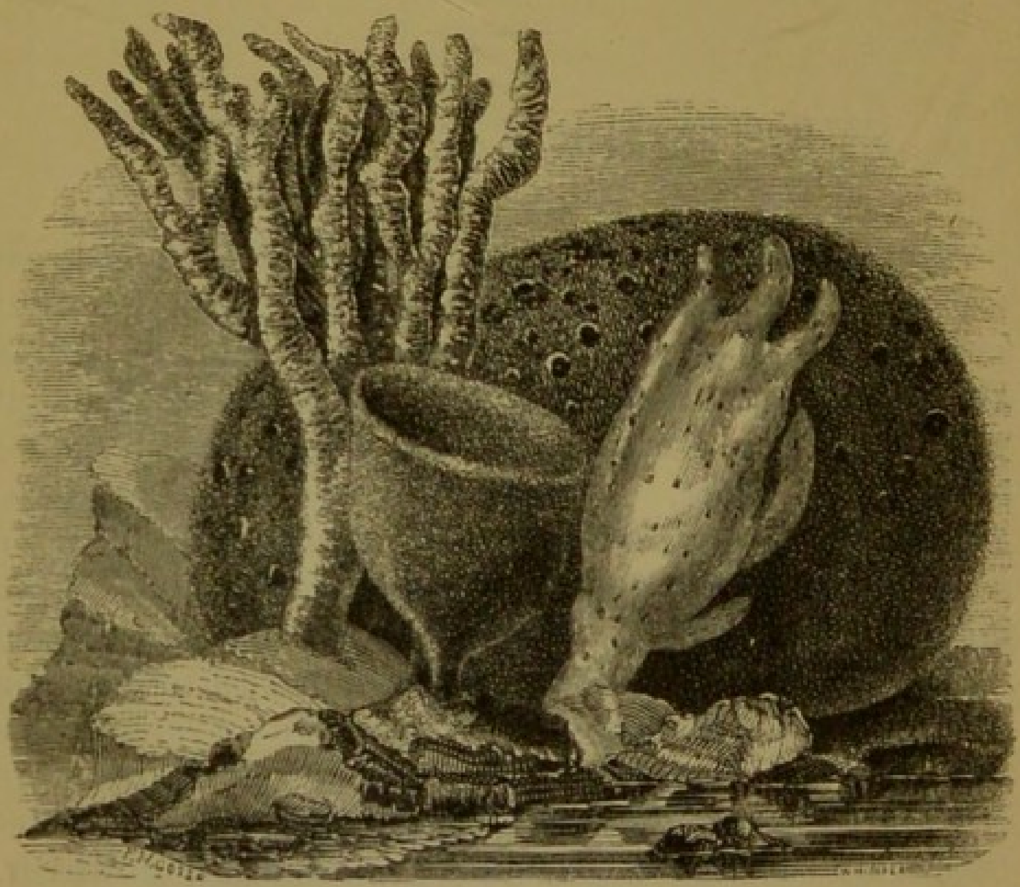
The powers of sensation and of will in animals seem to depend upon the presence of a peculiar substance called *neurine*, or nervous matter, which therefore naturalists consider as the most important portion of the complicated apparatus which makes up a living being. In man and the higher animals, the nervous matter is very distinct, and forms a brain, a main cord, and a multitude of branching threads that pervade every part of their body; and their powers and senses are developed in proportion to this completeness of their nervous system. In the creatures before us, however, the very lowest in the animal scale, the nervous matter cannot be detected by the closest scrutiny; we cannot, however, believe that it is not present, but that it exists in the simplest form; not gathered into masses, nor even into threads, but probably diffused in imperceptible atoms through the whole of their very simple structure. Hence they possess no muscles, nor any organs of sense; though some of them display considerable energy, power of motion, and the lowest kind of sensation,—feeling. They are for the most part mere stomachs, or bags formed of jelly-like substance, endowed with the power of digestion, or of converting other matters into their own substance.

* This word signifies "undiscerning," and refers to the supposed absence (or at least the low degree) of sensation in these animals.

13

CLASS I. PORIFERA.*

(*Sponges*).

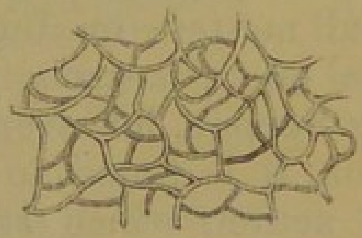


SPONGES.

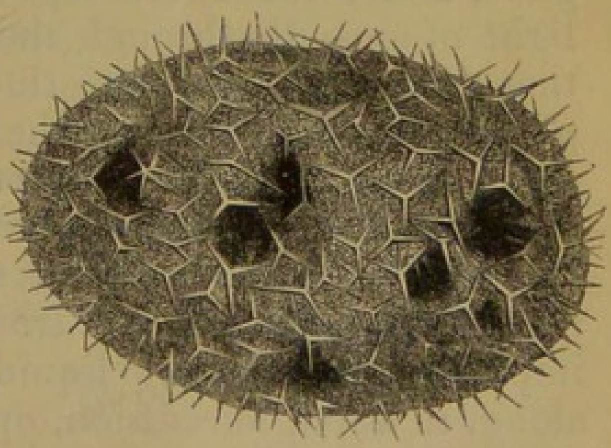
Every one is familiar with Sponge,—with its softness, its elasticity, its capability of absorbing and retaining fluids, and other qualities which render it so valuable in domestic economy. And yet how few are aware that it is the skeleton of an animal! In fact, Sponge is one of those dubious forms which have been placed, in the system of Creation, on the confines of the two great divisions of organic beings, apparently having little in common with either. The Sponges have afforded occasion for much controversy as to their proper position, but they are now almost

* That is, creatures furnished with "pores or orifices."

unanimously assigned to the animal kingdom. The common Sponge employed for household purposes (*Spongia officinalis*) is a native of the Mediterranean, but is much more familiar to us than our native species, of which there are many. The appearance which it presents is that of an irregularly-shaped mass, more or less rounded, composed of a brown woolly substance perforated by innumerable pores in all directions; and having, in addition, wide canals communicating with each other, and terminating in round holes or mouths on the surface. But if we take a small portion of its substance, and place it under a common magnifying glass, we shall see that it is composed of shining, horny, nearly transparent fibres, which, by uniting with each other at all angles and distances, form a loose and very irregular network. In a living state, every fibre was inclosed in a coating of thin clear jelly, which formed the living animal, the horny fibres constituting, as we have intimated above, only the skeleton. Imbedded in the substance of many species, some British ones for example, are found *spiculæ*, or needle-like crystals, of pure flint, varying much in shape in various kinds; while other species have similar crystals of lime. Where these occur in considerable numbers, the Sponge does not possess elasticity; it may be crushed, but it will not regain its original form. It is a singular fact, that Sponges of these three different kinds are sometimes found



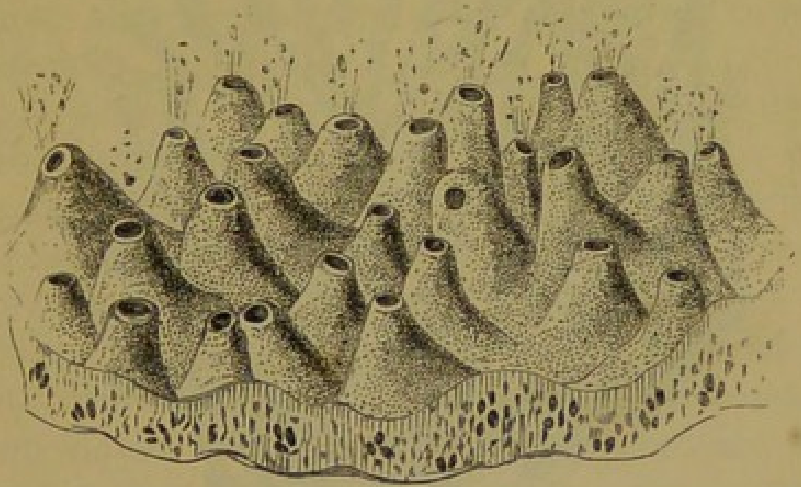
FIBRES OF SPONGE.



FLINT-CRYSTALS OF SPONGE.

growing close to each other, and all alike nourished by the same simple fluid, pure sea-water; yet they elaborate therefrom products so different as horn, flint, and lime. The animal nature of Sponges is not easily to be detected: no indication of sensation has ever been perceived in them when living, even though violence in many modes has been offered to them; though beaten, pinched with hot irons, cut or torn, or subjected to the action of the strongest acids. The substance may be destroyed, but there is no contraction, nor the slightest evidence of feeling; to all appearance they are as passive as the rock on which they grow. One proof of their animality, however, is open to any one: we are all familiar with a peculiar smell produced when horn, wool, feathers, &c., are burned; this smell arises from the presence of *ammonia*, and is peculiar to animal matter; on burning a bit of Sponge, this animal odour is strongly perceptible. On viewing a living Sponge, however, in water, with care and attention, it is found to exhibit a constant and energetic action, which sufficiently shows its vitality. Dr. Grant's account of his discovery of this motion in a native species, is very interesting.

"I put a small branch," he observes, "of the *Spongia coalita*, with some sea-water, into a watch-glass, under the microscope; and, on reflecting the light of a candle through the fluid, I soon perceived that there was some intestine motion in the opaque particles floating through the water. On moving the watch-glass, so as to bring one of the apertures on the side of the Sponge fully into view, I beheld, for the first time, the splendid spectacle of this living fountain vomiting forth from a circular cavity an impetuous torrent of liquid matter, and hurling along, in rapid succession, opaque masses, which it strewed everywhere around. The beauty and novelty of such a scene in the animal kingdom long arrested my attention, but after twenty-five minutes of constant observation, I was obliged to withdraw my eye from fatigue, without having seen the torrent for one instant change its direction, or diminish in the slightest degree the rapidity of its course. I continued to watch the same orifice, at short intervals, for five hours, sometimes observing it for a quarter of an hour at a time; but still the stream rolled on with a constant and equal velocity."*

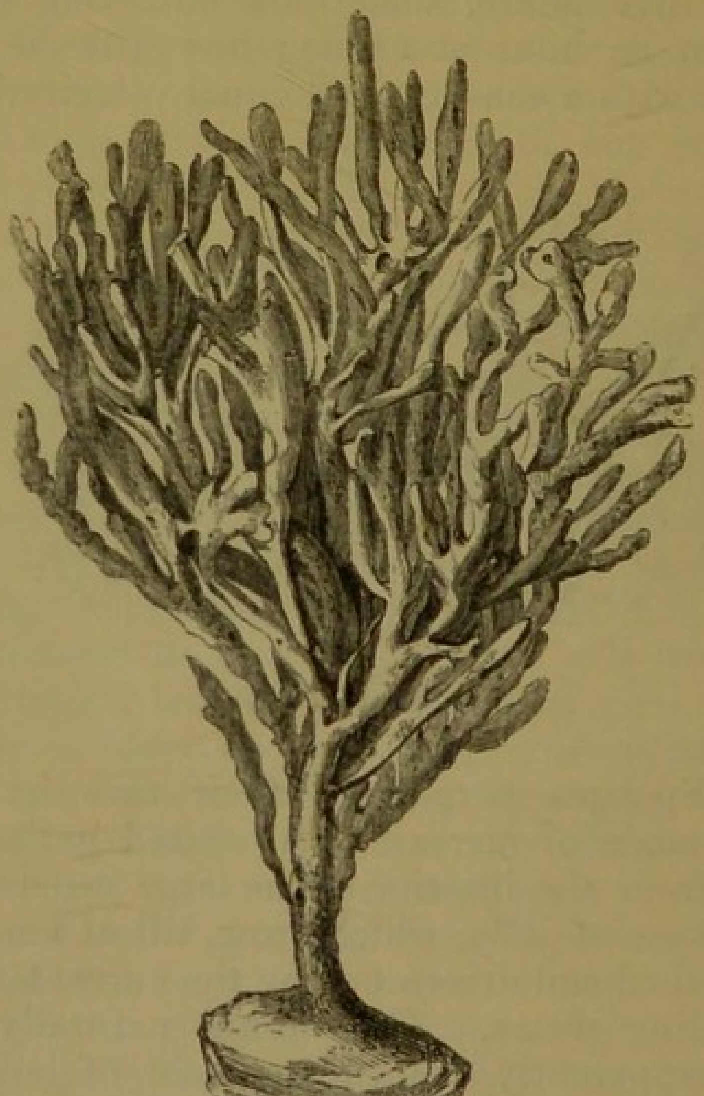


SPONGE IN ACTION.

The Sponges perpetuate their race by a very curious mode of increase. At stated periods there project from the interior of the large canals minute oval masses of jelly, which grow, till at length they are detached and driven out by the current into the surrounding water. One would naturally expect that so apparently helpless an atom of jelly would fall at once to the bottom; but in such a case, how could the species be dispersed? In fact, however, we behold with wonder a beautiful instance of Providential care, in the endowment of this minute atom of jelly. A power is conferred upon it, which is not possessed by the parent Sponge; for whereas that is firmly rooted to the bottom, incapable of changing its place, the little germ is able to swim rapidly through the sea. This is effected by *cilia*, or minute hairs, with which one end of it is beset, which constantly keep up a rapid vibration, and thus row the

* Edin. Phil. Journal, vol. xiii.

germ along until it reaches a distant and suitable spot, where it quietly settles down, becomes widened and flattened, and soon takes the form of a little Sponge.



HALICHONDRIA OCULATA.

Little choice of situation is exercised by Sponges, but they grow wherever the young offset or gemmule happens to drop, whether on the rock, on a shell, or on a sea-weed. If two of the same species, growing side by side, come into contact, their edges unite, and the two form a mass, so perfectly one that the most practised eye could detect no indication of the line of union. On the contrary, if the neighbours be of different species, the edges adhere by contact, but there is no union; and both of the contiguous edges will grow up far beyond their natural level, like walls striving to overtop each other, until the action of the waves prevents the continuance of a mode of growth so unnatural. Dr. Johnston speaks of two species of Sponge, which had become so intermingled in growth, without uniting, that, being of different colours, they presented the appearance of a coloured map.

The variety of appearance exhibited by these curious forms of ainmal life is very great; some of them are singular, and even beautiful. Sometimes they spread out into broad fans; sometimes they are cylindrical, like a thick stick; sometimes branching, like a tree; sometimes tubular, like a rain-spout; and sometimes divided into fingers, like a human hand. One of the most pleasing forms is that of a cup with a broad foot; this is presented by one of our native species, which is about as large as a tea-cup, but more funnel-shaped, whence its name, *Halichondria infundibuliformis*. The same form occurs also in several foreign species.

Sponges are found in most seas; those which are used with us come principally from the isles of Greece, where the procuring of them forms an important branch of industry.

CLASS II. POLYPIFERA.*

Some of the simplest of these forms manifest very little more of the appearance of animal life than the Sponges; but others are much more decidedly and obviously animals, having the power of digestion, of voluntary motion (both of their separate parts and from place to place), and of sensation. Their structure is very simple, consisting of merely an uniform jelly, more firm in some species than in others, having a cavity hollowed in its substance, which constitutes a stomach. The great majority are supported upon a stony skeleton, which is gradually secreted by the jelly-like body; many individuals exist together, on a common stony centre, inhabiting numberless orifices of varying forms on its surface. Others are free, and subsist in solitude and independence, like higher animals, each caring for itself alone, and depositing no stony centre.

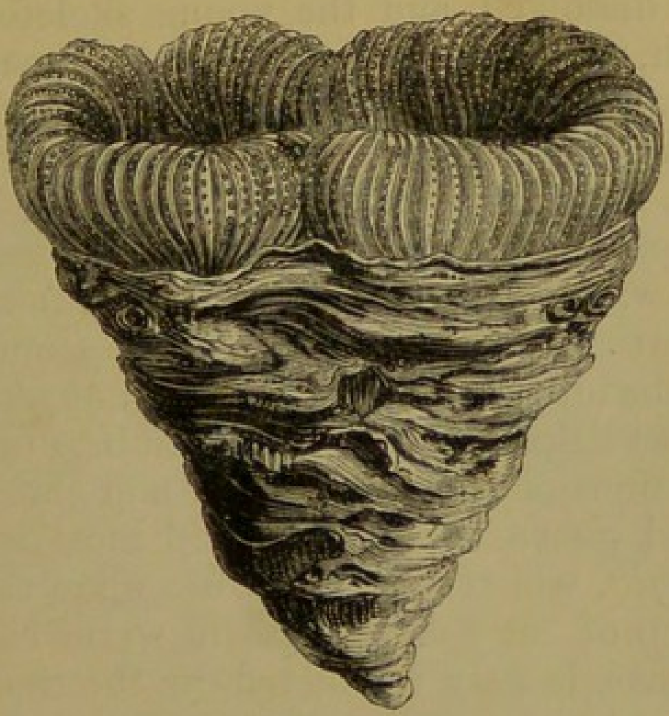
The number of these animals is immense; they all inhabit the waters, especially the sea: the ocean in the tropics is swarming with them in the most diversified forms, many of which are of great beauty. Many of them resemble brilliant flowers in their forms and colours, and hence they are often called animal flowers, and zoophytes, or animal plants. We can give our readers a notion of only a few specimens of this numerous array.

* This word means "polype-bearing," and principally describes the *corals*, and similar structures, which support many apparently independent *polypes*; the latter word signifies *many-footed*, in allusion to the feet or arms which in most of these animals radiate from the centre.

ORDER I. MADREPHYLLIA.*

(Mushroom-corals.)

Those who have visited any museum of Natural History must have observed and admired many masses of stony substance of singular beauty, the upper surface of which forms a multitude of thin vertical plates, set round a common centre, very much like the gills of a mushroom or fungus. These



FUNGIA.

are the skeletons of the simplest kind of Polypes, but little removed above the Sponges in the scale of life. While living beneath the surface of the sea, every one of these thin plates is overspread with a thin glairy film, which constitutes the animal. There are in it no perceptible canals, nor cells, nor mouths; and therefore we suppose that the nutriment which supports its existence and supplies its growth must be absorbed from the surrounding water through the whole surface. As it grows, it deposits, atom by

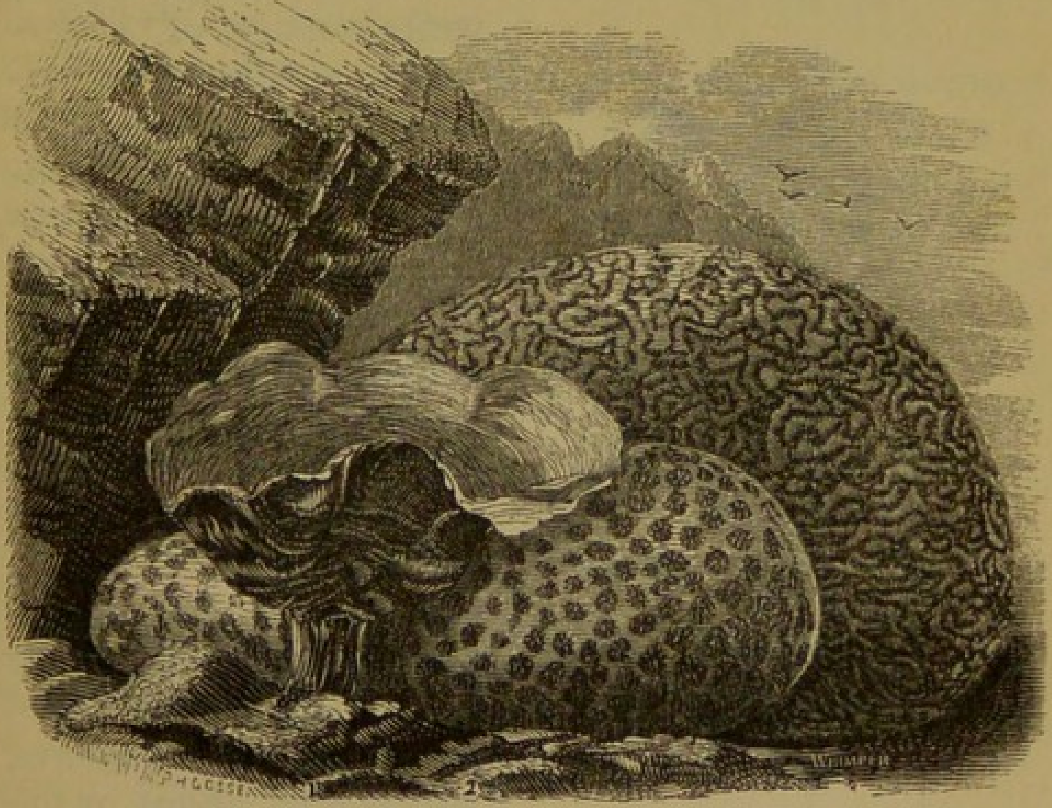
* The word signifies "water-leaves," and probably alludes to the leaf-like structure of these marine productions.

atom, the beautifully regular and delicate partitions of stone which excite our admiration in these ornaments of our cabinets. It has been commonly supposed that the stony framework, when once deposited, is absolutely dead; but the contrary seems to be proved by the following fact:—the young animal, which shoots forth from the parent as a little jelly-like bud, gradually deposits a stony skeleton of a mushroom form, which is attached firmly by its foot to the original skeleton. In process of growth the union is dissolved, and the young skeleton thrown off; which, it is presumed, could not be done without a living power existing in the stone. It is by no means certain, however, that a film of jelly of extreme thinness does not subsist between the foot of the young and the parent skeleton, even at their firmest junction; by whose action the former might be thrown off without the presence of life in the stone.

"It is beautiful to observe in this, apparently one of the most helpless and useless members of creation, the operations of the same power and foresight that shield and guard the highest and most intelligent. The *Fungia*, whilst it is alive, lies upon the sand at the bottom of the shallow seas of warm climates, or has its base loosely imbedded in the sand. It is unattached by any pedicle or root, so that a passing wave of any violence might easily take it up, and wash it to a distance from the spot it originally occupied. This being the case, what is to prevent the wave from turning it upside down? It is only upon the upper surface that the living crust is spread which forms the *Fungia*, so that, should accident reverse its position, the creature would inevitably perish. The arrangement adopted to prevent such an occurrence is simple enough, but not on that account less beautiful. The living film that coats its laminated surface has the faculty of secreting little bubbles of air within its substance; the bubbles so produced, although disseminated, as it were, at random, are sufficiently buoyant to act as floats;

and, thus provided, let the wave wash it ever so far, still the lightest side keeps uppermost, the floats prevent it from being reversed, and the creature settles down again in a right position upon the smooth bottom of the sea."*

The large rounded Madrepores, which are commonly called Brainstones, from the resemblance of the sinuous curves on them to those on the surface of the human brain, and one of which is represented in the accompanying engraving, are closely allied to the



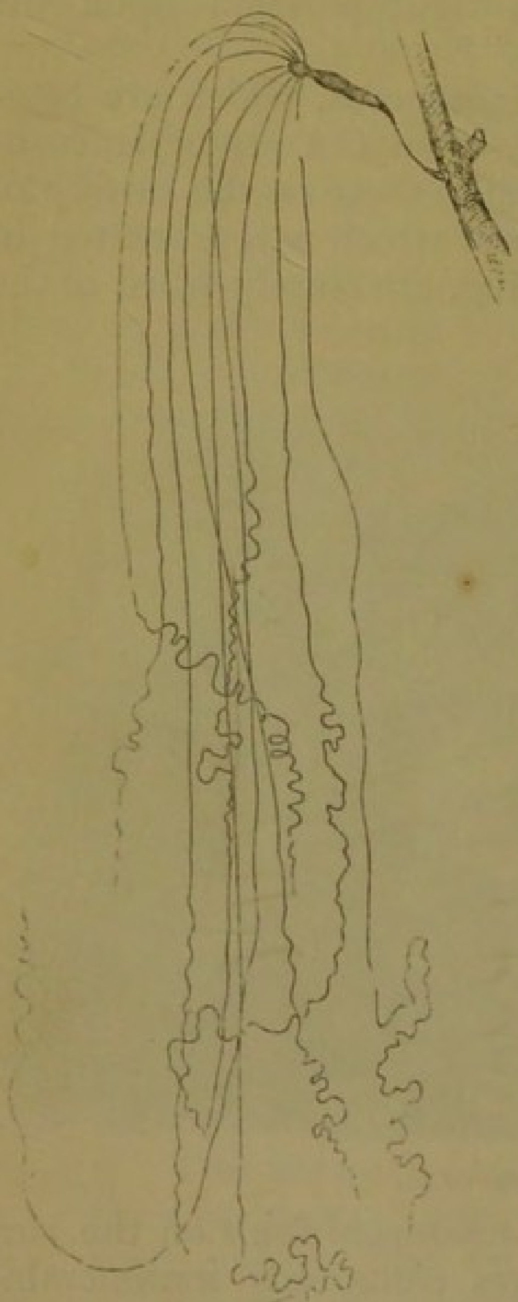
MADREPORES.

Fungiæ. The curiously-contorted folds on the surface are formed by ridges containing innumerable vertical plates, one set facing another, with a narrow fissure separating them. These, too, are covered with a gelatinous film during life, beset with little slender projections, which manifest, by their shrinking when touched, the first signs of sensation that we can appreciate. These threads are the earliest rudiments of *tentacles*, or unjointed limbs, which we shall find in all the subsequent forms of this class.

* Jones's Lectures, p. 26.

ORDER II. HYDROIDA.*

(*Hydras.*)



HYDRA.

If in summer we go to a stagnant pool, and take up a glass of the water, with some of the vegetation that mantles over its surface, we shall find that we have procured many objects well worthy of observation. After the vessel has stood some half an hour or more undisturbed, we shall probably discern in it, among many other living creatures, what look like bits of green semi-transparent thread, about a quarter of an inch long, fastened by one end to the stems of the water-plants, while the other is furnished with several radiating filaments, which float about in the fluid. If we rudely touch one, we find that the filaments first, and then the whole animal, contract, until it is shortened into a little globe, scarcely larger than a pin's head. But if one of the numerous water-fleas that are driving by little rapid jerks through the water, or the

* This term signifies "Hydra-like;" and the appellation *Hydra* is given to these animals in allusion to the fabled monster of that name, which was said to reproduce and multiply its heads as fast as Hercules could cut them off.

grub of a gnat, or a blood-worm, or any other minute animal, come into contact with it, though it touch but the tip of one of the filamentous tentacles, it is retained thereby, nor can all its struggles avail to free it; it is dragged by the contraction of the tentacle within reach of other tentacles, which seize upon it, and finally deposit it within an orifice in the top of the body, in the centre of the radiating arms. Thence it descends into the stomach, which is a simple cavity, occupying the greater part of the body; here it is rapidly digested, and then vomited through the same orifice by which it entered.

The substance of the *Hydra* consists of a number of semi-transparent grains, loosely connected by a glairy matter. During the slow and languid motions which it is capable of performing, these grains are seen to change their place and move freely about among each other. The stomach is a simple bag, formed by the substance of the animal, without any apparent organs. That the structure of these minute animals is, however, more complex than we can discover, may be inferred from the fact of a benumbing shock being apparently communicated to the prey at the moment of contact with a tentacle; which probably arises either from the emission of a poisonous fluid, or the transmission of a current of electricity; either of which supposes a somewhat complex organization.

One of the most interesting circumstances in the history of these animals is their power of reproduction, the discovery of which, about a hundred years ago, completely electrified the scientific world. It is found that the means which would ensure the instant death of most animals, if applied to these, communicates and multiplies life without limit. For, if a *Hydra* be cut into pieces, each individual fragment, however small, will speedily become a perfect animal in all respects like the original; the parts which were defective being produced in their proper situations. If with fine scissors we slit one half-way down, the result will be a *Hydra* with two mouths, each surrounded with the usual number of tentacles; if these be again, and again, and again divided, each division will cause new heads, thus forming a realization of the fable of the Lernean Hydra. Every one of the tentacles of this new-formed monster will capture food, and all the mouths will devour it. But this is not all. They may actually be grafted. If two be cut across, and the fore part of one be applied to the hind part of the other, and slightly pressed to it for a few moments, the two parts will unite, and form a perfect Polype, without leaving a scar. One may be thrust down into the stomach of another, in which condition they will unite and form a Polype, with a double number of tentacles. They may even be turned inside out, like a glove, without injury, and in this state will remain; that which was the external surface now being the stomach, and the contrary. Of course it was not intended by God that the animals before us should be propagated in these artificial modes; but the facts are interesting, because they prove that life is equally diffused throughout the substance, and that each atom is endowed with all the functions necessary to the formation of a complete animal. The ordinary mode of increase is by the young animals budding from the side of the adult, and detaching themselves; but, previously to their separation, they themselves often send out side-buds, so that several generations may sometimes be seen branching from one parent. Trembley has seen nineteen young of various ages growing on one, their numerous long tentacles twining about in inextricable confusion. The young capture prey with their tentacles some time before they are detached from the parent; the food in this case passing through the infant into the maternal stomach. The point of connexion, however, becoming gradually narrowed, the young one at length separates to commence its own independent existence.

There seems at first sight but little resemblance between these *Hydræ*, and the stony masses covered with a gelatinous film which we have described under the name of *Fungia*. Yet we have only to suppose a *Hydra* secreting a central skeleton of calcareous matter, and we have a *Fungia*, some species of which are destitute of tentacles, while others have them rudimentary, and scattered over the expanding film, as we have seen in the Brainstones. But there are higher forms, in which not only is there a calcareous skeleton, covered by a gelatinous film, but also a multitude of hydra-like Polypes, inhabiting cells in the surface of this common mass, and connected in some mysterious phase of life with it and with each other.

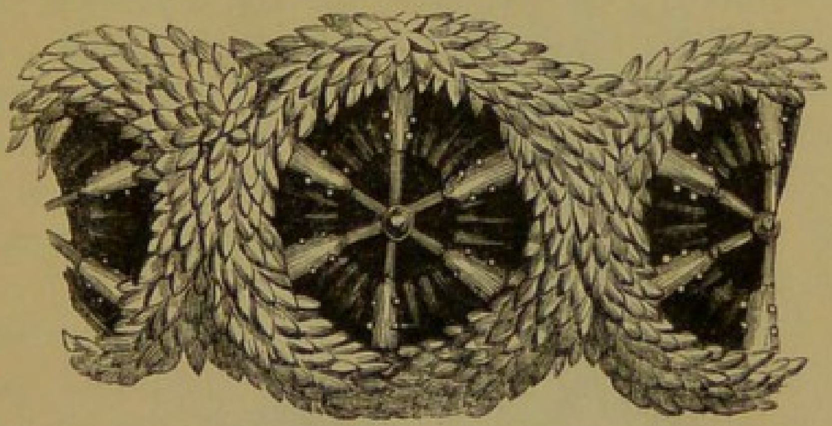
The consideration of these *Polyparies* may well be introduced by a glance at an intermediate series of forms, some of which are not uncommon on our own coasts. The *Alcyoniadæ* deposit no calcareous skeleton, but consist of a thick gelatinous mass, somewhat gristly in texture, the surface of which is inhabited by numerous little Polypes, each with eight tentacles. The central mass, when cut, is found to be intersected by tough fibrous bands, and sometimes contains points and needles of calcareous matter imbedded in its substance; many wide canals are pierced through it in various directions. Thus the *Alcyoniadæ* are regarded as analogous to the Sponges, but differing from them principally by having *Polypes* inhabiting the surface.

Those who are in the habit of searching the sands and shingles that margin our seas, may have often observed leathery teat-shaped bodies cast up by the waves, which the fishermen not unaptly term cow's paps, and, when branching, dead men's fingers. They appear to possess little to invite attention; "but let one of these lumps of jelly be placed in a glass filled with its native element, the sea-water, and watch it there; then, if the spectacle that it offers does not excite the attention of the observer, we apprehend there is nothing in creation that will. The gelatinous mass gradually swells, appears to be imbibing the water in which it is immersed, and as it dilates to a larger and still larger size, assumes

ALCYON.

a transparency that it did not possess before. When fully expanded, little pits or cells appear upon its surface, and from each of these issues forth a living flower, — for such it seems in shape, — a simple Polype, which, gradually expanding till it has attained its full development, reveals itself to be a *Hydra*, fishing for surrounding prey by means of petal-like tentacles placed around its mouth. The food thus obtained having been conveyed into the stomach of the Polype that caught it, and digested there, is absorbed into the general mass of the common body of the *Alcyon*, which in this way derives its nutriment from the numerous sources of supply distributed over its surface."*

We have now only to add to the structure of the *Alcyoniadæ* the deposition of a stony centre, in which the surface-cells are pierced, and we have the Madrepores, the skeletons of which are so highly prized for their beauty. Many of these stony



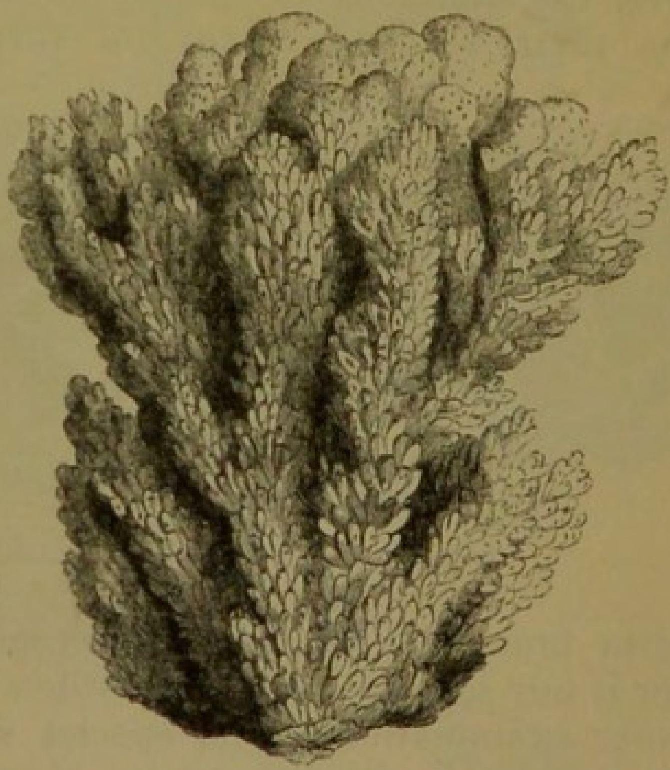
ORIFICE OF MADREPORE.

masses form branching clusters of exceeding elegance; nor is our admiration abated when we institute a closer examination. The species which we here figure is covered with an innumerable multitude of little warts, or projections, which are studded with minute holes, as if made with a pin's point. Under a microscope, each of these small apertures is seen to bear a six-fold division of most elaborate regularity and beauty. During the life of the animal, each of these little cells gave issue or concealment to a still more minute Polype, which protruded its eight arms like a stony flower in search of prey.

The shores of the ocean within the tropics are

* Jones, Lect. on the Nat. Hist. of Anim. 64.

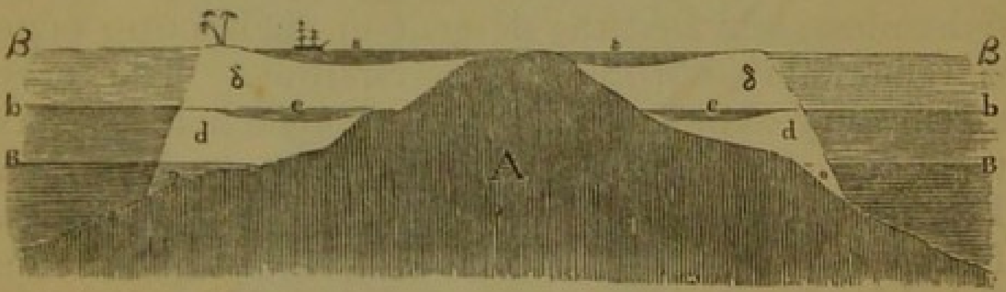
strewn with masses and fragments of these Madrepores, and the sands of the beaches are largely composed of their pulverized atoms. The shallower places of those seas are filled with them, in forms immensely diversified, and in numbers wondrously great, which constitute rocks, reefs, and even clusters of isles inhabited by man. Feeble and apparently insignificant as is the individual Polype of the Madrepore, the countless millions in which the species exists, and the industry with which each one perpetually secretes and deposits its successive



MADREPORE.

atoms on the ever-growing barrier, unite to make it one of the most important agents in the production of mighty changes in the exterior of the globe we inhabit. Some idea of the effects of its workmanship may be formed, when we remember the great extent of the Coral-reefs. One on the coast of Australia is nearly a thousand miles in length, and some of the coral groups in the Pacific Ocean have a length of twelve hundred, and a breadth of three hundred and fifty or four hundred miles.

Until recently, it had been supposed that all the islands of coral formation were reared from their bases, fathomless depths in the ocean, by the unaided efforts of these minute creatures; and from exaggerated notions of the rapidity with which the process was going on, anticipations were frequently uttered that a large portion of the Pacific might, at no very distant period, be occupied by the spreading structures united into a vast coral continent. Later and more accurate observations have, however, satisfactorily proved that the living animals cannot exist at a greater depth than twenty or thirty fathoms, so that the whole of these animal secretions must have been deposited within that distance from the surface. At the same time it is no less true that the water in the immediate vicinity of the islands is fathomless, and that the descent of their outer edge is remarkably abrupt and precipitous. The only satisfactory explanation of the phenomenon appears to be the one proposed and ably supported by Mr. Darwin, in his elaborate treatise on Coral Reefs. Many islands of the common rock formation are found in the Pacific, on the shelving sides of which, a few fathoms below water, the coral animals have fixed their stony habitations, forming what is called a fringing-reef, distinguished from others by being immediately attached to the land, without the intervention of any lagoon or channel of water. Mr. Darwin supposes that every island in the Pacific originally presented this structure, but that wherever a variation at present exists, the solid rock has been gradually, and perhaps very slowly, subsiding to a lower level. Now, let us assume this state of things for a moment, and look at the results. We must, however, mention two well ascertained instincts of the Polype; the one is, that it works up towards the light; the other, that its proceedings are most vigorous at the outer edge, where it is washed by the beating waves. Let A represent the section of a rocky island; B, B, the level of low-water; and D, the reef of coral fringing the coast. After the lapse of time, during which it has been subsiding, the water-level stands at *b*, *b*; the coral at D has died from the too great depth, but the animals have been working upwards upon the dead matter, so that living coral is still near the surface; the superior vigour of the species inhabiting the seaward edge, however, has caused that edge to be more elevated than the interior, as at *d*, *d*; so that the appearance is now that of a rocky isle, diminished in extent, surrounded by a reef at some distance, separated by the intervention of a shallow channel, *e*, *e*; this is exactly the appearance of Tahiti and the larger islands of the Pacific. The subsidence still goes on; and, after a while, the water, β, β, is level with the

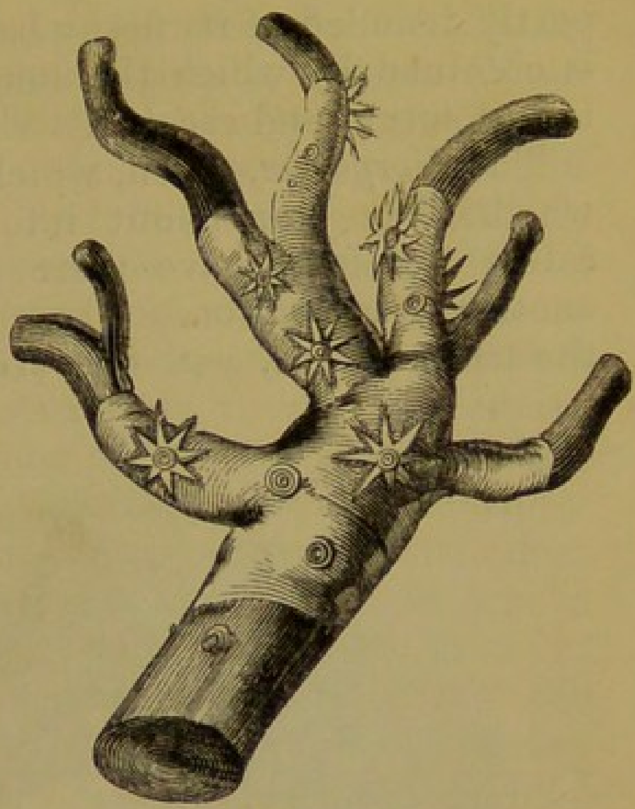


SECTION OF CORAL ISLAND.

summit of the island, which, of course, is now an island no longer; the growth of the coral has kept pace with the depression, and it is still at the surface, as at δ, δ; the more slowly-growing species of the interior are still overflowed, and, as the island is submerged in the centre, the water, ϵ, ϵ, is no longer an annular channel, but a round lagoon; and thus we have that ring-like form of a coral island which is so common in the groups of this formation.

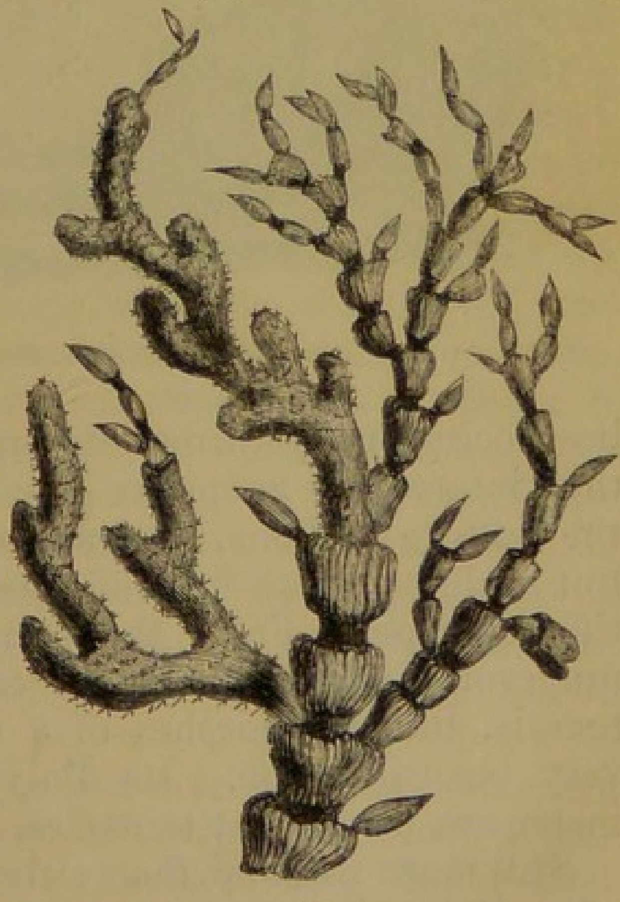
In another family, that of the Corals (*Corallidæ*), the skeleton takes a still more branched form, and may be compared to the boughs and twigs of a tree. The centre or axis, however, is solid, and destitute of cells, which are pierced only in the gelatinous flesh with which it is enveloped.

This is of firmer consistence than in the forms which we have yet considered, and is therefore able to afford the needful shelter to the Polypes that inhabit it. The common Red Coral of the jewellers, is the central stem of one species, of which the hardness and susceptibility of polish, as well as the brilliant scarlet hue are well known.



RED CORAL.

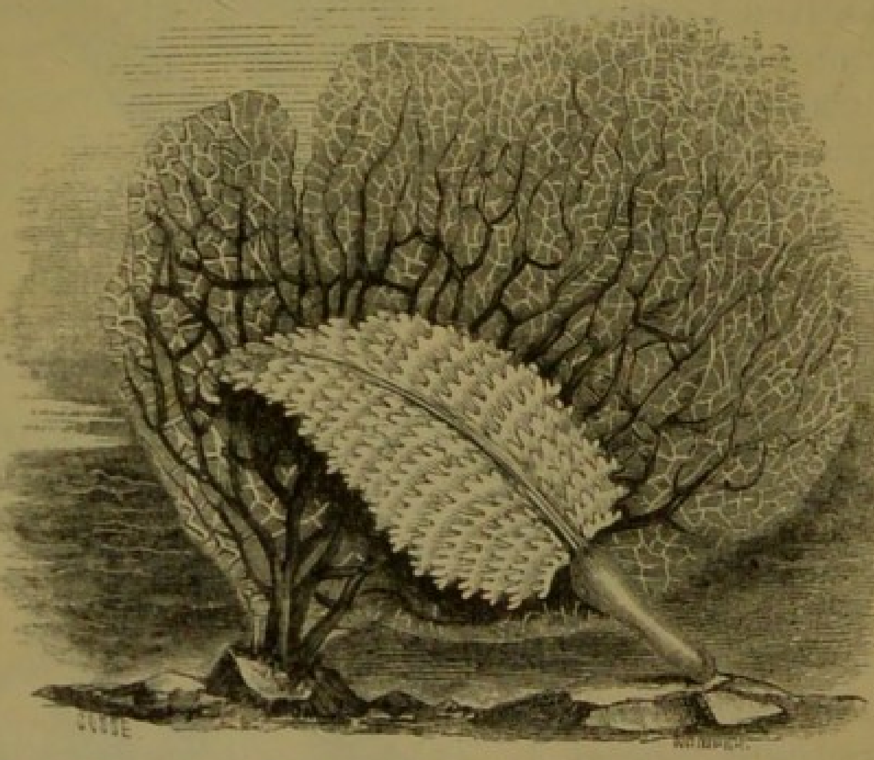
In other genera of this Family, the branches, which in the Red Coral are short and therefore strong, are lengthened to such a degree, that the force of the waves would perpetually break them, if hard and unyielding. The central skeleton, therefore, of these is not formed entirely of stony matter, but, by a beautiful contrivance of Infinite Wisdom, of alternate joints of stony and horny substance, as in the *Isis*, a specimen of which we here represent, partly covered, and



ISIS.

partly denuded of its fleshy bark. Thus a flexibility is obtained by which the long coral branches bend to the surge, and escape its violence.

The *Gorgoniæ*, again, which, from the manner in which they branch out into large flat plates, are called Sea-fans, have their flexibility secured by another modification. The species are numerous in the tropical seas, and one (*Gorgonia flabellum*) has



SEA-FAN AND SEA-PEN.

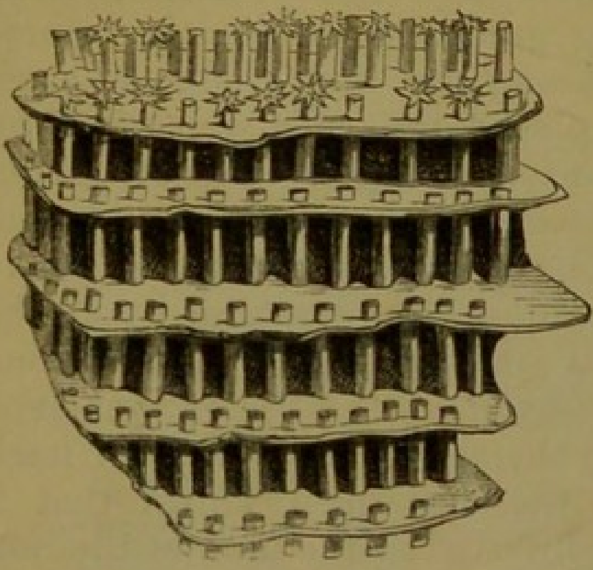
been occasionally thrown up on our own shores. In this interesting zoophyte the skeleton shews more the texture of bone, or perhaps of horn: it is black, but is clothed with flesh of a yellow colour, or sometimes purple. From the ramifications being very numerous, and uniting with each other at short intervals, like the meshes of a net, this species is a very beautiful one. Its Polypes, as in the other instances, have eight tentacles.

Still more singular than either of these is the form of a Polypidom,* often brought up by fishermen

* An aggregation of Polypes is called by this name.

attached to their baits, and by them called Cocks' comb, or, rather more appropriately, Sea-pen (*Pennatula phosphorea*). It very closely resembles a broad feather from two to four inches in length, and of a purplish colour. The lower part is cylindrical, or nearly so, and represents the quill, and the tip of this is tinged with orange. Above this the stem is fringed on each side with very regular, flat, dentated processes, diminishing gradually to the tip, representing the vane. Along the upper edge of each of these *pinnæ* are placed the cells, inhabited by minute, white, eight-rayed Polypes. The stem contains a long, needle-shaped bone, very slender at each extremity, which is bent backwards so as to form a hook. Some authors have affirmed that the Sea-pen swims freely in the sea by the waving motion of its *pinnæ*, but modern observations tend to throw discredit on this statement, which in itself seems improbable: the fishermen affirm that it abides with its stem inserted in the mud at the bottom; and those which have been kept for observation have remained at the bottom of the vessel, without any apparent power of even turning over on the other side. This species, as its scientific name imports, is one of the many animals that inhabit the sea, which are endowed with the faculty of producing light: in this instance, it appears from experiments that the power is exerted as a means of defence, as only when injured or irritated does the animal give out its light, which is of a faint bluish cast. Its sudden illumination at the bottom of the sea may have the effect of terrifying some of its enemies, and of thus protecting it from the dangers to which its otherwise helpless frame would be exposed.

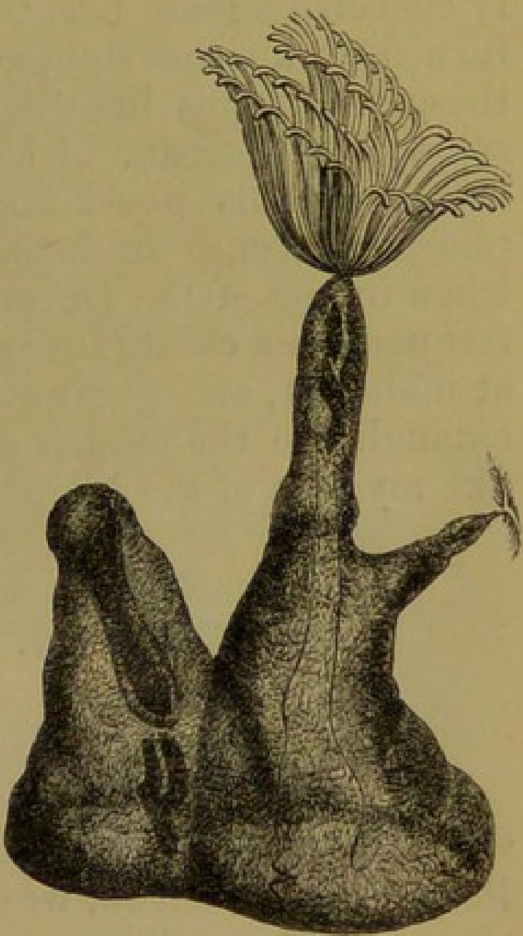
But we have not yet done with the singular and beautiful forms assumed by the Hydroid Polypes. Hitherto we have seen the solid part, either stony or horny, which we call the skeleton, deposited within the flesh, but there are many genera in which it forms a protecting covering to the gelatinous Polypes. The elegant aggregation of tubes called Organ-pipe Coral (*Tubipora musica*) is an example of this Family. It consists of an immense number of small cylindrical tubes of a rich crimson hue, placed nearly parallel, but at a short distance apart, and united at regular distances by successive stages or horizontal plates, which divide the series into ranges or stories, like the different floors of a house, supported by many pillars. From the mouth of each tube, in the living state, projected the eight tentacles of a starry Polype of a brilliant green colour, forming a fine contrast with the crimson hue of the tubes. Its protrusion is produced by a turning inside out, as it were, of its own substance, as we draw off a stocking, the tentacles being surrounded at their base by an invertible membrane, which is continuous with the stony tube. The latter is, in fact, gradually formed by the hardening of the flesh, in the substance of which the calcareous particles are deposited. At regular intervals the flesh of each, all at the same time, expands horizontally, and thus forms the thin plate or transverse stage which unites and consolidates the whole aggregated structure.



ORGAN-PIPE.

We need not, however, roam to the Indian seas for an example of tubular Polypes. Our own fresh waters afford us species of exquisite delicacy and beauty. On the inferior surface of the floating leaves of the water-lily, growing in clear running streams, may be found a species, the elegance of whose appearance cannot readily be surpassed, the

Plume Polype (*Plumatella cristata*). It is too small to be observed unless carefully looked for; but, under a microscope, it will afford a rich treat to the admiring students of nature. We have taken it in the neighbourhood of London, as for instance in a small pond at Lower Clapton. If one be taken alive, and put into a little clear water in a watch-glass, it will presently exhibit the appearance represented in the figure. These Polypes live in colonies of a dozen or twenty, inhabiting a sort of cup, sufficiently transparent to reveal the organs and motions of the inhabitants. The Polype is capable of entire retraction within its cup; but, when protruded, its numerous tentacles, each of which has a double curve, are arranged in the form of a horse-shoe, constituting a very elegant plume, as if formed of fine threads of glass. The mouth is in the centre of the tentacles, and communicates with a stomach, whence the remains of the food are rejected by another passage. The secretion of the horny case or cup is a process analogous to the production of the tube in the Organ-pipe; but the little *Plumatella* is not more than a quarter of an inch in length, even when the plume of tentacles is fully protruded.



PLUMATELLA.

Though the *Plumatella* is a fresh-water species, the great majority of the tubular Polypes are marine, and many are to be found on our rocky shores, inhabiting the tiny pools left by the tide, or adhering to the stems of sea-weeds. Mr. A. H. Hassall, who has paid much attention to this class of animals, has ascertained that all the transparent zoophytes are highly luminous. "Imagination," he observes, "can scarcely conceive a more beautiful spectacle than would be furnished by the shining of countless myriads of these tiny lamps lighting up the dark recesses and caves of the ocean. I had lately an opportunity of beholding this novel and interesting sight of the phosphorescence of zoophytes to great advantage, when in one of the Devonshire trawling-boats which frequent this coast (Ireland). The trawl was raised at midnight, and great quantities of corallines were entangled in the meshes of the net-work, all shining like myriads of the brightest diamonds."*

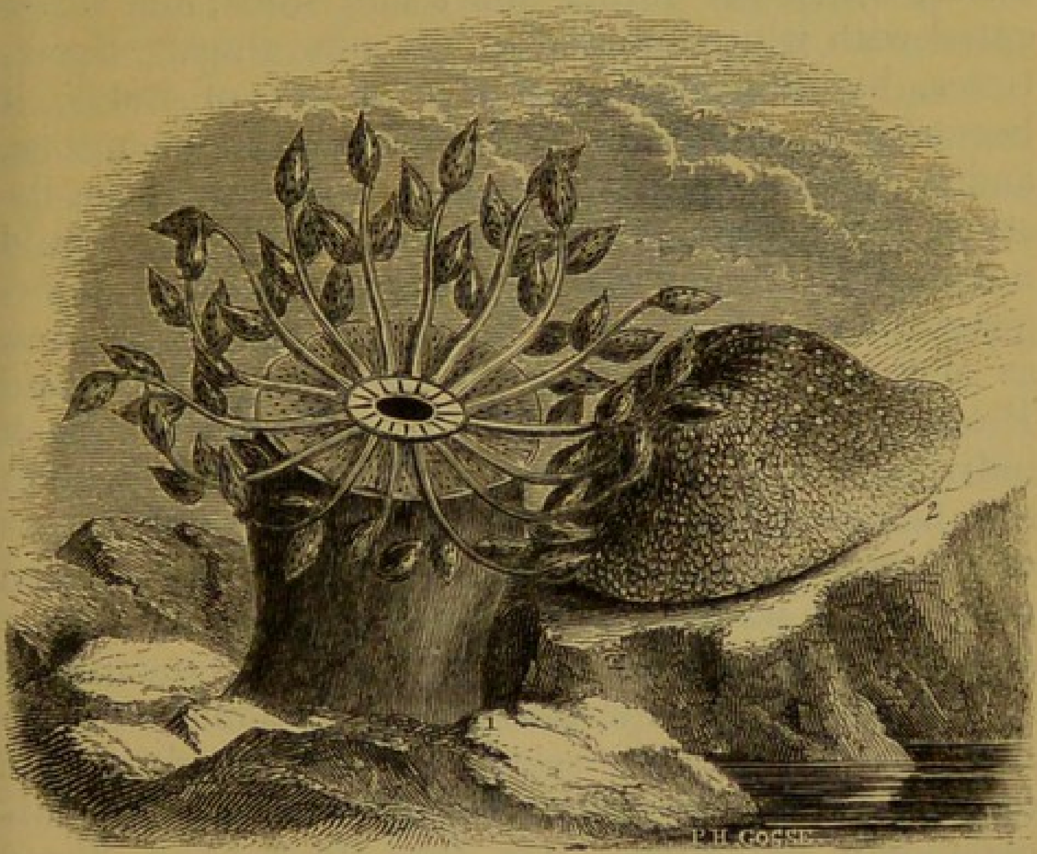
ORDER III. ZOANTHA.

(*Animal Flowers.*)

In the animals which we are now about to consider, while the general form and structure of the hydroid Polyps are preserved, we find an organization much more complex. The tentacles are very numerous, set in several circles around a disc, and when expanded, being often of gay colours, so much resemble composite flowers (such as the Daisy, the Marigold, the Aster, &c.) as to have given their names to different species, and the term "animal flowers" to the whole Order. When expanded and viewed laterally, the form is that of a short, broad pillar, with the tentacles radiating from the upper margin, the base being somewhat dilated; but when the absence of light or of water, or any other cause, induces repose, the tentacles contract, and the upper part of the body, by a partial inversion, closes over them, leaving no trace of the place where they disappeared but a wrinkled depression in the centre. The shape is

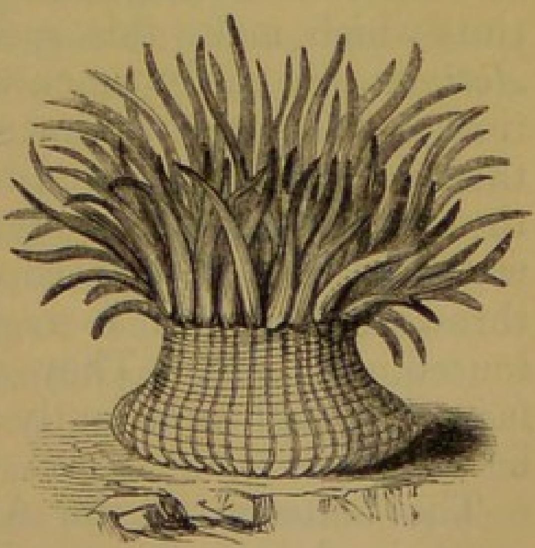
* Ann. and Mag. of Nat. Hist., June, 1841.

then more or less like that of a bell, as may be seen in the right-hand figure (marked 2) of the accompanying



ANIMAL FLOWERS: 1. *Actinia Alcyonoides*; 2. *A. Gemmacea.*

engraving, which represents one of our native species, *Actinia gemmacea.* This is a very beautiful example of the tribe, and is not at all uncommon on rocky shores, adhering to stones at low-water. When in a state of repose, its form is rounded or oval, often somewhat flattened, rarely exceeding an inch and a half in diameter, very variable in colour: sometimes being of a brilliant scarlet with pale warts, like rows of ornamental beads; at other times it is of a sulphur yellow, or pale green, with stripes of orange colour; and we have seen specimens of



EXPANDED ACTINIA.

a lively rose-pink, studded with green dots. When expanded, it displays three or four circles of tentacles, which are rather short and thick, and variegated with white and red in alternate rings. Sometimes, by imbibing a large quantity of water, it becomes distended to twice its usual dimensions, and is then nearly transparent. There is an instinct displayed by this species, which one would not expect to find in a creature of so low an organization, and which is worthy of our admiration, as showing how mindful the gracious Creator and Preserver is of His creatures' well-being. Such individuals as have taken up their residence upon the half-submerged rocks, where the daily recess of the tide exposes them to observation, are covered with rough warts, and blotched with dusky brown and dull orange, and coated with fragments of shells, sea-weed, and gravel, which adhere to the skin, by a glutinous secretion, so strongly as not to be washed off; and being thus veiled, the animals defy detection. On the other hand, those specimens which live in deep water, as if aware that the necessity for concealment no longer exists, have nothing of the kind; their skins are smooth and naked, and adorned with the vivid tints which make this species so beautiful. These *Actiniæ* are easily procured, and kept alive a long time in sea-water without difficulty; in a glass vessel their beauty is displayed to advantage, needing only the precaution of supplying them with pure sea-water every two or three days at most, or they will throw off their skin in ragged pieces, become discoloured, and die. They are capable of very long fasts, although sufficiently voracious when food is to be obtained.

The tentacles of the Animal-flowers are not always simple: in the species represented on the left hand of our engraving (p. 27), marked 1, they are much more complex. This large and beautiful species is named *Actinia alcyonoides*, and is a native of the South Pacific. The thick pillar-like body terminates in a circular green disc, spotted with shades of deeper green, and having an orifice in the centre of vivid rose-colour. Sixteen long tentacles radiate from the margin, which bear at their tips and on their sides fleshy knobs, covered with minute suckers, "by which the sensitive, the prehensile, and the respiratory surface of this remarkable zoophyte is greatly increased, and it is better enabled to perceive and to grasp larger prey floating or swimming freely through the sea."

The flesh of the ZOANTHA is not so soft and jelly-like as that of the *Hydræ*, but exhibits indubitable traces of muscular fibre, and their motions are marked by corresponding strength and energy. The power with which one of the tentacles will adhere to the human finger, if brought into momentary contact with it, is very remarkable, requiring considerable force to draw it away.

The stomach in these animals is very capacious, forming a large sac in the centre of the body; between this and the walls of the body there is a hollow space, communicating with the interior of the tentacles, which also are hollow. The *Actinia* has the power of forcing the sea-water from the stomach into this cavity, thus enlarging and filling it, and distending the tentacles, which are then fleshy tubes containing water. When the animal would become inactive, it forcibly contracts the tentacles by muscular effort, forcing the water partly in minute jets through orifices at their tips, and partly back into the cavity of the body. The water thus freely bathing the interior of the animal, is probably used in respiration.

Like the *Hydræ*, the *Actiniæ* can be increased by the division of one into many pieces; each fragment soon forming the portions which are wanting to it, and becoming a perfect animal. The ordinary mode of reproduction, however, is by minute germs, or ova, which in dense clusters are contained within the cavity just described, whence they find their way into the stomach by some minute orifices, and after remaining a while there, are at length discharged through the mouth into the sea, perfect, though small, *Actiniæ*.

CLASS III. POLYGASTRICA.*

(*Infusory Animalcules.*)

As the telescope enables the eye of man to penetrate into far distant space, and reveals to him myriads of suns and systems which otherwise would have remained for ever hidden from his natural sight, so the microscope opens up a world of life everywhere around us, but altogether unsuspected, astounding us as much by the inappreciable minuteness of its discoveries, as the former by the stupendous magnitude and remoteness of the objects. If we go to any ditch or pool which the summer sun has covered with a mantle of stagnant greenness, and lift from it a minute drop of water, such as would adhere to the head of a pin, we shall find it, under a high magnifying power, swarming with living beings, moving about with great rapidity, and approaching or avoiding each other with evident perception and will.

"Vain would it be," observes Professor Jones, "to attempt by words to give anything like a definite notion of the minuteness of some of these multitudinous races. Let me ask the reader to divide an inch into 22,000 parts, and appreciate mentally the value of each division: having done so, and not till then, shall we have a standard sufficiently minute to enable us to measure the microscopic beings, upon the consideration of which we are now entering.

"Neither is it easy to give the student of nature, who has not accurately investigated the subject for himself, adequate conceptions relative to the num-

* Animals furnished with "many stomachs."

bers in which the *Infusoria* sometimes crowd the waters they frequent; but let him take his microscope, and the means of making a rough estimate, at least, are easily at his disposal. He will soon perceive that the animalcule-inhabitants of a drop of putrid water, possessing, as many of them do, dimensions not larger than the 2000th part of a line, swim so close together, that the intervals separating them are not greater than their own bodies. The matter, therefore, becomes a question for arithmetic to solve, and we will pause to make the calculation.

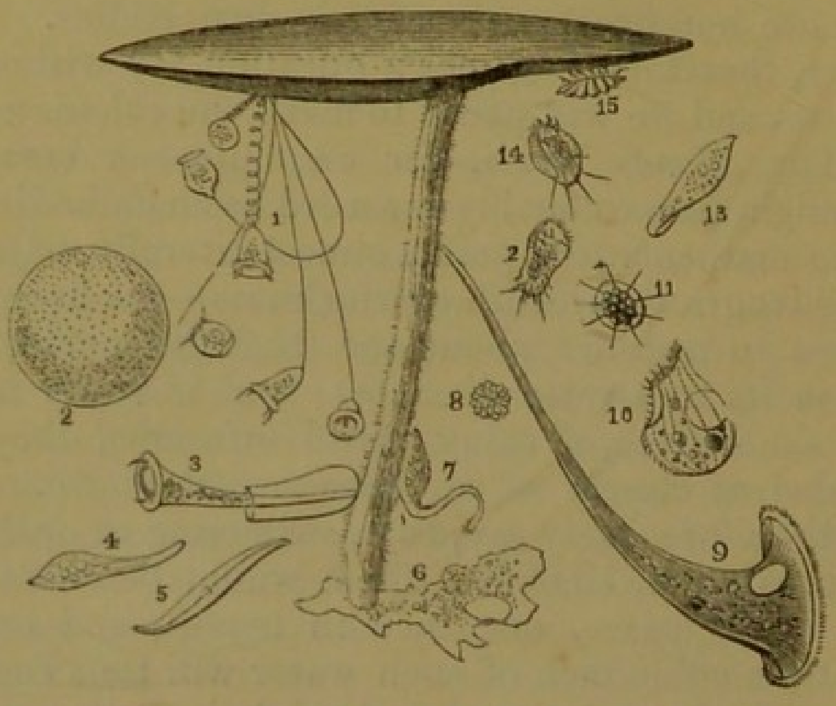
"The *Monas termo*, for example,—a creature that might be pardonably regarded as an embodiment of the mathematical point, almost literally without either length or breadth or thickness—has been calculated to measure about the 22,000th part of an inch in its transverse diameter; and in water taken from the surface of many putrid infusions, they are crowded as closely as we have stated above. We may therefore safely say, that, swimming at ordinary distances apart, 10,000 of them would be contained in a linear space, one inch in length, and consequently a cubic inch of such water will thus contain more living and active organized beings than there are human inhabitants upon the whole surface! However astounding such a fact may seem when first enunciated, none is more easily demonstrated with the assistance of a good microscope."*

The term *Infusoria* has been by some naturalists applied to these diminutive animals, because they are invariably found in the infusions of vegetable or animal substances. They can thus be obtained at all times, by simply steeping a little hay, or chaff, or leaves or stems of any plant in a vessel of water, and placing the infusion in the sun for a week or ten days.

The variety of form exhibited by these animalcules is immense; and most of them are totally unlike what we see in any other part of the animate

* Lect. on the Nat. Hist. of Anim. 99.

creation. They differ greatly also in the complexity of their structure; some displaying a much more elaborate organization than others. They agree, however, in the possession of numerous cells within the body, communicating with each other, which Professor Ehrenberg considers to be so many stomachs, but which Professor Jones supposes to be receptacles for

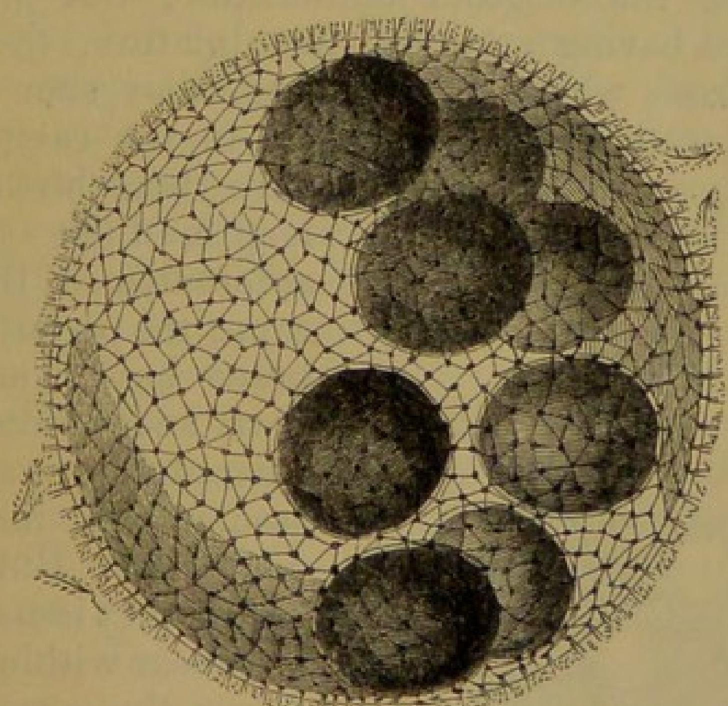


POLYGASTRICA ON A LEAF OF DUCKWEED.
Highly Magnified.

1. *Vorticella convallaria.*
2. *Volvox globator.*
3. *Vaginicola crystallina.*
4. *Amphileptus fasciola.*
5. *Navicula hippocampus.*
6. *Amœba diffluens.*
7. *Trachelocerca olor.*
8. *Polytoma uvella.*
9. *Stentor polymorphus.*
10. *Bursaria truncatella.*
11. *Pandorina morum.*
12. *Stylonychia mytilus.*
13. *Paramecium aurelia.*
14. *Euplotes truncatus.*
15. *Euplotes striatus.*

the digested food, but not properly digestive organs. Many of them are set with *cilia*, that is, short filaments of extreme delicacy and fineness, set in rows or circular series, each of which is endowed with the power of ceaseless motion, and all of which acting in concert, either row the animal rapidly through the water, or, by producing a current, perpetually bring food to the mouth.

The smallest forms of animal life which have yet been detected, are the *Monads*. The most powerful microscopes do little more than exhibit them as moving points; but sometimes one of superior size enables the observer to catch a glimpse of its structure. The *Monas termo* is then seen to have a little filament resembling a tail, and to have within its body several dots, already alluded to as supposed to be stomachs. The mode by which Ehrenberg detected the presence and the character of these internal cavities was very ingenious. Having kept his *Monads* some time fasting in very clear water, he put some into water tinged with carmine, and others into that mixed with indigo. The result was, that very soon there appeared in the translucency of the little animal the dots in question,—in the one case of a crimson, in the other of a blue colour.

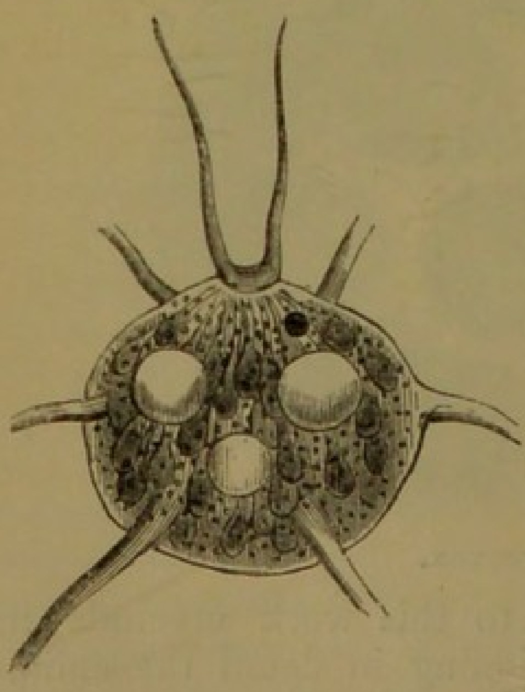


VOLVOX.

The limits assigned to this work preclude the possibility of our mentioning in detail the endless variety found in these atoms of existence; as a specimen we shall quote Professor Jones's interesting description of the *Volvox globator*, one of the most beautiful and wonderful of the whole.

"In shape it seems a microscopic globe, rotating slowly on its own axis,—a tiny world rolling majestically through the little quantity of water that forms its space, guided by some unseen and innate power. More accurately examined, we perceive the body to be formed of a transparent spherical membrane, studded with small green dots, and having all its surface covered over with vibrating hairs of infinite minuteness, which produce currents in the surrounding water, and thus cause the revolution of the globe, as well as its progression.

"The cavity of this most elegant transparent sphere is filled with fluid, and within are seen young *volvoces* rolling round and round in the interior of their parent—wheels within wheels. When first perceived, these young were merely opaque greenish spots, that sprouted forth like buds from the inner surface of the original animalcule; but growing larger, and having attained, in miniature, the form of that from which they sprang, they soon break loose and roll about imprisoned in the cavity that gave them birth. At length, their growth accomplished, they escape; the parent membrane bursts, and out they swim into the surrounding water to assume an independent life. But even before they issue forth, they bear within themselves the germs of a third race, destined in like manner to terminate by their liberation the existence of their parents.



MONADS OF VOLVOX.

"But the circumstances above narrated, connected with the history of the *Volvox*, form but a small portion of the wonders revealed to us in the economy of these amazing animals. If a small portion of the spotted film that surrounds, or rather forms, the body of the animalcule be examined under more intense magnifying powers, every speck that dots its surface is perceived to be a perfectly-formed animal—a *Monad;* so that the envelop of the *Volvoces* is but an assemblage of *Monads,* united into one community by the intervention of a sphere-shaped membrane; and the cilia distributed over the surface of its exterior are the protruded mouths, or proboscides, of the individual component animals, all of which co-operate in giving the movements of rotation and progression to the globular mass of aggregated beings." *

The form of the *Monads*, which compose this compound animalcule is represented in the above engraving, very highly magnified, displaying its own complexity of organs. The tentacles, proboscides, or cilia, project from the upper part; the numerous stomachs are seen connected with the upper part, where the mouth is situated; three spherical bags, having a contractile power, are placed among them; a red speck, near the base of the tentacles, is supposed to be an eye; and, finally, the six projecting filaments are portions of the threads which connect each *Monad* with those that surround it in the sphere. "How can we express our wonder at a scene like this! An atom, almost imperceptible to unassisted vision, is composed of multitudes of beings, every one so complex in its structure as to be beyond the reach of our philosophy to understand!"†

* Lect. on the Nat. Hist. of Anim. 123. † Id. 125.

CLASS IV. ACALEPHÆ.*

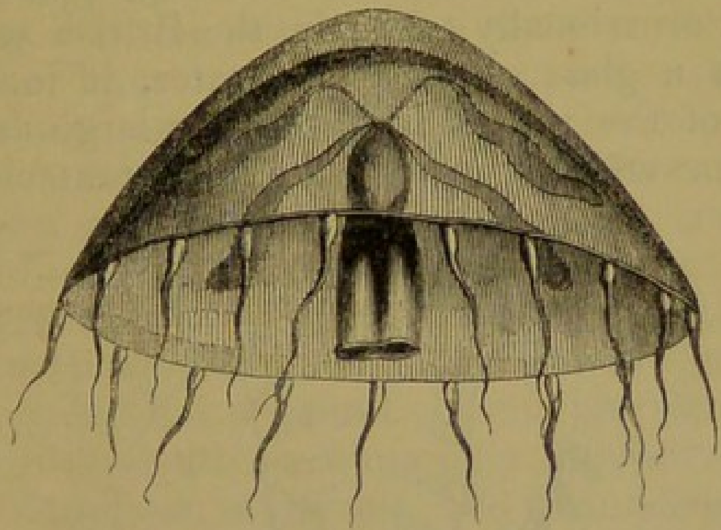
(*Sea-blubbers.*)

Any one who has been in the habit of walking along the line where the sparkling waves ripple up and break on the sandy beach, must often have seen cast up objects of various dimensions, presenting the appearance of rounded masses of the softest and most translucent jelly. They lie on the sand without motion; if we attempt to take them up, our fingers break in every direction through the soft but heavy mass; and if we leave them alone, and after a short time return to look at them, we find nothing left but a slight remnant of transparent cellular membrane, scarcely weighing as many grains as the original mass weighed pounds. If the process of dissolution were carefully watched in circumstances which permitted the retention of the parts that escaped, we should find that out of this delicate membrane had filtered nothing but a large quantity of pure sea-water, not to be distinguished, even on strict examination, from the common fluid around.

The forms of these Sea-blubbers, as they are called, cannot well be distinguished, when thus cast up by the waves; but if we look over the side of a ship at anchor, or take an excursion in a boat, we shall see many floating freely in their own element, and displaying the singularity, and, in many instances, the beauty of their structure. The most common species assume the form of a large inverted saucer, or an umbrella-shaped disk, of transparent jelly, marked with some more or less elaborate figures of rings or lines, placed around or radiating from the centre. The broad disk is seen to move through the still water by means of alternate con-

* The word signifies a "nettle," and refers to the power of stinging possessed by most of these animals.

tractions and dilatations, very regularly performed, about fifteen times in a minute. From a fancied resemblance of this expansion to that of the lungs in breathing, this Order of Sea-blubbers is called PULMONIGRADA. From the centre of the under side of the disk hangs down a loose mass of processes,

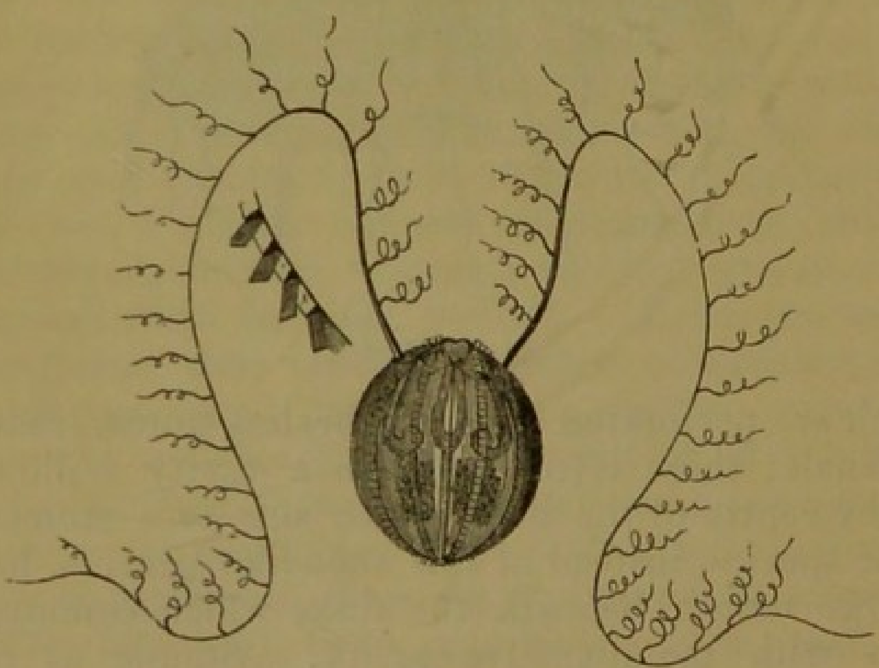


SEA-BLUBBER.

which are perforated with numberless pores, leading to canals; these latter meet in a cavity hollowed in the centre of the disk, which acts as a stomach. Some species, instead of this root-like process, have a large mouth beneath the disk, which communicates with the digestive cavity. Simple as this apparatus seems, its powers are sufficiently formidable, for animals of far greater strength and energy than the poor Sea-blubber, such as crabs and fishes, are dragged into this voracious stomach, and soon dissolved.

This will appear less surprising when we learn that most of these seemingly helpless creatures are endowed with the power of severely stinging the animals with which they come in contact; and from this property the name of the Class is derived. The human hand is most painfully affected by their touch, which blisters the skin and produces high and protracted inflammation; and it is probable that the marine animals which form the prey of these creatures are completely paralysed by it, if not destroyed. This power seems to reside in a caustic or poisonous fluid exuding from all parts of the body, but especially residing in the pendent tentacles or root-like processes.

Perhaps there are few animals of this Class more beautiful than the Globe Beroë (*Cydippe pileus*), which is occasionally taken in the British seas. If placed in a glass of clear sea-water, it looks like a globe of the purest ice, about as large as a nutmeg, from which proceed two long tentacles, fur-



CYDIPPE.

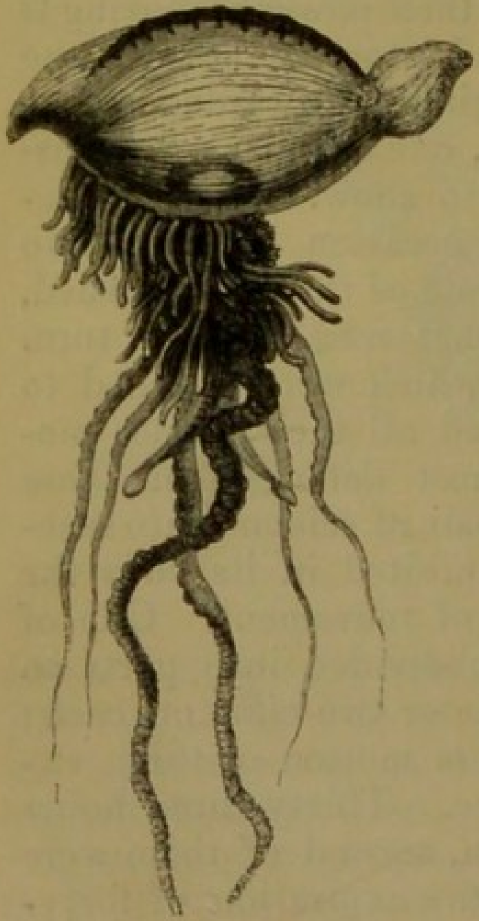
nished with spirally-twisting filaments along one side. The elegant motions of this little glassy globe excite the admiration of all who behold it, which is increased when we investigate the source of the motion. "Stretching from pole to pole of this translucent little orb, like lines of longitude upon a globe, and placed at equal distances, are eight broad bands, of more consistence than the other portions of the body. On these bands are placed thirty or forty paddles, broad flat plates,—for such they seem when magnified,—with which the little creature rows itself along. But here the difference lies between the art of man and nature. Man, to move his wheels, must have much cumbersome machinery; the furnace, and the boiler, and the herculean arm that makes the wheel revolve; but here all these may be dispensed with, for the paddles are themselves alive, and move themselves at will with such degree of force as may be needed, either at once or singly, or in groups, working with mutual consent in any way required. Thus do they all work equally; the *Beroë* shoots along meteor-like, or, if a few relax their energy, wheels round in broad gyrations, or revolves on its own axis with an ease and grace inimitable. The paddles are, in fact, gigantic *cilia*, each instinct with life, each acting independently, yet each associating with the rest. How far their power of moving is their own, and not produced by foreign agency, the following observations, obligingly forwarded to me by Mr. Patterson, of Belfast, one of our most industrious naturalists, will serve to show. This gentleman remarks, that on one occasion he took two *Beroës* after a storm, with some of the *cilia* abraded, and other parts of the body shattered, and even torn. Many of the *cilia*, however, which were attached to these mutilated parts, retained all their former mobility unimpaired. The most damaged of these *Beroës* was then cut with a pair of scissors into several pieces, and each part exhibited in its *cilia* the same undiminished rapidity of movement. One of these portions was again subdivided into parts so minute as to possess only one or two *cilia* on each; yet no change in the ceaseless motion of these extraordinary organs took place. Thirty-three hours after this minute subdivision, several of them were vibrating as usual; and at the expiration of forty-two hours, the *cilia* belonging to one fragment showed undiminished activity."*

Our readers, we are sure, will be ready to join in the beautiful reflection of Mr. Patterson, on a species nearly allied to the above, some of which having

* Jones's Lect. on the Nat. Hist. of Anim., 183.

been placed in a jar, were so transparent, that the blossoms of some flowers which were also there, were distinctly seen through them. "It was impossible to look upon these bright-tinted blossoms of earth, and on those colourless, yet not less delicate children of ocean, and not feel that *both* must have enjoyed the guardianship of Him from whom all their loveliness was derived; that He who had for ages preserved the flowers from perishing by frost, or wind, or rain, had likewise saved the *Beroës* from destruction, amid the wild tempests of the ocean."*

In some of the animals belonging to this Class, the means of support are afforded by a peculiar apparatus. "This consists of one or more bladders, capable of being filled with air at the will of the animal, which are appended to the body in various positions, so as to form floats of sufficient buoyancy to sustain the creature upon the surface of the sea when in a state of distension; but, when partially empty, allowing it to sink, and thus escape the approach of danger."†


PHYSALIS.

The little floating bubble of the warmer parts of the ocean, known to mariners as the Portuguese Man-of-war (*Physalis pelagica*), is an interesting example of this tribe. It closely resembles, when seen from the deck of a vessel, a child's mimic ship, with its sails set, and excites the wonder and admiration

* Patterson's Introd. to Zool. i. 35.

† Jones's Gen. Outline, 68.

of those who behold it, to see so delicate and frail a bark breasting the broad billows, as it seems that the first breaking sea must inevitably overwhelm and dash it to pieces. Yet, there it floats and dances—now on the curling crest, now in the deep hollow,—in spite of wind and wave. Often, when passing just under the lee of a vessel, the sudden lull made by the interposition of so great a body between it and the wind will cause it momentarily to lie flat on the water, but it instantly resumes its upright position. When examined closely, the animal is seen to consist of an oblong transparent bladder, pinched up at the upper part into a kind of rumpled edge; this edge is of a delicate pink, but the lower part of the bladder is fine blue, and both these colours are gradually softened into the clear membrane, the middle of which is colourless. From one end of the bottom proceeds a large bunch of tentacles, like strings, hanging down in the water; these are of a brilliant purple. The vividness of the colours varies much, some being only of a pure white above. They differ much also in beauty of form: in some, the *sail* is merely a narrow ridge or border, in others it rises into a tall and wide semicircular membrane. The hanging tentacles have, in a very formidable degree, the faculty of stinging the hand that touches them. Mr. G. Bennett has given a most terrific account of the effect produced on him by the contact of his hand with the tentacles of one of these animals. The pain was most severe, extending gradually up the limb to the chest, and continued to be felt for many hours.

The reproduction of the *Acalephæ* is involved in much obscurity. The red spots that are placed around the margin of the disk in some species, have been thought to contain germs or ova; but Ehrenberg, Owen, and other naturalists, consider these to be rudimentary eyes, or at least organs adapted to receive the stimulus of light. Milne Edwards has observed in *Æquorea* a number of thin plates on the under surface, radiating from the mouth as a centre. Seventy-four of these plates were counted in one individual, all of which were filled with countless ova.

The important discovery has recently been made by Dr. Siebold and M. Sars, that the young *Acalephæ* pass through a series of metamorphoses before they attain the form of the parent. The eggs being hatched give birth to little creatures having the form of *Polygastric animalcules,* covered with *cilia,* by the vibration of which they row themselves rapidly through the water. After a while the little creature attaches itself to some fixed body, and undergoes a change. One end thickens; a depression forms in its centre, which soon is hollowed into a stomach: meanwhile the margin expands, and soon divides into four processes; four others appear in the interspaces of these, and all of them increase in length; the base dilates into a sucker; and thus we have a perfect representation of an eight-armed *Polype,* which feeds on true *Polygastrica* and on their brethren that have only as yet attained the *polygastric* form.

In the polype-form the young *Acalepha* remains through the winter months, doubling in the meantime the number of its tentacles, and increasing in thickness; it now shoots out buds like the *Hydra,* which grow into young Polypes with the power of completing their change into the perfect Acaleph. At length, the creature whose metamorphoses we have been tracing, perfects its form; and this it does by spontaneously dividing into ten or fifteen transverse segments, which look like so many cups piled up, one in another. At length these separate, and each takes the form of the original disk.

How wonderful are these processes! and what an idea they give us of the inexhaustible resources of the infinite mind of God; "the treasures of wisdom and knowledge" that are hid in Him who has created all things for His own glory! To Him nothing is great, nothing small: the invisible animalcule that swims in a drop of water, and revels there like a leviathan in the ocean, bears in the elaborate beauty of its construction, and in the wondrous adaptation of its organism to its condition, as full an evidence of Divine skill and mercy, as the leviathan himself. Yet we cannot say—

> "He sees with *equal eye*, as God of all,
> A hero perish, or a sparrow fall;"

for He has himself said to us, "Ye are of more value than many sparrows;" and the lesson we should learn from these examples of creative and sustentative care, is not that He views his creatures with an undistinguishing regard, but rather the consolatory inference which He has himself drawn from a parallel comparison: "Your heavenly Father feedeth *them;*—are ye not *much better* than they? . . . Shall He not *much more* clothe you?"

CLASS V. ENTOZOA.*

(*Intestinal Worms.*)

If our astonishment has been already excited by observing with what a vast and boundless profusion animal life is distributed in the globe we inhabit, it will not be diminished when we consider with what a careful economy provision is made for its well-being, so that space and support may be afforded to it at the least possible expense. The Class before us presents a wondrous illustration of this divine economy. We have already seen how every drop of water is made to teem with multitudes of animated creatures, yet so minute that each pursues its avocations at large, uncrowded, unannoyed by its numerous fellows; but we have now to learn that even the bodies of living animals are worlds to another set

* Creatures living "within animals."

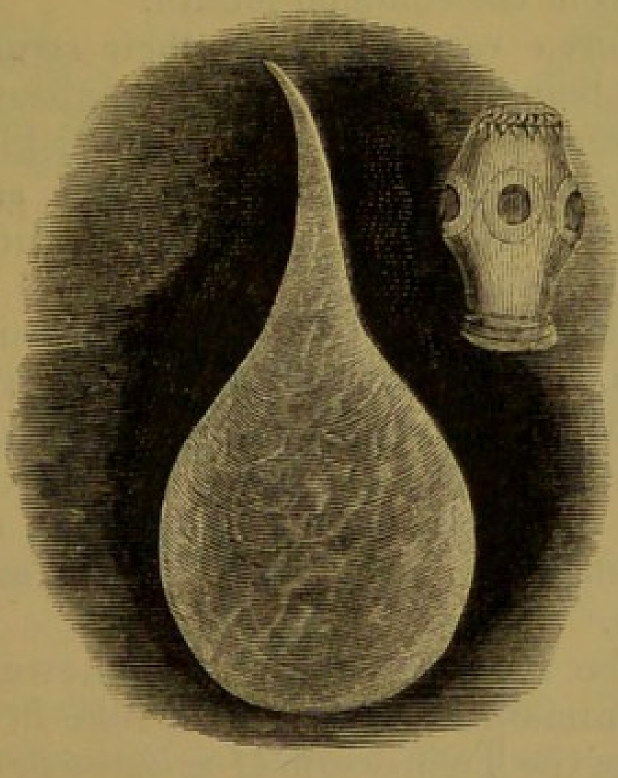
of animals; their juices, their tissues, their viscera, constituting fields in which living beings are appointed to dwell, finding their habitation and their nourishment there; sometimes by incalculable millions. The muscles of the human body, when dissected by the anatomist, are sometimes observed to be filled with minute specks, as if dusted with a pepper-box: under the microscope each of these dots is found to be a living parasite, contained in a minute bladder, about $\frac{1}{50}$ of an inch in length. These dwell between the bundles (*fasciculi*) of fibres that together constitute the muscle; but Mr. Bowman has discovered that even the slender muscular fibre itself is sometimes converted into a tube, containing great numbers of parasitic worms, closely packed together. But what are these examples to the fact that some of the ordinary healthy secretions of man are filled with living and moving atoms of a definite and symmetrical figure; yet so minute that, according to Reil, 300,000 of them would only extend to the length of an inch?

Nor is the occurrence of these internal parasites in the bodies of animals rare and unusual: there is scarcely a known species but is infested by its peculiar parasite, and generally more than one; and it is a rare thing to dissect any individual animal without discovering more or fewer of these intestinal worms. As many as eighteen species, which infest the human body, have been enumerated.* But more remains to be told; the very intestinal worms themselves, in many instances, are infested by parasites which inhabit *their* bodies and live upon *their* juices in turn. There is a minute worm, not more than $\frac{1}{70}$ of an inch in length, which inhabits the humours of the eye of the Perch, and sometimes is found in such numbers that the poor fish's eye-ball seems filled with them. In this minute worm Dr. Hardmann observed many capsules, which, when opened, were found to be filled with living beings, smaller than

* Prof. Owen, Lect. on Comp. Anat. i. 42.

the smallest infusory animalcules, yet active and agile! And Professor Owen has found in some bladder-like *Entozoa* (*Echinococcus*), which infest the hog and other domestic animals, multitudes of organized beings resembling the *Polygastrica*.

One of the simplest forms of the Entozoa is that assumed by a species which inhabits the flesh of the hog, and which is the cause of that diseased condition which is known as *measly pork*. It is termed *Cysticercus*, which signifies "bladder-tail," and consists of a globose transparent bag, with a



CYSTICERCUS; AND ITS HEAD MAGNIFIED.

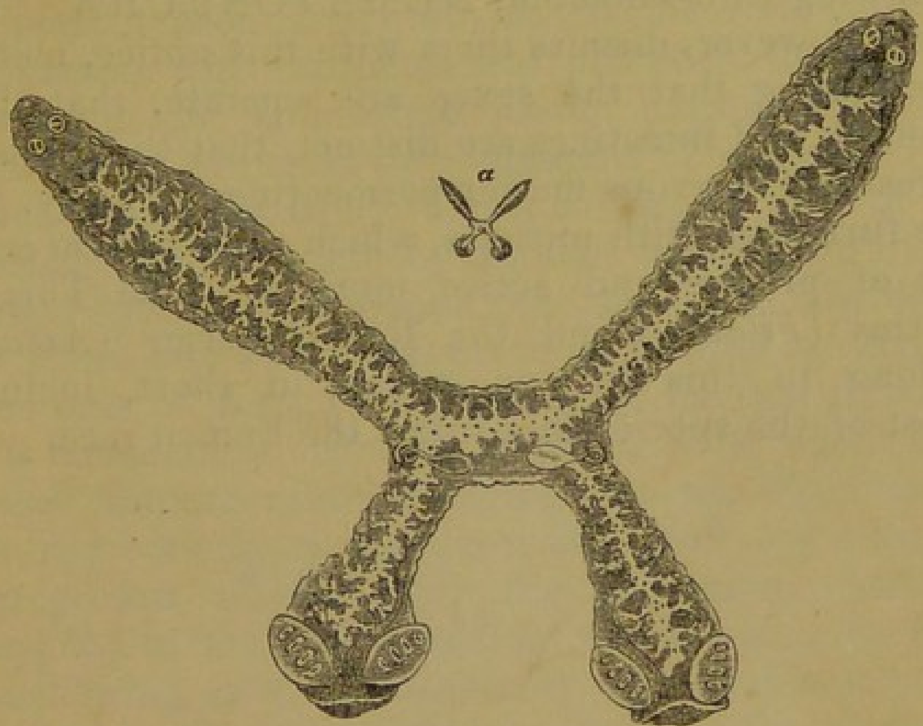
slender neck, terminated by a singular head. This organ, the form of which, with slight modifications, extends through many genera of these animals, is furnished with a mouth set round with a double row of recurved spines, by means of which a firm hold is maintained while the juices on which it feeds are imbibed, and the flow of which is doubtless increased by the irritation. In addition to these hooks we see four suckers, which also help to attach the head, perhaps, in situations when the hooks cannot penetrate the surface, or cannot maintain a hold.

The horrible tape-worm (*Tænia*), some species of which are known to attain the length of sixty or a hundred feet, consists of a great number of joints, sometimes amounting to five hundred, which become very slender as they approach the head, and form a long thread-like neck. The head in these is found to be constructed upon the same principle as that just noticed, a double circle of hooks and four suckers; but, what is surprising, each joint is found to be, in a certain sense, a distinct animal,—a distinct generative system being found in each, yet all nourished from the common mouth.

The *Entozoa* vary much in their structure and form, some being comparatively complicated, while others are very simple. Of the former kind is the Fluke (*Distoma hepaticum*), well known as inhabiting the liver of the Sheep, but found also in other animals, and even in Man. It resembles in form a little Sole, about an inch in length, furnished with two suckers, each of which was, at one time, supposed to contain a mouth, but one of them has been since found to be simple. When sheep are pastured in low wet meadows, this animal often multiplies excessively in them, producing dropsy, or rot, and finally death.

One of the most singular of all known forms is seen in an animal resembling the Fluke in its internal structure, the Twin-worm (*Diplozoon paradoxum*). It literally possesses two bodies, each precisely resembling the other, and united by a band, which passes from the middle of one to the other, reminding the observer of the Siamese twins exhibited some years ago. This strange little creature, not more than a quarter of an inch in length, is found attached to the leaves of the gills in the Common Bream (*Cyprinus brama*), to which it adheres by suckers at each of the four extremities, and from which it derives its nutriment.

The introduction of these worms into other animals is but little understood. Some zoologists have supposed that they are produced spontaneously from the tissues which they inhabit; others, with Linnæus, have conjectured that the creatures in question are found in other situations, but so diverse in form, colour, and size, as not to be recognised; and that their appearance as true *Entozoa* is dependent on the abundant supply of warmth and nutriment which individuals enjoy when accidentally introduced



THE TWIN-WORM; *a*, nat. size.

with food or drink into a living body. This supposition is somewhat confirmed by the existence, in every stagnant ditch, of little animals (*Planaria*) which are very similar in structure to the Intestinal Worms: they are about a quarter of an inch long, of a blackish hue, and resemble little leeches in appearance.

In the Intestinal Worms there is a progressive development of structure, rising from the simplest forms to those which are highly organized. Hence it is difficult to include them all under one great division of the animal kingdom; for, while the forms to which we first alluded are truly *Acrita*, no nervous matter being discernible in them, the Flukes and

Twin-worms begin to manifest decisive traces of its existence: and there are other genera which are so complex in structure, and in which the nervous system is so distinctly developed, that they have been commonly separated as a Class by the name CŒLELMINTHA (or hollow worms), from the others, to which the term STERELMINTHA (or solid worms) is applied. The former have, moreover, been assigned to the following Sub-kingdom, NEMATONEURA. We shall, however, dismiss them with this notice, merely mentioning that the sexes are separate, that their stomach and intestines are distinct, that they possess threads of nervous matter permeating the body, and are furnished with muscles, which render them capable of precise and active motions. The Thread-worms (*Filaria*) and the Round-worms (*Ascaris*) belong to this division, which, in short, includes most of the species that infest the human race.

SUB-KINGDOM II. NEMATONEURA.*

The divisions in which zoologists arrange the objects of their study are not to be considered as separating with mathematical precision the animals placed in one from those placed in another. The changes of form and developments of structure, the investigation of which forms so large a part of the science, proceed, not by sudden leaps, but by an imperceptible progression; so that the characters by which any zoological group is defined are strictly true only of some of its members, those with which it is commenced, as well as those with which it is closed, imperceptibly merging into the characteristics respectively of the preceding and the succeeding groups. Thus, while the distinctive character assigned to the Sub-kingdom which we have been considering is the absence of appreciable *neurine*, we find in the more elaborate forms of the *Acalepha* and the *Entozoa* this important substance decidedly manifesting its presence; yet it would be forced and unnatural to separate these from the more simple forms of the same Classes, of which the character is strictly true. Thus, too, the lower members of the grand group at which we are now arrived are with difficulty separable from those we have dismissed; yet, before we terminate its investigation, we shall be introduced to animals of a much higher and more complex type of organization, which in their turn closely take hold of the group next above them.

With this precaution, then, we may remark, that the *Nematoneura* differ from the *Acrita* in possessing nervous matter distinctly collected into visible

* Animals having "thread-like nerves."

threads, which, like the wires of an electric telegraph, serve for the transmission of various sensations. They have also distinct muscles, by which the motions of their bodies, both voluntary and involuntary, are rendered more energetic and more precise. Their digestive apparatus is not composed of simple cavities, hollowed out of the general substance, but forms a stomach and intestines, endowed with separate functions, enclosed within their own membranes, and loosely attached to the interior of an abdominal cavity. We no longer find the multiplication of the same organ, as the *pore-mouths* in the sponges, the *stomachs* in the polygastric animalcules, and the *ovaries* (egg-organs) in some of the intestinal worms; nor (except in rare cases) an increase of the species by budding, or spontaneous division; both of which peculiarities mark a very low grade of animal life, and evidently assimilate it with that of plants.

CLASS I. BRYOZOA.*

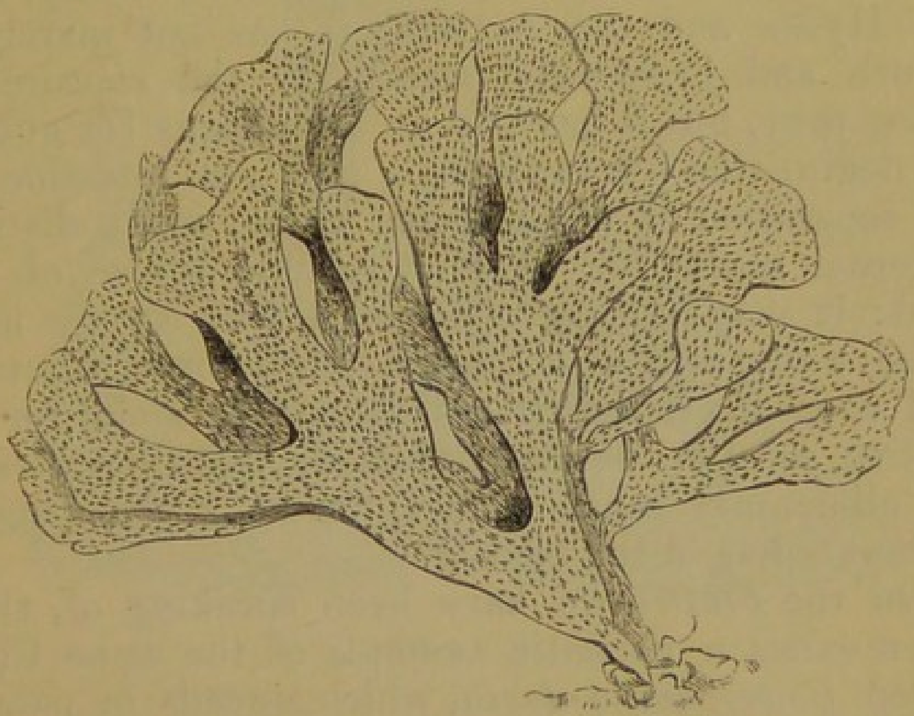
(*Ciliated Polypes.*)

Those who have amused themselves with collecting the graceful and interesting sea-weeds that are so abundant on the shore, may have often observed the stems to be coated, in patches, with a delicate film, so thin as not to hide the form of the surface on which it is spread, yet, when examined closely, discovered to consist of a vast number of symmetrical cells, placed close to each other, somewhat like those of a honeycomb. Or the inquisitive collector may have found a substance very similar to this in texture and appearance, but independent, and itself taking the form of a branched and leaf-like sea-weed, presenting, on both sides of its flattened expansions, the

* A term derived from two Greek words signifying "sea-moss," and "an animal:" it may be rendered *Moss-like Polypes.*

same honeycomb arrangement of tiny cells. To these substances, which are so very common, that any of our shores present abundant specimens for examination, naturalists have given the name of *Flustra*, and they afford examples of the interesting Class of animals at which we are now arrived.

If we take an example of the last described sort (*Flustra foliacea*), and bring it under a lens of high magnifying power, we discover an assemblage of



FLUSTRA.

oval cups of a horny texture, the margins of which are set with spines diverging on each side. But this is merely the skeleton; during life, each of these myriad cups was inhabited by a little, hungry, active animal, Polype-like in form, but displaying a much higher and more complicated organization. Around its mouth are set numerous long tentacles; but these are not, as in a Polype, mere fleshy filaments or petals, but are furnished with innumerable *cilia*, or short hairs set in rows, capable of rapid vibration at the will of the animal, so as to produce a strong and constant current in the water in any given direction. By this wonderful provision two ends are obtained; fresh particles of water are incessantly brought to the respiratory organs of an animal unendowed with locomotion, and, by the same means, every minute swimming substance in the vicinity is dragged by the ceaseless whirlpool into the midst of the ciliated tentacles, when they are forced by the currents down to the mouth, and such as are fit for prey are seized and swallowed.

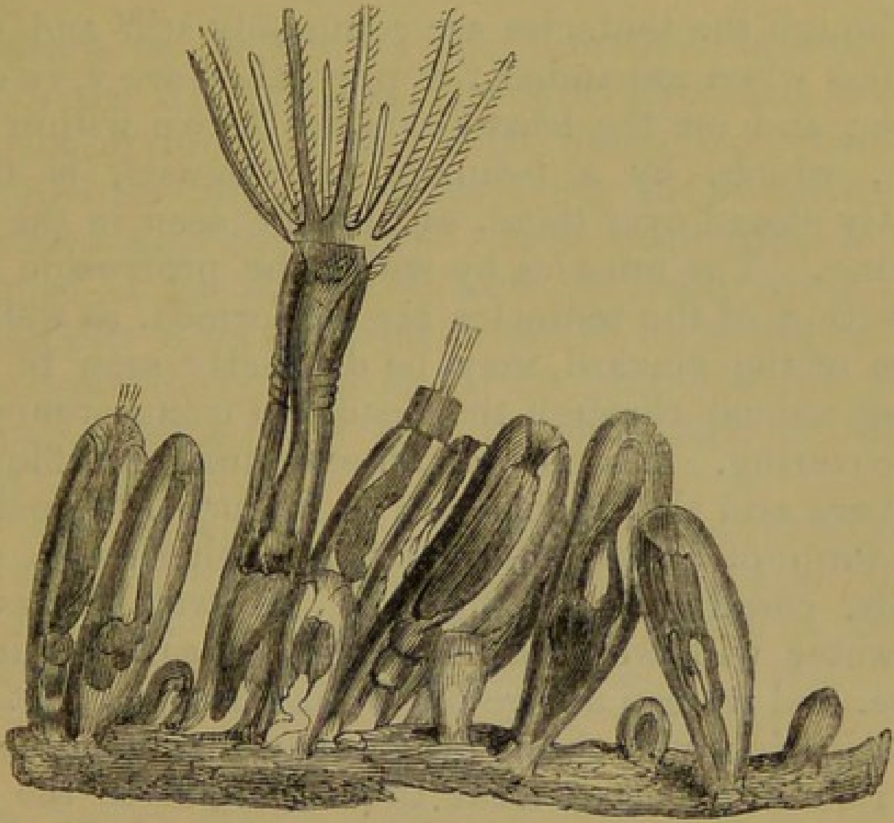
"The Bryozoon," observes Professor Owen, "has not merely the characteristic digestive cavity, like the Hydra and the Actinia; it has not merely a mouth and prehensile organs for the capture of living prey, but it has also an œsophagus [or gullet] for deglutition [or swallowing food], an intestine for the separation of the nutrient chyle, and a distinct external outlet for the indigestible refuse of the food: it may possess a stomach with strong muscular walls, and a dentated lining for trituration, and a second stomach with glandular walls for digestive solution or chymification, and thus present an alimentary canal as complicated and as highly elaborated as in the bird."*

On the *Flustra* we have been speaking of, there often exists a parasitic example of the same Class, called *Bowerbankia densa*, which spreads in patches over its leaf-like expansions. Each of the animals composing these patches inhabits a delicate tube of perfect transparency, about $\frac{1}{12}$ of an inch in length, and clusters of these glassy cells rise from a creeping stem, common to the whole group. This little parasitic Bryozoon possesses a structure more highly organized than that of the *Flustra*, on which it lives, and it is to this that the learned Professor just quoted alludes when he compares the complex apparatus for digestion found in this minute creature to that of a bird.

The tubes of these animals consist of three parts; the lower portion is stiff and horny, though quite

* Lect. on Comp. Anat. i. 94.

pellucid, which texture extends about two-thirds of the length: above this it becomes flexible, and at length terminates in a marginal row of delicate points or bristles, united by a web or membrane of exquisite delicacy. Above these points the ten-



BOWERBANKIA.

tacles, ten in number, expand, and form a sort of funnel, of which the mouth is the bottom, or centre. The tentacles are stiff, and are furnished with a row of *cilia* on each side; besides which there is a row of immoveable spines on the back of each, pointing downwards.

The mouth leads into a wide gullet, which gradually becoming narrower, terminates in a globular muscular gizzard, the grinding faces of which are set with horny teeth, for the purpose of bruising the food, which is thence transmitted into the digestive stomach,—a long conical sac, with its walls studded with glands. The food is rolled about in constant agitation, and is frequently returned into the gizzard to be ground afresh: at length it is passed into the intestinal canal, which may be traced in the engraving, from the upper part of the stomach on one side, to its termination just below the base of the tentacles. When the refuse is ejected, its particles are immediately hurled away by the outward current of the *cilia*.

Though the tentacles are commonly stiff and motionless when expanded for prey, they are very sensitive; and on the least alarm are drawn within the tube, which, by a beautiful mechanism, is then tightly closed over them, as may be seen in the engraving. The muscles by which the protrusion and retraction of the tentacles are performed, as well as those of the gizzard, may be distinctly seen in the living animal through the beautiful transparency of the covering. Nor is such an examination difficult: we have said that the species is frequently found in the form of little mossy patches adhering to seaweeds, corallines, and flustræ. A watch-glass of sea-water will well display them beneath a microscope, and we can assure our young readers that the investigation will abundantly repay their trouble by the rich intellectual treat thus afforded to the eye and the mind. An ocular observation of this kind will furnish a lesson in zoology never forgotten, and, accompanied by an intelligible description, will teach more in a quarter of an hour than could be learned from volumes without personal examination.

We thus discern in the little animals we are describing an organization considerably elevated in development above that of the Acrite forms, which we lately examined. Yet in one point they have made no advance; the multiplication of the race is effected by means in no essential respect differing from those common to the Sponges and Polypes. One of these modes is by division; a portion of the creeping stem, with its tubes and inhabitants, cut off from the rest, will continue to live and grow without manifesting any injury. Another mode is by the sprouting forth of buds, one of which is seen in our engraving; and yet a third is by the production and emission of ciliated *gemmules*, like those of a Sponge, which whirl themselves through the water to a distance from the parent stem, and thus people the ocean-bottom with ever-advancing colonies.

When we reflect on the innumerable forms in which the All-wise and Almighty God has created life, and remember that each individual atom that vibrates its tiny *cilia* is enjoying its existence, we are filled with admiration. How exquisitely is each adapted to its situation; how perfectly are all the conditions of its existence fitted to its requirements; how beautifully does it fill its place in the grand chain of being; and how unremittingly is all its need supplied!

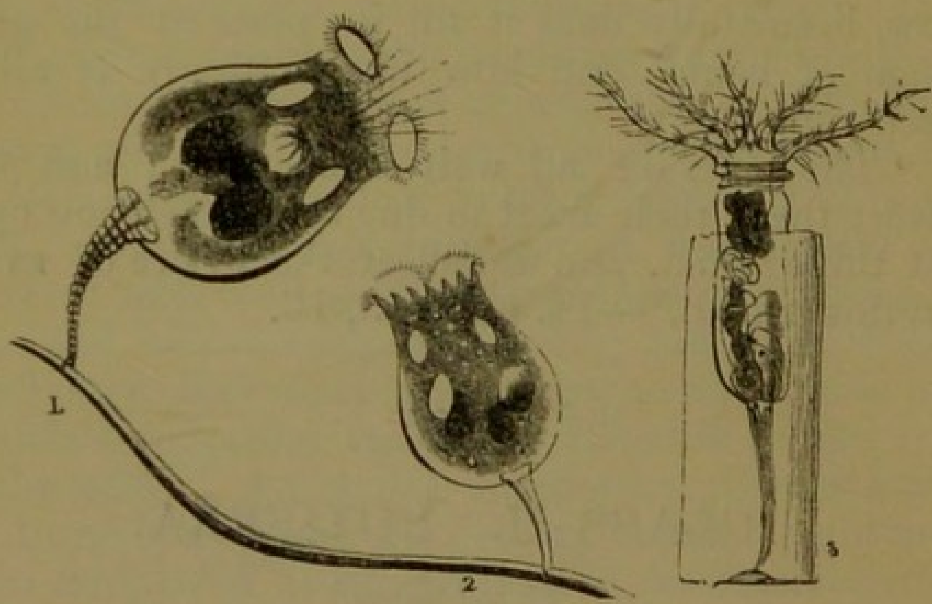
"The eyes of all wait upon thee; and thou givest them their meat in due season. Thou openest thine hand, and satisfiest the desire of EVERY LIVING THING."—Ps. cxlv. 15, 16.

CLASS II. ROTIFERA.

(*Wheel-bearers.*)

If we imagine a Bryozoon to be deprived of the power of increasing by sprouts and buds, to have its tentacles modified in such a manner that the *cilia* shall be arranged in segments of circles upon rounded lobes or short processes, and to be provided with a clasping forceps, by which it can anchor or liberate itself at pleasure, we shall have a Rotifer. The figure marked 3 in the accompanying engraving represents a species (*Stephanoceros Eichornii*) which seems to form a connecting link between the two Classes; for though it displays the tentacles of the BRYOZOA, these are shortened and thickened, and the internal anatomy agrees with that of the ROTIFERA.

The appearance of these Wheel-bearers is thus graphically described by Professor Jones:—"Our stagnant waters, we already know, swarm with innumerable tribes of Infusorial Animalcules; every drop is densely peopled, and the countless hosts have divers forms and habits, such as have been described in a preceding chapter. Returning to this spectacle, we take from any pool, overgrown with duckweed, a few drops, and, placing them beneath our microscope, carefully inspect the little world exhibited within them. The crowds of Polygastrica are recognised at once as they go gliding past, or sporting about in



1, 2, *Brachionus*; ROTIFERA. 3, *Stephanoceros*.

giddy dance; but ever and anon there comes, rushing among their swarms, like a fierce tiger among a flock of sheep, some monster of a different kind, having, on what appears to be its head, great wheels that spin continually round, and, like the paddles of a steamboat, row about these dread leviathans,—for such they seem, compared with the small fry around them. The animals in question have been named Rotifera, or Wheel-bearers; in their size they much exceed the humbler Infusoria, over which, indeed, they tyrannise. Their length may be roughly computed at about one-fiftieth to one-hundredth of an inch,—terrific giants when contrasted with their tiny victims, although themselves scarcely perceptible by unassisted vision."*

The name of Wheel-bearers has been given to these minute but highly organized creatures from the very singular appearance presented by their *cilia* when in rapid motion. This exactly resembles that of the crown-wheel of a watch in swift rotation, and the early microscopic observers supposed this to be actually the kind of motion with which the organs in question were endowed, though by what sort of mechanism living organs could really rotate, and yet preserve a connexion with the body of the animal, they could not conceive. Better instruments, however, and closer observation have solved the difficulty. Instead of being real revolutions of the wheels, it is now clearly established that these rotations are merely an optical illusion, exactly similar to that by which, when the waves are rolling in upon a beach, the *particles of water* appear to the eye to move rapidly forward, while, as is well known, they merely rise and fall perpendicularly in constant succession. Dr. Arthur Farre remarks, that under high magnifying powers, "the *cilia* have the appearance of moving in waves, in the production of each of which from a dozen to twenty *cilia* are concerned, the highest point of each wave being formed by a *cilium* extended to its full length, and the lowest point between every two waves by one folded down completely upon itself, the intervening space being completed by others in every degree of extension, so as to present something of the outline of a cone. As the continuance of each *cilium* in any one of these positions is of the shortest possible duration, and each takes up in regular succession the action of the adjoining one, that *cilium* which, by being completely folded up, formed the lowest point between any two waves, in its turn by its complete extension

* Lect. on the Nat. Hist. of Anim., 230.

forms the highest point of a wave; and thus, while the *cilia* are alternately bending and unbending themselves, each in regular succession after the other, the *waves* only travel onward, while the *cilia* never change their position in this direction, having, in fact, no lateral motion."*

The *cilia* are variously arranged in different species, sometimes being set so as to produce a single wheel, more commonly two, and occasionally many wheels; and, on the variations of these organs, the Class is subdivided into Orders. Into these details we have not space to enter.

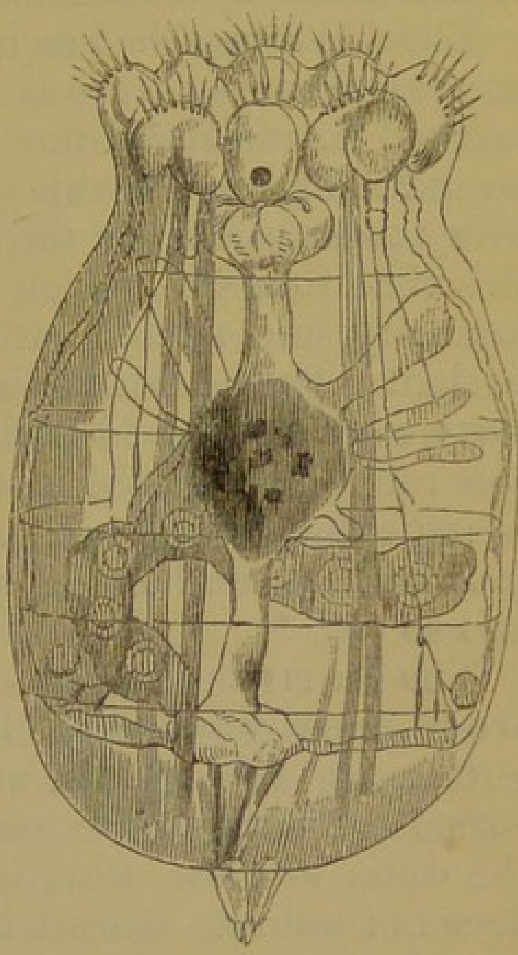
It is very evident that the rotatory undulations are perfectly under the control of the animal. The whole circle is instantly set going, and as instantly stopped; at one time the motion is suddenly accelerated, at another it becomes languid, and again is quickened. A single wave may sometimes be seen performing its course, or two or three cilia bend and straighten themselves, without performing any undulation.

The object of these energetic motions appears to be twofold; first, as we saw in the BRYOZOA, to produce currents in the water, by which prey is brought to the mouth, while the body remains fixed; and secondly, to row the animal in any given direction when disengaged, as a steam-vessel is propelled by the rotation of her paddles.

A common form of the ROTIFERA is that of a transparent glassy cup, more or less oblong, often terminating in a slender foot or tail, which is flexible, and furnished at its extremity with a sort of forceps, enabling the animal to grasp the stems of aquatic plants or other small objects, and thus maintain a fixed position. Some are inclosed in a transparent shell, often variously armed with spines at one or both extremities; but others are not so inclosed. The engraving on p. 56, figs. 1 and 2, which repre-

* Phil. Trans., 1837.

sent *Brachionus urceolaris,* a shelled species, will afford an example of their general appearance, while the accompanying figure of *Notommata clavulata,* which is destitute of a shell, will display their internal structure.



NOTOMMATA.

In this species the *cilia* are arranged on a number of rounded lobes, which are supposed, by Professor Ehrenberg, to be muscular, and to be capable of producing by their contraction the ciliary vibration. In the centre of one of these is seen a red dot, supposed to be a single eye; below, a globular gizzard leads by a canal into a capacious stomach, into which six glandular bodies pour their secretions —by Ehrenberg believed to represent the spleen, by others the liver, of higher animals. The stomach merges into a short intestinal canal, behind which is seen a large and long bent sac, which is the ovary; it is transparent, and permits the eggs at certain seasons to be discerned within it, as displayed in the figure.

The eggs themselves afford a beautiful subject of microscopic study; they are covered with a transparent shell when they leave the parent, through which the parts of the little embryo as they develop themselves, gradually become distinctly visible, until at length the *cilia* are seen to perform their rapid rotations, though as yet the imprisoning shell has not been broken; at last, by the action of these organs, which every moment becomes more energetic, the transparent membrane is ruptured, and the little creature bursts forth upon its new existence. The time from the exclusion of the egg to the hatching is commonly about twelve hours.

Ehrenberg watched an individual through eighteen successive days; it was full grown when he first marked it, and it did not die of age at last. "Such an individual is capable of a four-fold propagation every twenty-four or thirty hours, bringing forth in this time four ova, which grow from the embryo to maturity, and exclude their fertile ova in the same period. The same individual producing in ten days forty eggs, developed with the rapidity above cited; this rate, raised to the tenth power, gives one million of individuals from one parent, on the eleventh day four millions, and on the twelfth day sixteen millions, and so on."*

The Rotifera are inhabitants of fresh waters, and are frequently found in clear pools, and, it is said, in gutters, in rain-spouts, and in the depressions and corners of leads on the roofs of houses. The fact that the water in these situations is frequently dried up, does not militate against their presence. The sandy dust in such places sometimes contains millions of Rotifera, particularly if it be composed of particles of a reddish-brown hue; and if a pinch of this dust be put into clear water, the animalcules will soon revive and swim about as actively as if they had never been dried. Specimens have been kept in a dry state for four years, and then revived on being moistened; but it is essential to their surviving so long a sleep that they should be preserved from the action of the air by being buried in sand.

A more certain way of obtaining them, is by tying a few sage leaves together, and allowing this to remain suspended in a jar of boiled water, replacing the bunch as it becomes decayed: in a few weeks the water will abound with animalcules, among

* Prof. Owen's Lect. on Comp. Anat., i. 38.

which the beautiful wheel-animal (*Rotifer vulgaris*,) will be found especially numerous.

Since every collection of water, however free from other matters at first, becomes in a short time, if exposed to the air, filled to swarming with Infusory and Rotiferous animalcules, we may well inquire, How are they or their germs introduced? The above facts seem to supply an answer to the question. "When the once thickly tenanted pool is dried up," says Professor Owen, "and its bottom converted into a layer of dust, these inconceivably minute and light ova will be raised with the dust by the first puff of wind, diffused through the atmosphere, and may there remain long suspended, forming perhaps their share of the particles which we see flickering in the sunbeam, ready to fall into any collection of water, beaten down by every summer shower into the streams or pools which receive, or may be formed by, such showers, and by virtue of their tenacity of life, ready to develop themselves wherever they may find the requisite conditions for their existence."*

That these atoms of existence are not spontaneously formed in water, was proved by some interesting experiments of Professor Schulze, of Berlin. He half filled a glass flask with distilled water, in which were mixed various animal and vegetable substances; he then closed it with a good cork, through which were passed two glass tubes, bent at right angles, the whole being air-tight; it was next placed in a sand-bath, and heated until the water boiled violently. While the watery vapour was escaping by the glass tubes, the Professor fastened at each end an apparatus which chemists employ for collecting carbonic acid; that at the one end was filled with concentrated sulphuric acid, and the other with a solution of potash. By means of the boiling heat, it is to be presumed that every thing living and all

* Lect. on Comp. Anat., i. 31.

germs in the flask or in the tubes were destroyed; whilst all access was cut off by the sulphuric acid on the one side, and by the potash on the other. The apparatus was then exposed to the influence of summer light and heat; at the same time there was placed near it an open vessel, containing the same substances that had been introduced into the flask, these also having been subjected to a boiling temperature. In order to renew constantly the air within the flask, the experimenter sucked with his mouth several times a day the open end of the apparatus, filled with the solution of potash, by which process the air entered his mouth from the flask through the sulphuric acid. The air was of course not at all altered in its composition by passing through the sulphuric acid in the flask; but all the portions of living matter capable of becoming animated, were taken up by the sulphuric acid and destroyed. From the 28th of May until the beginning of August, Professor Schulze continued uninterruptedly the renewal of the air in the flask without being able, by the aid of the microscope, to discover any living animal or vegetable substance, although, during the whole of the time, observations were made almost daily on the edge of the liquid; and when at last the Professor separated the different parts of the apparatus, he could not find in the whole liquid the slightest trace of *Infusoria* or *Confervæ*, or of mould; but all three presented themselves in great abundance a few days after he had left the flask standing open. The open vessel which he had placed near the apparatus contained on the following day *Vibriones* and *Monads*, to which were soon added larger Polygastric INFUSORIA, and afterwards ROTIFERA.*

* Edinb. New Phil. Journ. xxiii. 165.

CLASS III. ECHINODERMATA.*

(*Star-fishes.*)

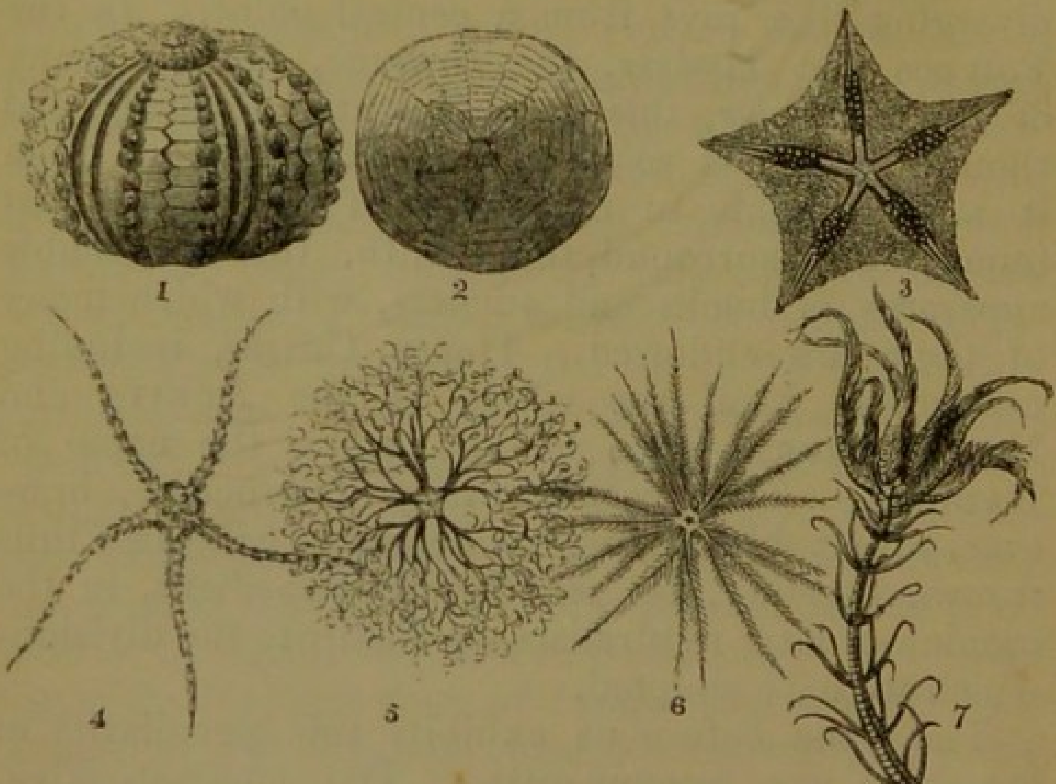
In most of the animal forms which we have examined, we have observed a symmetrical arrangement of their parts very different from that which prevails in a beast, bird, fish, or insect. There is no part which we can designate as the front or the back, the right or the left, but the arrangement is circular or radiate, the parts more or less obviously diverging like rays from a central point. In the Polypes and Hydras, the *Bryozoa,* and in many of the *Acalephæ,* this is sufficiently obvious; and though it is less so in the *Entozoa,* yet in them it is discernible in the order of the parts that immediately surround the mouth, the formidable apparatus of hooks and suckers, with which many of them are endowed. Hence Cuvier, including under one head the whole of the Acrita and Nematoneura, gave to the group the name of Radiata. The great diversity of structure, however, observable in the assemblage of creatures thus thrown together, has rendered it expedient, in the opinion of later naturalists, to institute the divisions which we have adopted.

The Class before us exhibits this peculiarity of structure very prominently. The common Five-finger (*Asterias rubens*) that lies upon the mud at low-water, or is cast up on the sands by the tide, will familiarly recur to our sea-side readers. It consists of five pointed rays, extending from a central point, and hence is frequently called Star-fish or Sea-star. The nervous system consists of distinct threads, radiating in the same fivefold

* A term derived from two Greek words, signifying "hedgehog-skinned," in allusion to the dense covering of spines with which many of the species of this Class are furnished.

manner. Some of the highest forms lose this radiated symmetry in the form of their digestive and respiratory organs, approaching the animals which succeed them in the scale; but in these, the rayed principle is still conspicuous, as is seen in the arrangement of the lines and tubercles on the shell of a Sea-urchin (*Echinus*), and particularly in the elaborate jaws and teeth, organs which we now find, for the first time, and which are fivefold, set at equal distances around a point in their centre, to which they all converge.

The form and appearance of the various animals



ECHINODERMATA.

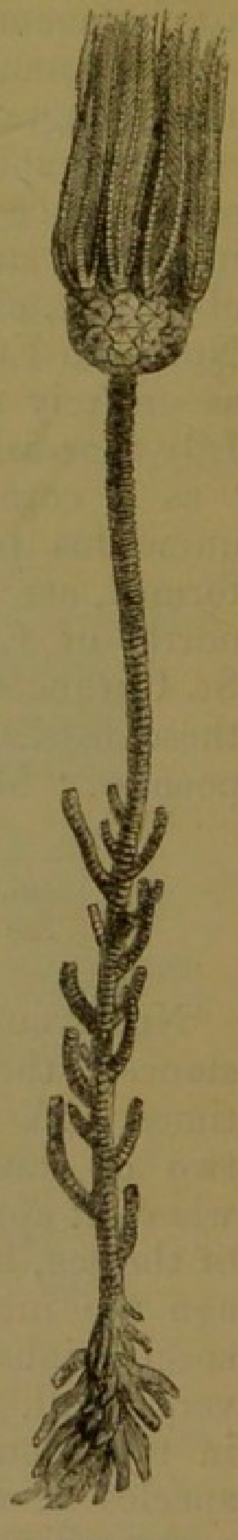
contained in this Class are so dissimilar, that at first sight we are tempted to conclude that creatures so much unlike can have no affinity with each other. The accompanying engraving exhibits some of these diverse forms, and is intended to show the steps by which they gradually glide into each other. The transition before us, effected as it is by a multitude of imperceptible gradations (a few only of which we have figured), is one of the most beautifully perfect in the whole range of Zoology, and is well worthy of a few moments' attention.

We commence with the figure marked 7 in the above engraving, which represents one of the Encrinites; species which derive their name from their resemblance to a lily. Many large kinds are found in a fossil state, in limestone formations; vast strata of marble, extending over large tracts of country in Northern Europe and North America, being almost as entirely made up of the petrified skeletons of Lily Star-fishes, to use the words of Dr. Buckland, "as a corn-rick is composed of straws." The numerous perforated joints of which the stem is formed, are frequently found disjointed, and in the north of England these are popularly known as St. Cuthbert's Beads. Sir Walter Scott alludes to these fossils, and to the vulgar superstition, in his poem of "Marmion:"—

> ——— "On a rock by Lindisfarn
> Saint Cuthbert sits, and toils to frame
> The sea-born beads that bear his name."

Numerously abundant as are these fossil "Lily-stones," the form is exceedingly rare in present times. A fine species (fig. 7) has been found on two or three occasions in the West Indian seas, where it appears to be fixed to rocks at the bottom of the sea, by the base of its stem. Not many years ago the interesting discovery was made of another species, inhabiting the British seas; this, however, is very small, not exceeding three quarters of an inch in total length. It differs from the great tropical species in the stem not being furnished with any accessory rays, and in the principal rays being merely double, instead of being much subdivided. Mr. Patterson says of it, that it "has five pairs of beautifully pinnated arms, and is of a deep rose-colour, dotted over with minute brown spots, which are regarded as the ovaries. It is dredged up on many parts of the Irish coast, and is occasionally found upon the strand. The first specimen we ever possessed was taken on the beach, about six miles from Belfast, and was brought to that town alive. Anxious to secure so attractive a specimen for the cabinet, we placed it in a shallow vessel of fresh water, and found, to our surprise, that it emitted a fluid, which imparted to the water a roseate tinge."*

FOSSIL



LILY-STONES.

The attentive observer cannot fail to remark how beautiful a link this little animal affords us, with the polype-like creatures which we have dismissed. Many of those, as we have seen, deposit a stony skeleton, which imparts solidity to their otherwise feeble structure: in like manner, the Encrinite deposits, atom by atom, the earthy matter in the substance of its flesh, which thus becomes filled with jointed pieces, imbedded in the soft parts by which they are held together. The flexible skeleton thus formed, incloses in its perforated centre the internal organs of the animal, which is itself clothed with a covering of living flesh.

* Zoology for Schools, i. 47.

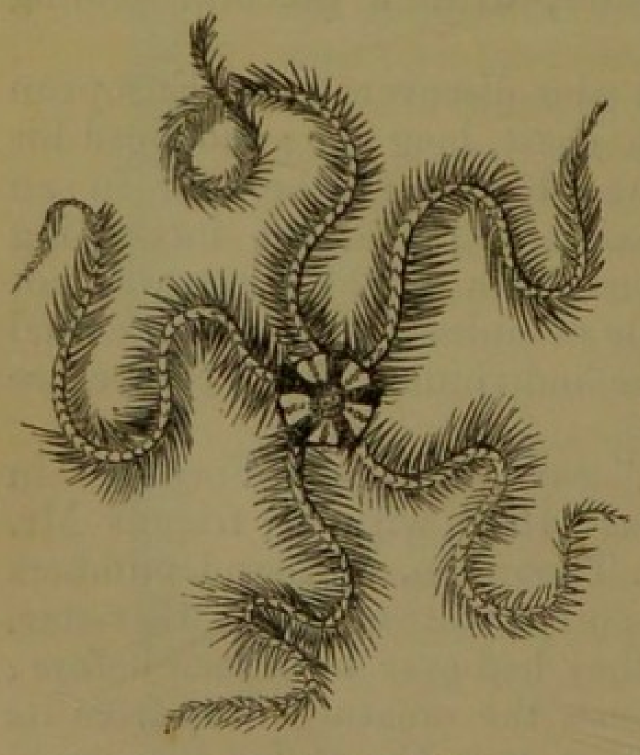
The figure in our engraving marked 6, is that of a *Comatula*, or Feather-Star, in which we have made a manifest advance towards the ordinary form of a star-fish. Yet the *Comatula* is but an Encrinite deprived of its stem, and thus enabled to rove freely through the sea; even close observation failing to detect any other difference. The central box, which contains the *viscera*, is made up of many strong pieces, with a star-shaped mouth in the centre; around which radiate five arms or rays, which are divided each into two or more smaller rays, the whole being set with a double row of jointed filaments, formed on the same principle as the rays themselves. By means of these elegant rays, the Feather-star can creep on the bottom of the sea, using them as feet, or twining them around the stems of sea-weeds or corals, as it climbs in search of prey; while at other times, the undulations of its feathery filaments row it from place to place, through the free water, with a graceful gliding motion.

The able zoologist who discovered the European Encrinite on the Irish coast, long ago announced his persuasion that it was but a Feather-star in an early stage of its existence; that the interesting transition from the one form to the other, was not only a step in the scale of animal life, but an actual metamorphosis of the individual. This conjecture has been verified.

"When dredging," says Professor Forbes, "in Dublin Bay, in August, 1840, with my friends Mr. R. Ball, and Mr. W. Thompson, we found numbers of the *Phytocrinus* or polype state of the Feather-star, more advanced than they had ever been seen before; so advanced that we saw the creature drop from its stem, and swim about a true *Comatula;* nor could we find any difference between it and the perfect animal, when examining it under the microscope."*

* Hist. of Brit. Starfishes.

Another advance is made towards the compact and rounded form of the Sea-urchins, by the next figure (5) in our engraving. This is the Medusa's Head (*Gorgonocephalus*), each of the five rays of which divides into two, near its base, each of these divisions into two more, each of these again into two, until at length they terminate in curling filaments of great slenderness, and exceedingly numerous. The lateral feathery filaments of the rays are no longer found, but the arms seem used to capture prey still, but in a manner peculiar to these species, the intertwined assemblage of living tendrils forming a sort of net, in which small animals are entangled and dragged to the mouth. The central portion is more developed than before, though it is as yet very small compared with the rays; but by many intervening steps, presenting minute variations, we at length arrive at a group called Snake-tailed Star-fishes (*Ophiuradæ*), one of which we have represented at fig. 4. The proportion between the extent of the rays and that of the central disk, is now much less in favour of the former, which are moreover no longer divided into branches, nor furnished with jointed filaments at their sides. The sides of the slender rays, however, are set with spines, varying in length in different species, which probably aid the animal in crawling upon the rocks, as they certainly do to a slight extent in swim-



SPINY STAR-FISH.

ming. The taper rays are curiously constructed; and being flexible, and twisted about with great agility when the creature is disturbed, look not a little like the tails of serpents; whence the name given to this Family:—a resemblance which is increased by the rays being covered with scaly plates which overlap each other.

The central disk, small as it yet is, is beautifully constructed of innumerable regular pieces accurately soldered, as it were, together. The mouth is in the centre, and from it radiate five furrows, pierced with holes, whence are protruded at will numerous small sucker-feet, which we now meet with for the first time, but which we shall have occasion to describe more at length hereafter.

A very interesting circumstance in the economy of these animals, is the extreme brittleness of their rays. On the least alarm or excitement, the animal throws off one or perhaps all of its rays, or in the act breaks them into a thousand fragments. Professor Forbes's account of this phenomenon in *Luidia fragilissima*, is very graphic. After speaking of the wonderful power which the *Luidia* possesses, of "not merely casting away its arms entire, but of breaking them voluntarily into little pieces," he says, "This faculty renders the preservation of a perfect specimen a very difficult matter. The first time I ever took one of these creatures, I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing-bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment I found only an assemblage of rejected members. My conservative endeavours were all neutralized by its destructive exertions, and it is now badly represented in my cabinet by an armless disk, and a diskless arm. Next time I went to dredge on the same spot, determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which article, Star-fishes have a great antipathy. As I expected, a *Luidia* came up in the dredge, a most gorgeous specimen. As it does not generally break up, before it is raised above the surface of the sea, cautiously and anxiously I sunk my bucket to a level with the dredge's mouth and proceeded in the most gentle manner to introduce *Luidia* to the purer element.

"Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not, but in a moment he proceeded to dissolve himself; at every mesh of the dredge, his fragments were seen escaping. In despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision."*

Our readers may be surprised at the mention of an eye in a Star-fish; there is, however, at the extremity of each ray a bright red speck, which is supposed by some zoologists to be a rudimentary organ of vision: a delicate filament of nervous matter proceeds to it from the nervous ring that surrounds the mouth, swelling into a small *ganglion* or knot, just beneath the speck.

Referring again to our engraving, we shall readily perceive the transition from the Snake-tails (fig. 4) to the true Star-fishes (*Asterias*), one of which is represented at fig. 3. By imperceptible gradations, as before, the rays have become shorter and wider at the base, and the central disk has much enlarged: the distinction between the disk and the rays has become in fact obliterated, for the latter now contain, in their interior, prolongations of the *viscera* from the body. Other species succeed, in which the enlargement of the central part still goes on, as also the widening and shortening of the rays, and thus the spaces between the latter being gradually

* History of British Star-fishes.

filled up, we have at length a five-sided figure, with perfectly straight edges.

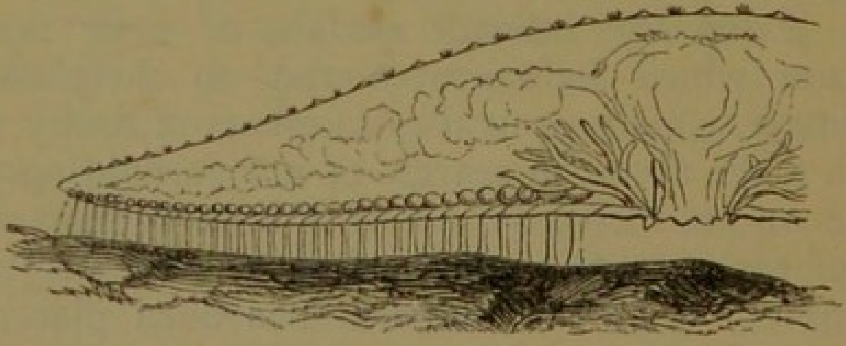
It is clear that the powers of motion which resided in the flexibility of the rays, must by this time be altogether lost; though in those species of the true Star-fishes, in which the rays, though short, are distinct, these still are sufficiently flexible to admit of their points being bent downwards, forming five feet on which the animal may to some extent move forward. But even this would be impracticable in the straight-edged species. It is then an interesting inquiry by what organs locomotion is now effected; and we shall, in answering the question, exhibit a most elaborate apparatus, astonishing us by the ingenuity of its contrivance, and by the perfection of its construction, no less than by its fitness to produce the desired result.

"Let a Star-fish," observes Professor Jones, "be placed in some transparent pool left by the tide, within a rocky basin; watch it there, and doubtless, soon the most incurious looker-on will find himself compelled to gaze in mute astonishment at what he sees. From the inferior surface of each ray, the creature which before appeared so helpless and inanimate, slowly protrudes numbers of fleshy tubes, which move about in search of a firm holding-place, and soon are fixed, by means of little suckers at the end of each, to the smooth surface of a neighbouring stone, or, if the Star-fish has been placed in a glass filled with salt water, to the inner surface of the glass, where every movement may be plainly seen. When these have laid fast hold, others appear in quick succession, and likewise are attached to the smooth surface, till at last hundreds of little legs, for such these suckers seem, are actively employed; and by their aid the creature glides along with such a gentle motion, that it seems rather to swim than crawl."*

* Lect. on the Nat. Hist. of Anim. i. 255.

The skeleton of the Star-fish consists of an innumerable assemblage of separate pieces of earthy substance, varying in shape, but all united with perfect accuracy by a dense leathery membrane ; but the pieces which run along the inferior surface of the rays are of more regular shape, and arranged transversely, diminishing in size towards the point of the ray. These lines of *vertebræ*, as the pieces are called, form a furrow, to which the name of *ambulacrum* has been given, from a fanciful resemblance to a walk or avenue. Each *vertebra* is perforated with one or two holes, and as they are arranged in pairs, there are regular rows of orifices, of which the common Star-fish (*Uraster rubens*) has four down each ray.

Through every one of these minute holes projects a little membranous tube, with its extremity dilated into a disk or sucker ; while within the skin it is connected with a little globule filled with a liquid, and capable of muscular contraction or expansion. The accompanying figure of a Star-fish's ray, divided



SECTION OF RAY.

perpendicularly, will explain the mechanism of these sucker-feet. By the contraction of a globule, the fluid which it contained is forced into the projecting tube, which is thus stiffened and lengthened, until its sucker reaches the ground and adheres to it ; then the tube is contracted and the globule is expanded, causing the fluid to return into the latter : the tube being thus shortened while the sucker maintains its hold, the animal is dragged forward to the spot, and, though apparently helpless and inert, "are capable of overpowering the struggles of the most active of their victims. When watching for their prey they rest with the rays gently bent towards the mouth. The instant that a shell-fish or unlucky crab comes within their grasp, they fold themselves closely over it, the rays pressing it to the mouth, which is dilated to receive it: still it might be supposed capable of escaping by the exertion of strength and activity; not so, for no sooner do the rays fold over it than all the suckers, to the amount of more than three hundred in each ray, are protruded and fixed tenaciously upon it: its efforts are in vain, and struggle as it may, it is dragged closer and closer, and at length engulfed. In a short time the soft parts of the prey are dissolved, the hard and shelly portions being rejected. Small crabs and small shell-fish are swallowed entire, for the stomach is amazingly dilatable; but shell-fish of large size are not the less the victims of the Asterias, though it cannot swallow them whole. The destruction which it commits among oysters was indeed well-known to the ancients, who believed that it obtained the mollusk by inserting one of its rays between the valves of the shell when the creature happened to lie with them partially open, and that it then gradually forced itself in, till its prey became in contact with its mouth." *

This procedure, though sufficiently ingenious, is not the mode pursued by the Star-fish; it has the singular faculty of protruding its stomach from its mouth, in several lobes turned actually inside out; from these there exudes a poisonous fluid, which being dropped between the shells of the oyster, at once deprives it of all power of closing its valves. The protruded stomach of the Star is then thrust in, and, embracing the flesh, digests it where it lies.

The modification of form in the ECHINODERMATA

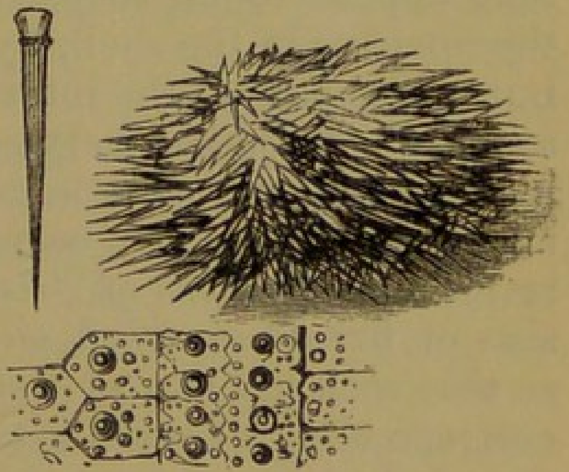
* Martin's Pict. Museum, ii. 403.

still proceeds; the points of the pentagon gradually becoming more rounded, until the genus *Scutella* (fig. 2) presents the form of a nearly circular flattened shield. The traces of the pentagonal figure, however, yet remain in the *ambulacra*, which are seen to radiate like the petals of a flower, from the centre. The skin is no longer flexible or leathery, but composed of dense calcareous plates of regular shape accurately fitted together, so as to form a firm shell. Motion is not performed by sucker-feet, but by other organs not less admirable. "The *Scutellæ*," observes Professor Jones, "bury themselves beneath the surface of the sand, a situation in which suckers would be of little use, but for which these animals are admirably adapted by a contrivance not less calculated to excite the admiration of the observer. The exterior of the shell is entirely covered with minute appendages, resembling, when seen by the naked eye, delicate hairs, but which, when examined under a microscope, are found to be spines of most elaborate structure. Innumerable as these spines are, every one of them is articulated to the shell by a kind of ball-and-socket joint, and susceptible of being moved in all directions, so that by their combined efforts the Scutella can speedily bury itself either for the purpose of procuring food, or of eluding observation."*

Through many connecting forms, some of which exist only in a fossil state, we arrive by the most gradual steps at the globose Sea-urchins (*Echinidæ*). These for the most part resemble an orange in shape, being a flattened sphere, at each pole of which is an orifice, the one being the mouth, the other the vent. In fig. 1 of our engraving, a common species is represented, divested of the spines, with which it is clothed during life, in order to the better display of its form as compared with its fellows. The radiated form which allies it with the

* Outline of Anim. Kingdom, 143.

Star-fishes is still plainly seen in the five segments into which it is divided by the marks on its surface, diverging from each central point. Upon each of these segments are seen two rows of nipple-like tubercles, on every one of which a spine is placed, varying in length and in sharpness in different species. The spine is not immovably fixed, but is formed to work freely on the tubercle by a ball-and-socket joint, so as to turn in various directions, as we saw in the hair-like spines of the *Scutella*. Between these two rows run down two channels, or ambulacral furrows, perforated with hundreds of minute holes, through which are protruded or drawn back the sucker-feet. Multitudes of smaller spines project in all directions from the surface of the skin, besides the larger ones above mentioned. Every segment is composed of many pieces of a regular six-sided figure, which are dovetailed into each other with beautiful precision; an admirable arrangement, by which alone the growth of the animal could be permitted. For if the shell were composed of one continuous piece, formed as it is by deposition from the surface of the animal, it is plain that every layer deposited would diminish the interior, while the contained animal would be ever increasing in size. But, as it is, every one of these six-sided pieces is increased by layers on its inner surface, each layer being a little wider than the preceding; and thus each piece gradually enlarges (and consequently the whole shell), while at the same time the definite form of each is exactly retained.



GREEN-PEA URCHIN.

The sucker-feet protrude from the whole circumference; and are sufficiently long to be extended beyond the tips of the longest spines, even in those species in which these appendages are of the greatest length. Their construction and office are similar to what we have already described in the true Star-fishes; and by these the globular Sea-urchin is enabled not only to travel along the rocky bottom of the sea, but even to mount up the sides of the rocks, and creep along pendent from the roof of submarine caverns, clinging by the sucker-like disks with which the extremities of these singular organs are furnished.

The mouth is carried on the under surface as the creature crawls upon the ground: it is a circular orifice, placed in the centre where the radiating lines meet, and is filled up by five sharp and hard teeth, somewhat like the front teeth of a Squirrel, the points of which meet in the centre. "Externally they appear to be suspended from the margins of the opening in the shell, by a leathery-looking skin; but on examining the interior of the shell, they are seen to be fixed in a very curious frame-work, which in shape somewhat resembles an old Grecian lantern, and has consequently been called after its first describer, *the Lantern of Aristotle*. This lantern consists of five three-sided pieces, arranged in a circle so that each has two of its sides in contact with the corresponding sides of the two pieces contiguous to it, the whole being bound together by strong muscles, and moved in every needful direction by a very complicated apparatus of levers and ropes, disposed with admirable precision. All the contiguous sides of these five pieces are grooved like files of most beautiful workmanship, and between these ten files every particle of food must pass before it gets into the stomach, so that soft substances are thus bruised and triturated, as by means of a mill, before they are swallowed. But the most important use of this frame-work is to furnish sockets wherein those teeth that project out of the mouth may *grow;* for, hard as their points are, they would soon be worn quite down to the opening of the mouth, by constantly biting such substances as the *Echini* swallow, did their growth not keep pace with their wearing away. Each of these teeth is, therefore, implanted in a separate socket, and is constantly growing at its root, as fast as it is ground down at its point, which is thus kept always of the proper length; and from its peculiar prismatic shape, it is never blunted by the hard work it has to do. But the most puzzling part of this singular apparatus, which, indeed, is quite unique in the animal creation, is, that notwithstanding the extreme elaborateness of its construction, and the delicacy of the ten files between which the food must pass, the alimentary canal of the Sea-urchins is generally found filled with the most intractable substances, such as sand and broken pieces of shells and coral, as though these animals were destined to economize the last crumbs that fall from Nature's bounteous table, by extracting, even from the very sand, such particles of organized matter as might still be made available as nutriment; as some worms have to swallow the mould in our gardens, thence to obtain the remnants of decay, that even they might not be lost. Vast, indeed, is the store of food provided for the nourishment of living beings, and we might well suppose that a supply so boundless, and so lavishly dealt out, allowed some waste, and that the leavings of so large a banquet might be left uncared for; but we here perceive how the last morsels are used up, and made the provender of creatures framed to reap enjoyment from the humble meal."*

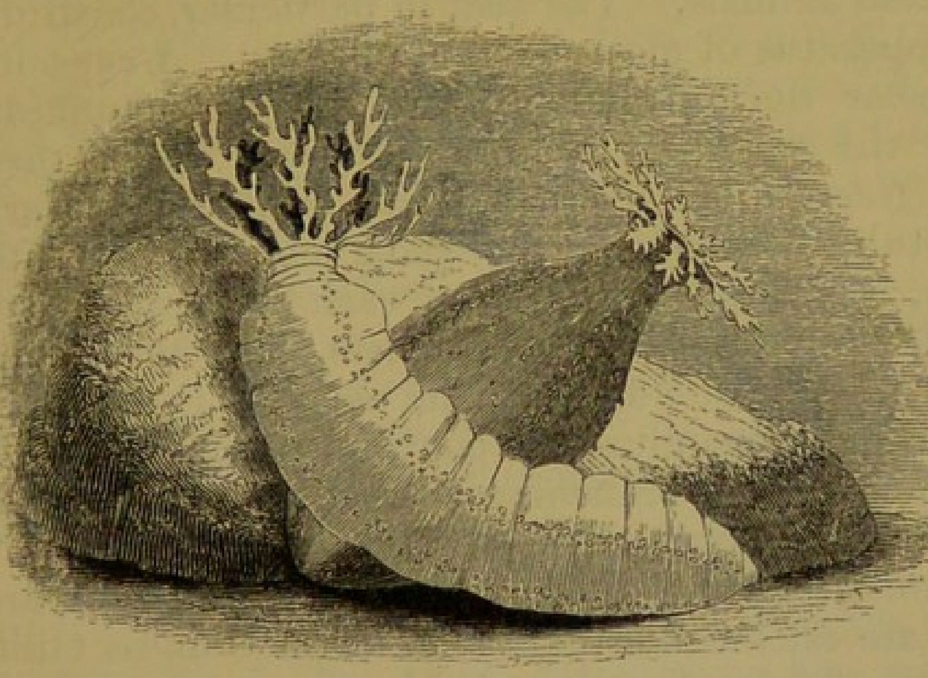
We have traced the gradual progress of the ECHINODERMATA from the polype-like form of the Encrinite, with its stem and its expanded tentacles, through a multitude of gradations, to the globular and highly organized Sea-urchin. There remains another link in this interesting chain; that by which

* Prof. Jones's Lectures on Nat. Hist. i. 282.

these "Stars of the sea" take hold of a higher order of being, connecting themselves with the lengthened and annular forms of Worms and Insects.

The fisherman's dredge occasionally brings up, on our own coasts, slimy creatures, bearing no slight resemblance to a cucumber, whence they are commonly known by the name of Sea-ghirkins or Sea-cucumbers. It is in the tropical seas, however, that they most abound, where they lie on the mud in the shallows, or crawl over the coral-rocks. The surface of the body is composed of a dense, tough, leathery skin, capable of being dilated or contracted, lengthened or shortened at the will of the animal, by means of longitudinal, circular, and oblique bands of muscle. No stony substance is deposited upon the body; but relationship to the Urchins and Star-fishes is manifestly preserved, not only by the internal anatomy, but by the organs of locomotion, which are suckers of precisely the same structure as those already described. In most species these run down the body in five radiating lines, as in the Urchins; but in some they are confined to *a broad fleshy disk on one side only*, which thus becomes the belly, as on it the animal crawls like a caterpillar or a slug. The reader will not fail to remark the important step thus made towards these higher forms.

As if, however, to manifest an affinity also with the low polype-form, we find in the *Holothuriæ* a circle of branched tentacles which surround the mouth. These are capable of being withdrawn into the body, but are commonly protruded in expectation of prey, which is seized and dragged to the mouth by them. They greatly resemble in appearance the tentacles of some of the *Actiniæ*, especially when the *Holothuria* has buried its whole body in the mud or sand, with the exception of the beautifully branched tentacles which expand like the petals of an exquisite flower upon the surface. Around the mouth, at the base of the tentacles, is a series of thin and frail plates composed of stony matter, that represent the teeth of the *Echinus*, but endowed with far less power.



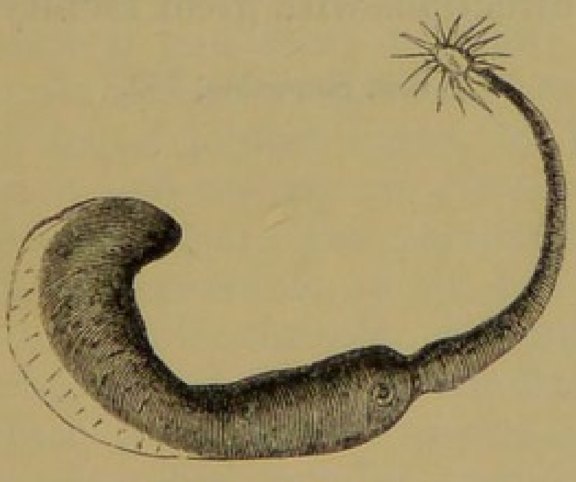
HOLOTHURIÆ.

We have seen these Sea-cucumbers numerous in the sunlit shallows of the West Indian seas. When taken out of the water they are soft and flexible; but while held in the hand they presently contract so forcibly as to become perfectly hard and rigid, while the sea-water contained in the body is ejected in a forcible stream or jet from the terminal orifice. Sometimes these spasmodic contractions are so violent as to cause the viscera themselves to be discharged; yet this misfortune is soon remedied; for by another analogy with the Acrite Polypes, the *Holothuriæ* have the power of renewing any parts of which they have been accidentally deprived. Sir J. G. Dalzell has seen them deprive themselves of their tentacles, their mouth with its circle of teeth-plates, and even the gullet, leaving the body an empty sac; yet all the lost parts are regenerated within the space of three or four months. The same zoologist has observed that some species divide spontaneously through the middle into two or more parts, which become ultimately perfect by the development of new organs.

The systems of nutrition, of circulation, and of respiration, are very complex and highly developed in these animals. The last, in particular, constitutes an apparatus of most elaborate beauty. A capacious sac near the extremity of the body communicates with the sea-water by a large orifice, and is therefore freely filled by that fluid; from this sac arise two tubes running up the whole length of the intestines, giving off branches on each side, which subdivide with exceeding minuteness, so as to resemble trees of exquisite delicacy and elegance. The water is driven by the muscular contraction of the sac into these minutely branching vessels, and thus supplies the needful oxygen to renew the circulating fluid.

Uninviting as is the appearance of these creatures, they are esteemed as delicacies at the Chinese tables; and the fishing for them, with the subsequent processes of preparing and bringing them to market, forms no unimportant branch of commercial industry in the Oriental seas. Some of the species are two feet in length, and seven or eight inches in circumference, but others are much less. The larger sorts are sometimes obtained by spearing them upon the rocks in shallow water; but the ordinary mode of obtaining them is by diving in from three to five fathoms, and collecting them by hand: a man will bring up thus eight or ten at a time. They are prepared for the market by being split down one side, boiled, and pressed flat with stones: then, being stretched on bamboo slips, they are dried in the sun, and afterwards in smoke, and packed away in bags. In this state the article, now called *tre-pang*, is put on board the junks, and is in great demand in China for the composition of nutritious soups, in which that singular people so much delight. The quantity of this article of food annually sent to China from Macassar, amounts to 8333 cwt.; the price of which varies, according to the quality (for there are upwards of thirty varieties distinguished in the market), from thirty shillings sterling to upwards of twenty guineas per cwt. The extent of the traffic may be inferred from the number of vessels employed in it: Captain Flinders was informed, when near the north coast of New Holland, that a fleet of sixty proas, carrying a thousand men, had left Macassar for that coast two months before, in search of this sea-slug: and Captain King was assured that two hundred proas annually leave Macassar for this fishery. They sail in January, coasting from island to island, till they reach Timor, and thence steer for New Holland, when they scatter themselves in small fleets, and having fished along the coast, return about the end of May, when the westerly monsoon breaks up.

Removed by another step from the *Holothuriadæ* are the *Fistulariadæ*, which have a lengthened and slender body, and all the aspect of the Worms, with the exception of the circle of tentacles around the mouth, by which they indicate their lingering affinity to the ECHINODERMATA; but even this character in some species is almost obliterated. They have no suckers or feet; many of the species are marked by



HERMIT SIPUNCULUS.

wrinkles running round the body, as in the common Earth-worm. In their habits, also, these animals generally resemble the Worms, most of them boring deep holes in the sand, in which they lodge their slender bodies; others conceal themselves in the crevices of rocks, and there is one species (*Sipunculus Bernhardus*), which adopts the manners of the

Hermit-crab, and selects the shell of some periwinkle or whelk for its abode. This sea-worm appears, however, to be of a less changeable disposition than its crustacean namesake, rarely quitting a shell that it has once selected. "Whether the egg," remarks Professor Forbes, "is originally deposited in the future abode of the animal by some wonderful instinct, or is only developed when lodged by the waters in such a locality, or whether the parent Siponculus bequeaths the chosen lodging of its caudal termination to its eldest-born, and so on from generation to generation, we know not at present; but the inquiry is a most interesting one, and well worth the attention of the experimental Zoologist. The Siponculus is not, however, content with the habitation built for it by its Molluscan predecessor; it exercises its own architectural ingenuity, and secures the entrance to its hole by a plaster-work of sand, leaving a round hole in the centre sufficiently large to admit of the protrusion of its trunk, which it sends out to a considerable length, and moves about in all directions with great facility."*

* Brit. Star-fishes, 252.

SUB-KINGDOM III.

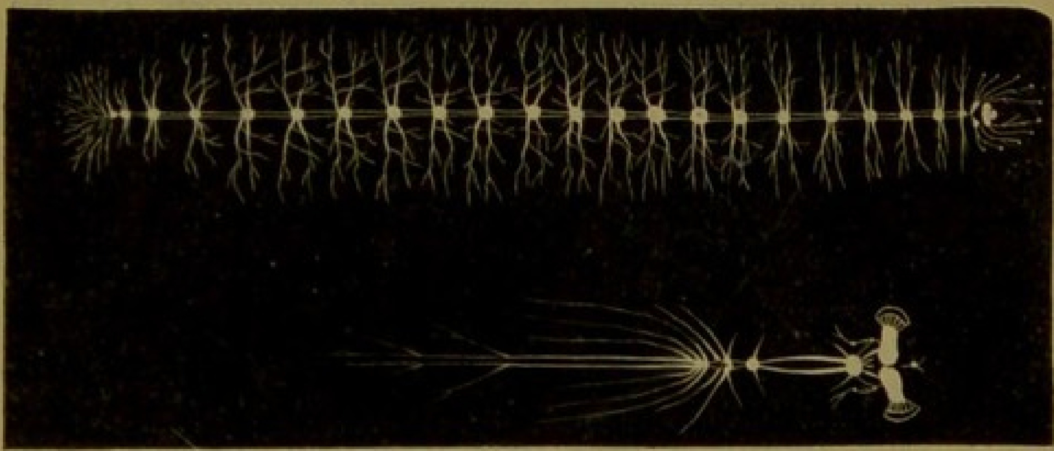
HOMOGANGLIATA.*

(*Jointed, or Ringed Animals.*)

We have now surveyed two great divisions of the Animal Kingdom, both of them very populous; but neither these united, nor all the rest of known animal existences added to them, would equal or even approach, in number of species, that at which we are now arrived. The subjects of our present consideration are constructed on a higher model than those which we have dismissed: we have, it is true, seen an organization beautifully elaborate in the Star-fishes and Urchins, and in the Sea-cucumbers we have nearly lost the trace of a radiated arrangement of parts; but in neither the one nor the other, do any of the organs of sense (with the exception of feeling, the lowest and most indefinite of all) exist, beyond a doubtful and rudimentary condition; nor have we yet found jointed limbs, by the action of which precision and energy are given to an animal's motions. But above all, the nervous matter, wherever it has been discernible at all, has existed only in the form of slender threads, without any masses or centres into which it is accumulated. In the creatures which we have now to examine, however, there is a distinct and regular arrangement of the nerves, which are now sufficiently obvious: a double chord runs down the central line of the body on its under part, which at regular intervals swells and unites into knots called *ganglions*, from which proceed nervous threads on each side. The pair of ganglions nearest the mouth are not situated, as are

* Animals having "ganglions," or nerve-knots, similar to each other.

all the rest, below the alimentary canal, but above it,—the nervous chords forming a collar around the gullet, on the top of which the anterior nerve-knot is placed; this, as it supplies nerve-threads to the antennæ, eyes, and other organs of sense, may be regarded as a sort of brain; though each ganglion of the whole chain is a brain to its own region of the body, sensation being thus distributed over the whole



NERVES OF LEECH AND COCKCHAFER.

length, instead of being concentrated into one part. The comparative energy of sensation is, however, dependent on the fewness of these nervous centres; and thus in the predatory Beetles, the Spiders, and the Crabs, we find the ganglia few in number, but large, compared with those of the Leeches and Worms.

The term HOMOGANGLIATA expresses this peculiarity, that the ganglions are alike; and though somewhat repellent in its appearance, it is more suitable, inasmuch as it expresses a more essential distinction, than those of ARTICULATA and ANNULOSA, both of which have been applied to this vast group of animals. As we may have occasion, however, to use these terms, it may not be amiss to explain them. The former signifies *jointed*, the latter *ringed*, and they both refer to the same peculiarity, the division of the whole body into successive rings, formed by the skin; these are very numerous in the Leeches and Worms, but in Insects, and still more in Spiders and the higher Crustacea, this skeleton of skin is consolidated by the soldering together, as it were, of several of the joints, so as to make them few in number.

In these animals, we for the first time find the power of moving freely upon the earth and through the air. The feeble bodies, and undeveloped senses of the creatures we have yet considered, render them unfit for existence in any other element than water, or the juices of other animals, analogous to it. But many of the HOMOGANGLIATA are endowed with senses and powers which fit them for a higher sphere, though still a great number of these inhabit the waters.

CLASS I. ANNELLIDA.

(*Ringed Worms.*)

CONFORMABLY with the principle that "Nature proceeds not by leaps," but by gentle and almost imperceptible steps, we find the animals with which we commence the vast group before us, not much removed in appearance and form from the lengthened and soft-bodied ECHINODERMATA. They, too, have the body lengthened, and, as the name ANNELLIDA imports, divided into numerous segments or rings, of which the common Earthworm will afford a familiar example. Many of them have tentacles proceeding from the head, which serve as instruments of touch. But in addition to the difference in the nervous system already described, the Worms are marked by the possession of red blood, which circulates in a double system of arteries and veins. Each of the rings of the body is generally furnished with a series of short bristles, which assist the animal in its change of position and place, and appear to be the first rudiments of true limbs.

If we examine the dead shells which we pick up near low-water mark, or rough stones, or pieces of crockery, or any rough substances sufficiently heavy to lie still at the bottom of the water, we shall be almost sure to observe, here and there, slender shelly tubes attached to them, twisted about in irregular curves. These are the tubes of a species of *Serpula*, one of the Annellida which we are considering. It is a worm composed of many rings, somewhat flattened at its hinder part, and destitute of limbs. The front, or the part which we may call the head, presents, during life and activity, a beautiful spectacle; for from each side spreads an elegant fan of branched filaments, of a rich purple or crimson hue, which float loosely in the water, and serve the animal as breathing-gills to extract oxygen from the element in which it lives. But besides these splendid fans, there is a tentacle on each side of the mouth, one of which expands into a broad trumpet-shaped extremity. The outline of this accurately fits the mouth of the tube, and when the creature is alarmed, it quickly draws in this singular trap-door, and remains within its shelly cell safe from external violence. After a few moments, however, of quiet, its alarm subsides, the trumpet-shaped stopper is cautiously protruded, and the beautifully-tinted gills are expanded as before. Some of these animals form shelly tubes, which are rolled up in a very regular spiral coil; others have the fore part free, and elevated from the surface of the substance to which it is attached.

TEREBELLA MEDUSA.

In these species the shelly tube is composed entirely of calcareous matter secreted by the skin of the animal; but in others it is formed of extraneous matters, such as grains of sand, fragments of shells or whole ones, small stones, &c., glued together by the animal secretion, which hardens into a tough leathery consistence. The *Terebella*, for example, unfolding the coils of its body, extends its large tentacles in every direction in search of fragments of shells. These it drags to its head, fastens them in a sort of ring or collar, by means of a gummy matter, and, by lengthening this, forms a tube prettily studded with little shells.

Leaving the ANNELLIDA which dwell in tubes (*Tubicola*), and which are, therefore, necessitated to have their breathing-organs situated where they can be protruded, we come to those which are not so protected, and which have the gills set in pairs along the body, hence called *Dorsibranchiata*.* In some cases every ring is thus furnished, but in others only those rings which are near the middle. These are free, burrowing in the mud and sand, or swimming in the open sea; they are therefore supplied with organs of locomotion, which for the most part assume the form of short moveable spines, or packets of retractile bristles attached to each segment of the body.

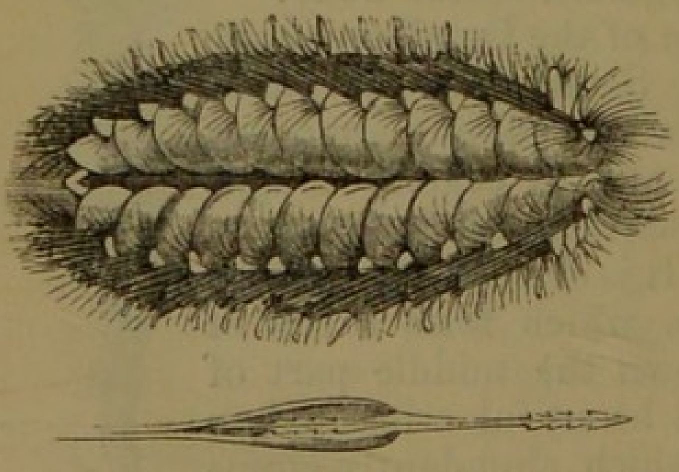
SAND-WORM.

A good example of the Dorsibranchiate ANNELLIDA is the Sand-worm (*Arenicola piscatorum*). It is exceedingly abundant on sandy shores, and is eagerly sought and used by the fishermen as bait, by whom it is called Lug. It is of a reddish colour; and the gill-tufts, which form a row of little bunches down the middle part of the body, are of a beautiful crimson hue from the blood which abundantly circulates in them. It bores rapidly in the sand by means of its conical head, which

* Having "gills" (*branchiæ*) on the back.

can be lengthened or shortened at pleasure; and, as it moves on, the sides of the treacherous passage are prevented from closing up again by a secretion from the body of the animal, which unites the particles of sand into a kind of wall; this, as the creature advances, is left behind, exhibiting, in miniature, the mode in which the brickwork of a tunnel is constructed.

The crimson tufts of the Sand-worm render this a species not destitute of beauty, but it is far surpassed in splendour of colouring by some of its kindred; for there are animals belonging to this Order which will vie with the most richly adorned bird or beetle. One of these, which is frequently dredged up from muddy ground, is the Sea-mouse (*Halithea aculeata*), whose form is much shorter than that of most ANNELLIDA, approaching even to an oval. This animal is four or five inches in length, of a grey hue, clothed with a fine silky down on the back, under which are concealed fifteen pairs of scaly plates, one pair on each ring, covering the gill-tufts. The under surface is smooth, but is marked by transverse divisions, forming about forty rings or segments. From the sides project bunches of flexible spines or bristles, of a splendid golden hue, on which play all the changing tints of the rainbow: and which, as Cuvier observes, "are not inferior in beauty to the plumage of the Humming-bird, or to the lustre of the richest gems." Each of these bristles, moreover, is seen under the microscope to be a barbed dart or harpoon, the extremity being cut into several teeth pointing backward, affording truly



SEA-MOUSE.

formidable *chevaux de frise*, for protection against violence. But as these spines, as usual in animals of this Class, are, when not in use, drawn back, and sheathed as it were in the body, an additional provision is necessary. It is obvious that barbed spines, such as these, imbedded in the flesh of the animal, would be exceedingly painful, as every movement of the body would force some of the points into the surrounding parts, and laceration and injury would be the infallible result. To prevent this, each individual spine is provided with a smooth horny sheath, composed of two blades, between which it is lodged, which closing upon it when drawn inwards, effectually protect the flesh from injury.

Each of the segments is produced at the margin into a short fleshy sort of oar, armed with spines; which may be contracted at the pleasure of the animal into a conical wart, and serves to row the body through the water, being moved with precision and energy by means of a special set of muscles.

"It is a beautiful sight," observes Professor Jones, "to see a man-of-war's barge full-manned with sturdy rowers, gliding along over the level surface of the sea, the oars all keeping time with such precision that they seem to move as by one impulse. It is a grand spectacle to behold the meteor-like progress of a steam-ship as it cleaves its onward path; but far more beautiful, far more magnificent to the admirer of the works of Nature, is it to observe the movements of these splendid worms.

"We have before us now a specimen of one of the largest and most elaborately constructed species, the *Eunice gigantea*, measuring upwards of four feet in length, and consisting of four hundred and forty-eight segments, all provided with their complement of oars. Let any one of my readers imagine this gorgeous animal, free in its seas, blazing as it does with iridescent tints that answer back again the glowing brilliancy of a tropical sun, while it rows along its 'oary state' by means of upwards of seventeen hundred distinct propelling laminæ, all wielded with such energy that the eye can scarcely follow the rapidity of their movements, and he will perhaps form some faint idea of the efficiency of a locomotive apparatus such as is provided for the Dorsibranchiate Annellidans. Upon our sea-coasts, indeed, he may indulge himself by witnessing a similar spectacle upon a smaller scale, and succeed in forming some estimate of the perfection of this complicated machinery." *

In this Order of ANNELLIDA, the mouth, if mouth it may be called, exhibits a very singular structure. The commencement of the alimentary canal is capable of being turned inside out, like the finger of a glove, when it appears like a thick proboscis, armed with a truly formidable array of sharp teeth, curved fangs, keen knives, horny plates resembling rasps or files, varying in different species, but all calculated to seize and retain passing prey. No sooner is some small animal seized with this wonderful instrument of offence than the whole protruded proboscis is quickly inverted, carrying the hapless victim into the living cavern, from which there is no escaping.

Like so many others of the inhabitants of the sea, some of the ANNELLIDA are luminous, a very interesting example of which is quoted by Mr. Patterson from the pen of Mr. R. Ball.† The species is not named, but it was probably one of the *Dorsibranchiata*. "The most beautiful instance," observes this gentleman, "that I ever saw of luminous animals, occurred when I was passing at night between the islands of Arran, in the Bay of Galway. My attention being attracted by spanglings of light on the field of Zostera (grass-wrack) below, I let down my small dredge. On its touching the bottom, a blaze of light flashed from the Zostera; and as the boat was pulled along, the dredge seemed as if filled with liquid molten silver. On drawing it up, I found the light to proceed from numbers of a very small species

* Lect. on Nat. Hist. i. 333. † Zoology for Schools, 67.

of Annelid; these little animals were bright red, and so soft that they could not be taken out of the dredge. Any attempt at preservation would have been vain. By daylight, it is probable, their very existence would have been unnoticed, so little conspicuous were they. An idea of the size and luminosity of the Annelid may be formed by supposing its body to be represented by the slit in a silver spangle, and its luminosity by the disc of the spangle.

We have now to notice those ANNELLIDA which are totally destitute of gills; and which respire by means of numerous small sacs situated within the skin, and communicating with the external medium through minute pores, on the surface of the skin, as the Leech (*Hirudo medicinalis*), and the Earthworm (*Lumbricus terrestris*).


LEECH.

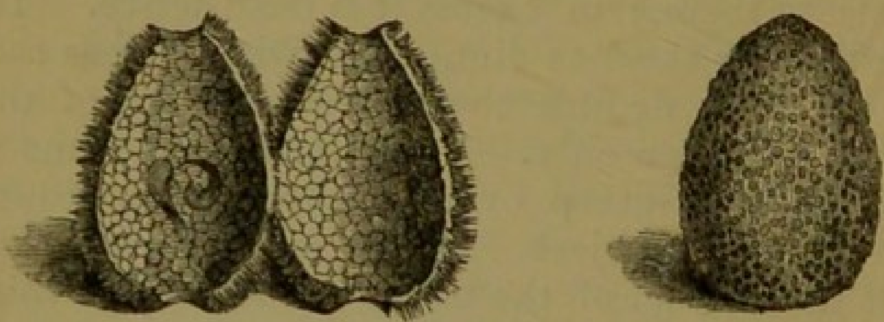
The former is the representative of the Suctorial ANNELLIDA, and, as is well known, is of a lengthened form, generally flattened, marked with very many transverse wrinkles. At each extremity is a fleshy disk, which acts as a sucker in progression; the head being stretched forward to its fullest extent, the fore-sucker is attached; the rings are powerfully contracted, and the hind-sucker attached near the former, which is then loosened, and thrust forward as before. The Leech, however, can swim with much elegance, though not with rapidity; this is performed by quick serpentine waves perpendicularly, the body being flattened into a thin band. The instinct which induces the Leech so greedily to suck the blood of other animals, has been turned by man into a very valuable means of alleviating human suffering. Its mouth, situated in the middle of the front sucker, has three little teeth placed triangularly, each with a saw-like edge; and when the action of the sucker has made the skin of the patient tense, these teeth are pressed against it, until three cuts are made, extending to some depth, and the blood thus liberated is sucked largely into the stomach of the animal. It would appear that this instinct is a direct and exclusive ordination of Providence for man's advantage. That blood is not the natural food of the animal is probable from the fact, that in the streams and pools which they inhabit, not one in a hundred could in the common course of things ever indulge such an appetite; and even when received into the stomach, it does not appear to be digested; for though it will remain there for weeks without coagulating or becoming putrid, yet the animal usually dies, unless the blood be vomited through the mouth. The demand for these useful creatures, at least for two species, the Medicinal Leeches (*H. medicinalis* and *H. officinalis*), for the purposes of surgery, has caused them to become scarce with us, but great numbers are annually imported from the Continent. The former of these is sometimes called the German, or brown, or grey Leech, or the true English, or speckled Leech, while the latter is known as the Hungarian or green Leech. In the former the belly is spotted, in the latter it is spotless. One German is considered to be as good as two Hungarian Leeches.

Some notion of the importance of these animals in a commercial point of view may be gathered from the fact, that four of the principal London dealers import 7,200,000 annually. Their increasing scarcity renders their preservation an object of interest. That difficulty is found in keeping them arises from insufficient knowledge of their requirements and habits. "Though aquatic animals, it is not enough that they be supplied with water. They breathe by their entire surface, and are accustomed to change their skin every four or five days. Their body is covered, like that of all animals and plants that inhabit the water, by a slimy or mucilaginous fluid, which not only enables them to glide through the water, but keeps an aerial stratum in close contact with their respiring surface. When present in a limited degree, this mucous secretion is highly serviceable to them,; in excess it is destructive. It is impossible for them to diminish it when it has accumulated, or to denude themselves entirely of their old skin, in water only. They must have some resisting body to creep over or through in order to accomplish this object. Some leech-dealers keep clay at the bottom of the troughs, and though this is useful as a material in which the Leeches can burrow in warm weather, (by which they are always more injured than by cold, if not intense ; and it is their habit to retreat to the deeper waters of their native rivers or ponds in summer,) it is inadequate to the end."* The best method of proceeding seems to be that recommended by Fee :—

Into a marble or stone trough a layer of seven inches of a mixture of moss, turf, and charcoal of wood is to be put, and some small pebbles placed above it; at one extremity of the trough, and midway between the bottom and the top, place a thin plate of marble pierced with numerous small holes, upon which there should rest a stratum of moss or portions of the *equisetum palustre*, or horse-tail, firmly compressed by a stratum of pebbles. The trough to be replenished with water only so high that the moss and pebbles should be but slightly moistened. A cloth is to be kept over the mouth of the trough. This is imitating as near as possible their natural condition, as the charcoal not only aids in keeping the water sweet, but appears to prevent the Leeches being attacked by parasitic animals, to which they are very liable. The water should be changed about once a week, and more frequently in warm weather.

* Penny Cyclop. xiii. 384.

When kept in large reservoirs, with clay banks fringed with rushes and aquatic plants, the Leech will increase its kind. It lays about a dozen eggs, inclosed in a mucous cocoon of an oval form, about a quarter of an inch long.



COCOONS OF LEECH.

In the month of August, holes may be observed in the mud or clay of the banks, each of which contains a cocoon. One end is weaker than the other part, and from this the young escape. The enclosed eggs are hatched in about a week, but three weeks elapse before they leave the cocoon. During the interval, the cocoon has distended a good deal, and the little animals are continually pushing its walls with their heads as if trying to find the weak point and escape. When at last their increasing strength enables them to burst forth, they are about a quarter of an inch long, and no thicker than a thread.

The Earthworm is not furnished with a sucker at either extremity; it is dependent on other resources for its power of locomotion. Its body consists of a number of fleshy rings, capable of great extension and contraction; these, though they appear smooth, are furnished with sets of short horny bristles, recurved, pointing towards the tail, any or all of which can be protruded or withdrawn at will. The Worm then proceeds in the following manner: the head and fore rings of the body are stretched forward and considerably lengthened: then the bristles of these parts, of which there are four pairs on the under side of every ring, are thrust out, and, being strongly pressed against the ground, take a firm hold, while the body is forcibly contracted; the hind part, being alone at liberty, are of course drawn forwards when the bristles of these rings, being in their turn pressed against the ground, afford a resistance, by means of which the head is again advanced. By a process exactly similar, the animal burrows in the earth; the head, being lengthened out to a fine point, is inserted into very minute orifices, or between very close particles; a hold being thus obtained for the bristles, the contraction of the body forcibly swelling the rings in proportion to their shortening, enlarges the passage, and thus the Worm is enabled rapidly to move through a substance which would seem, at first sight, to present an impenetrable obstacle to its soft and yielding body.

The digestive canal of the Earthworm is very capacious; for as this animal devours mould impregnated with animal and vegetable matters in a state of decomposition, a large quantity must be taken into the stomach to afford sufficient nutriment for its support. The pellets of earth thrown to the surface of the soil, and called worm-casts, have been supposed to be a highly fertilizing manure; but this appears to be a mistake: they consist, indeed, of finely pulverized earth, but deprived, by the process of digestion, of every particle of organized matter.

This animal, then, affords us an instructive and beautiful example of the frugality of Creation. We might have supposed that the minute and inappreciable atoms of organic matter that fall upon the ground and mingle with the soil, were lost; but no: here are myriads of stomachs prepared, living alembics, in which the process of separating the nutritive particles from the inorganic is carefully carried on, and animal life is sustained by the result. What an important lesson! Nothing in the works of God is wasted; there is a boundless liberality, but no waste! He who by His Almighty word could swell a few barley-loaves into a meal for five thousand men, said, when their appetites were satisfied, "Gather up the fragments that remain, THAT NOTHING BE LOST!" *

The mud at the bottom of ponds and streams is perforated by animals closely allied to the Earth-worms, belonging to the genus *Naïs*. Their body is slender, and the rings, into which it is divided, are few, and but slightly marked. They commonly live in their burrows, merely protruding the head, which is furnished with a long proboscis. This is the organ with which the food is taken, and for this purpose it is continually moved about. These water-worms have a power of multiplication which is surprising in animals so highly organized, though we have been familiar with it in the lower Orders. They increase by spontaneous division. One of the most common species of our brooks, the *Naïs proboscidea*, consists, when full grown, of about fourteen segments. After a time, some new segments are formed, not at the extremity, but a little way above it. These lengthen, including what was the original extremity, and soon begin to separate, by a constriction, from the parent, at the same time taking the form of a new *Naïs*, by the gradual formation of a proboscis, and by the appearance of eye-specks. But before this newly-formed animal has quite broken its connexion with its parent, another offspring had been in the course of production near its own tail; and sometimes even this has begun to form a fourth, before the separation of the first is complete.

"To those who are fond of indulging in curious speculations," observes Professor Jones, "this division of the old *Naïs* into young ones, presents a very curious phenomenon. As the segments that will form the new *Naïs* are produced, not from the tail of the original one, but only in the neighbourhood of the tail, it will be seen that after separation the tail of the old animal belongs to the young one; and when a similar process is repeated, to give origin

* John vi. 12.

to a third offspring, the same tail is bequeathed as a sort of heir-loom, and so on from generation to generation this immortal tail is transmitted from parent to progeny, forming as strict an *entailed* estate as any eldest son could wish for."*

CLASS II. MYRIAPODA.†

(*Centipedes.*)

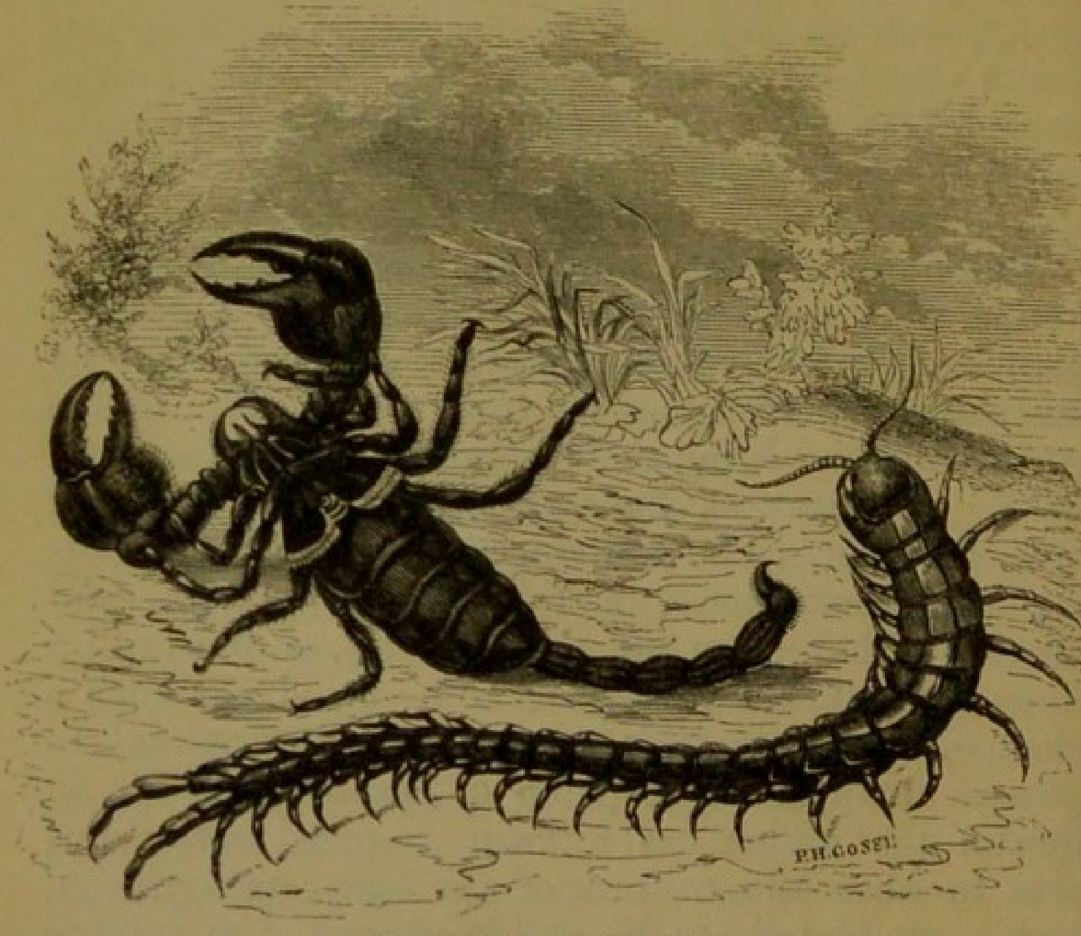
The animals which have thus far come under our notice, with very trivial exceptions, have possessed bodies of so feeble and yielding a structure, as to be incapable of performing the functions of life, unless surrounded and supported by water, a dense medium, nearly as heavy as their own substance. We are now, however, to be introduced to creatures inhabiting the atmosphere, a thin and rare fluid, and moving either upon the solid ground, or buoyed up upon the subtle air itself. To be fitted for such a change, not only is it needful for the animal to possess an apparatus capable of respiring the air, in lieu of that which has hitherto respired water, but also to have the texture of the body strengthened and consolidated, to be endowed with firm jointed limbs, which may act as levers upon the irregular surface of the earth, and to have the nervous system concentrated by reducing the number and increasing the relative size of the *ganglions* or nerve-knots, so as to impart the needful energy to the limbs, and other organs, and to receive the more varied and acute sensations of an aerial existence.

These changes we accordingly find: the air-breathing animals which we have now to describe are furnished with air-pipes or lungs, into which the atmosphere is admitted through orifices situated in

* Lectures, i. 330.

† "Ten-thousand-footed," a hyperbolical term, implying the presence of many feet.

various parts of the body; their structure is strengthened and defended by a hard and horny skin, forming an external skeleton, and affording a firm attachment to powerful muscles; limbs, composed of several joints, and capable of precise and varied



SCORPION AND CENTIPEDE.

movements are found; and elaborately constructed organs of the higher senses, no less than anatomical investigation, point out a concentration of the nervous ganglions, progressively increasing, as we approach the predaceous Insects.

At the same time in the earlier of these forms, as in the Class before us, we find much to remind us of the Worms that we have just left. The body is still greatly lengthened, and divided into many rings or segments, agreeing in form with each other. In the *Julus*, the short and thread-like feet, which are fastened to the bottom of every one of its numerous segments, remind us of the recurved bristles of the

ANNELLIDA, while the slow and undulating motion of these worm-like insects, and the power of rolling themselves up into a coil, increase the resemblance.

The animals of the Class before us, are divided into numerous very distinct segments, each of which is commonly furnished with two pairs of legs, terminated by a simple hook. The head is furnished with a pair of jaws, which do not, however, move up and down, but horizontally, their cutting-edges meeting like those of a pair of scissors. On each side of the head there is a group of eyes, in some Species so closely united as to present the appearance of a large convex lens, cut into hexagons, the common form of eyes among the true Insects. On the forehead are two organs named *antennæ,* composed of many joints, undoubtedly the seat of some delicate sensation, though we are as yet ignorant of its nature; there seems much reason for suspecting however, that the *antennæ* are organs of hearing.

The respiration of these animals is carried on by means of little oval openings, situated on the sides of the body, one on each segment; these admit the air into tubes, which then divide into numerous branches, and thus carry the vivifying fluid to all parts of the system.

We have already seen in the case of the ACALEPHÆ examples of *metamorphosis*; that is, the gradual change of form from the young to the adult animal. In the vast class of Insects, as well as in the Crustacea, this phenomenon is most remarkable, prevailing nearly without exception: and in the MYRIAPODA, we trace it also. Numerous as may be the segments and the pairs of feet with which the adult Julus is endowed, it has but eight segments at birth, and but three pairs of feet. But as we saw in the *Nais*, that multiplication took place at the part immediately above the tail, so in the Julus does the increase of its segments take place in the same region. The seventh segment, at a certain period, divides transversely into six segments, while at the same time three new pairs of feet are formed on the segments succeeding these which were so furnished before. At the next moult or change of the skin, (which is always connected with these developments,) the last segment but one divides into six in like manner, and three pairs of feet are added; and this process goes on successively, until the total number both of segments and of feet belonging to the adult animal be complete.

There are but two families in this class, the Millepedes or *Julidæ*, which feed on vegetable matter, and the Centipedes, or *Scolopendridæ*, which are carnivorous and rapacious. The former are distinguished by their nearly cylindrical form, their slow, gliding motion, produced by the alternate action

JULUS.

of their very numerous little feet, which sometimes amoun t tomore than a hundred, and their habit of rolling themselves into a close spiral when touched. They resort to damp and dark places, such as under stones and moss, and still more commonly beneath the bark and in the wood of decayed trees. They are considered harmless, feeding on decomposed vegetable substances. Most of the species emit a very rank, disagreeable odour.

The Centipedes are much better known, and oftener seen: they have a large flattened body, with many joints, usually hard and polished; the hindmost feet are long and directed backwards. They crawl with great swiftness, pursuing their insect prey over the grounds, but generally avoid the light. Several small species are common in our gardens, but in hot climates they grow to a great size, and are much dreaded. Some of the tropical species are more than a foot long, and very venomous: the second pair of feet terminates in a strong claw, which is pierced at the point like a serpent's fang, and emits a poisonous fluid into the wound which it makes: the bite of these, though rarely fatal, is more powerful than the sting of the Scorpion. Some of the Centipedes, as *S. electrica*, a British species, are luminous.

The following note, on the occurrence of this species, was communicated to the "Zoologist" for 1843, by the author of the present work. "About eleven o'clock, on the night of the 23rd of March, I observed on the pathway of my garden, a little blue gleam, like that of the glow-worm. Taking it for granted to be that insect, though wondering to find it in such a situation, I approached it. On stooping down I perceived that the light was motionless, of an oblong form, about as large as a small kidney-bean. I could feel no insect, but picked up the luminous substance with my fingers, and placed it in my hand, where it still shone, although less brilliantly. Some of the luminous matter remained on the earth, disturbed and somewhat scattered by my fingers; over this the light played fitfully for a few seconds, and then gradually went out. On bringing in my capture to the candle, I could at first discover nothing but a pinch of damp earth; but presently observed a very common-looking, slender, almost white, centipede, crawling on my fingers, on which I doubted not that I saw, for the first time in my life, the electric centipede, (*Scolopendra electrica*). I placed the insect in a box, and carried it into a dark room, but there was not now the slightest radiance; this, however, I have observed in the splendid fire-flies of America (*Lampyris corusca*, &c.,) whose light soon wanes, and is seldom renewed in captivity. The next morning I put some damp sand in the bottom of a drinking glass, on which I allowed my prisoner his parole, having first ascertained, however, that he could not crawl on perpendicular glass. I threw in a dead fly or two, on the juices of whose bodies I thought I once detected him in the act of feeding. Night came, but no luminosity; another, but all was dark; when I began to think I might have missed the true cause of the light, after all, and that the presence of this centipede was merely accidental. He had been, however, slightly injured by the lid of the box at first. At last, I thought that excitement might produce its light, and remembering the impatience and apparent distress that I have often seen manifested by insects when under the human breath, I breathed strongly on the centipede, and was pleased to see that it instantly became luminous through its whole length, writhing and throwing itself about in violent contortions, though at other times very inert. It quickly became dark again, and on repeating the experiment, I found its influence became less and less, until it soon ceased to be affected at all by the breath; but after the lapse of another day and night, my breathing produced the same results as at first."

CLASS III. INSECTA.*

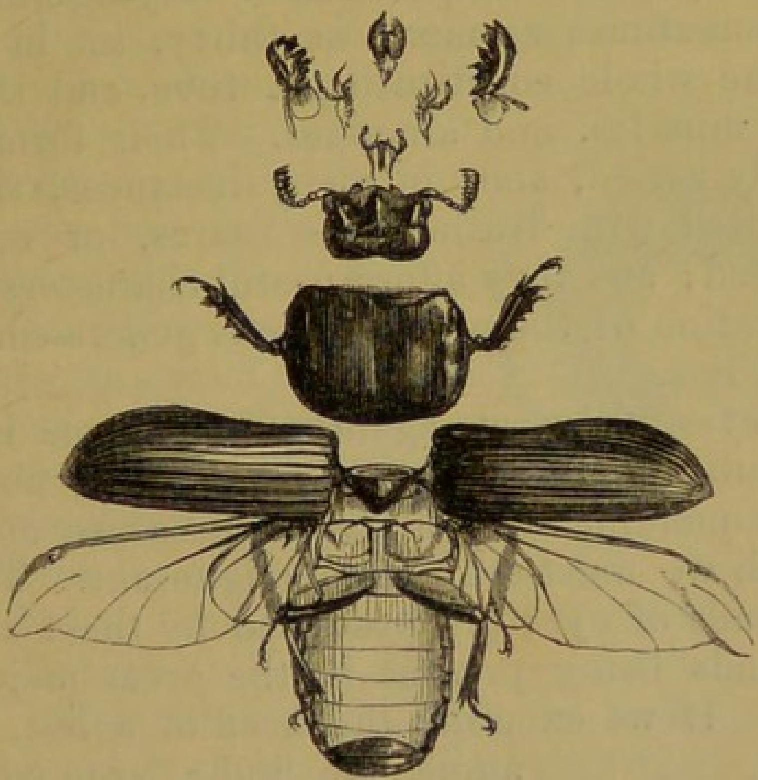
(*Insects.*)

The vast assemblage of small animals included in this Class are characterized by a still higher concentration of the skeleton, and of the nervous matter. Though composed of rings or segments, in common with the Myriapoda, these are reduced to the number of twelve, which again are so compacted together as to display but three primary divisions, the head, the thorax, and the abdomen. The first of these carries the principal organs of sense; the second, the organs of motion; the third, the organs of digestion and reproduction.

We speak of the *skeleton* of an Insect, but it must not be understood of an internal bony frame-

* Animals "cut into," or divided into segments; of which a wasp or a beetle affords a familiar example.

work, such as we find in the Vertebrate Classes: it is external to the muscles, and forms, in fact, the skin

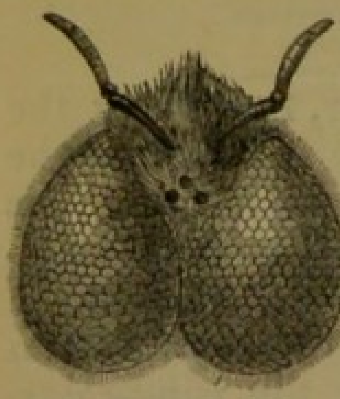


DIVISIONS OF A BEETLE.

of the animal. In its use, however, furnishing the various points of attachment for the muscles of the body, it is analogous to a skeleton of bone. This skin, then, is commonly a hard, horny crust, sometimes approaching the rigidity of shell, though, in some cases, as the upper surface of the abdomen in beetles, commonly protected by the wing-cases, and in the early stage of many tribes, it is thin, soft, and easily ruptured. It is largely composed of a peculiar chemical substance called *chitine;* is not, like other animal substances, soluble in caustic alkali, and retains its form when subjected to a red heat.

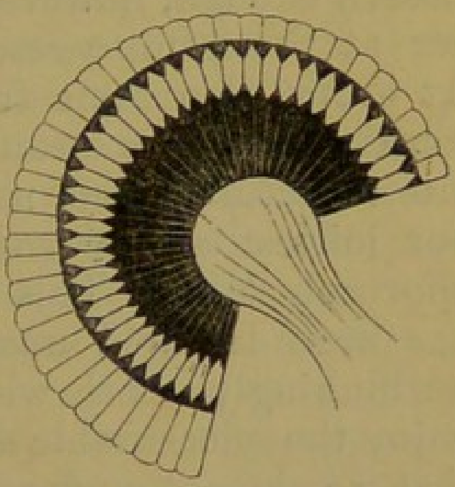
The organs of sense in Insects are distinct and well-developed; though we cannot, in all cases, precisely determine the sensations of which they are the channels. Thus the two jointed members, called *antennæ,* that project from the head in all Insects, are believed by some to be organs of touch; by others, to convey some delicate perceptions unknown to us; but by the generality of entomologists, they are now considered to be in some way sensible to sound. They are composed of a varying number of rings, sometimes as many as thirty, set in succession: the whole constituting a tube, and inclosing nerves, muscles, and air-pipes. Their form is exceedingly varied, and, in many instances, they are ornamented with feather-like beards, or curiously sculptured; and they afford useful characters for the identification of the multitudinous genera comprised in this Class.

The eyes of Insects again present some interesting peculiarities of structure, indicative, no doubt, of corresponding diversities in the sense of vision, of which we must ever remain ignorant. Two distinct kinds of eyes are possessed by these animals; both kinds being present in the great majority of species. If we examine the head of a bee, for example, we find a large convexity on each side, which a magnifying glass discovers to be composed of an immense number of facets; and on the summit of the head, between these, we see three shining points, resembling minute polished gems, set in a triangular form. The former are termed compound, the latter simple eyes.



EYES OF BEE.

The simple eyes consist of a glassy lens, behind which a nervous thread is spread out, forming a *retina* or net-work, as in the higher animals, to receive impressions of sight. The structure of these organs is sufficiently intelligible, but our admiration is greatly excited when we come to consider the large convex organs of compound vision, and find that each of these contains many thousands of eyes, each capable of distinct perception. The microscope reveals to us that the compound eye of an Ant contains fifty lenses, that of a Fly four thousand, that of a Dragon-fly twelve thousand, that of a Butterfly seventeen thousand, and that of a species of Mordella, (a kind of beetle), the amazing number of twenty-five thousand. Every one of these regular, polished, and many-sided lenses, is the external surface of a distinct eye, furnished with its own iris, and pupil, and a perfect nervous apparatus. The following figure represents the eye of a Dragon-fly cut perpendicularly through the middle. It will thus be seen that each hexagonal facet forms a transparent horny lens, immediately behind which is a layer of pigment diminishing to a point in the centre, where it forms a pupil; that behind this a long six-sided prism, answering to the crystalline and vitreous humours in man, extends, diminishing to its lower extremity, where it rests upon the retina, or net-work expansion of the optic nerve. Some of the minuter details of this exquisite organization are still matters of conflicting opinion: but these we omit, as our purpose is rather to convey to our readers a general idea of the structure of this complex organ of vision.



COMPOUND EYE OF A DRAGON-FLY.

As the eyes of Insects are immoveably fixed in the head, it is probable that this great number of lenses and visual tubes is needful to see different objects, some or other of the component eyes being turned towards every point. Yet we must suppose that distinct vision embraces only a single object at a time, as we see only a single point at a given moment with distinctness in a large landscape which our sight embraces indistinctly; or rather, perhaps, that the Insect is conscious of perceptions received from but one point at a time, though rays from all other points may, at the same moment, enter the various eye-tubes. This, however, we cannot determinately settle; nor the differences between the perceptions of these compound eyes, and those of the simple lenses that are set in the crown of the head. We discern enough, however, to excite our adoring wonder at the infinite resources of the Almighty God. At every turn some fresh wonder, some admirable contrivance, some beautiful adaptation, some elaborate structure meets us, and reminds us how utterly our loftiest attainment of knowledge must fail to approach Him. This marvellous skill and power has been lavished upon a crawling insect that we unthinkingly crush with our foot, to enable it to enjoy the pleasurable sensations of vision in modes that we do not understand! "He that formed the eye, shall He not see?" "Thou, God, seest ME."

"One insect preys upon another; pursues and attacks like the falcon, on the wing; but, with better mastery over the air-element, it can tear to pieces and devour its prey without alighting. Another insect, sedentary and inactive, imbibes the juices of a plant; a third eats its way into the hard wood; a fourth burrows in the earth for roots or worms.

"Some traverse the surface of the earth with a succession of steps too swift for definition; some by leaps so extraordinary, as to have excited the powers of the dynamical calculator from the earliest periods. The waters, also, have their insect population; some swiftly cleaving the clear element, some gyrating on the surface, whilst others creep along the bottom. Nor are the activities of the aquatic insect confined to that lower sphere. The *Nepa*, or the *Dytiscus*, at the same time, may possess its organs of creeping, of burrowing, and of flight; thus, like Milton's fiend, it is qualified for different elements, and

> 'Through strait, rough, dense, or rare,
> With head, hands, wings, or feet, pursues its way,
> And swims, or sinks, or wades, or creeps, or flies.'

"With such diversified powers of attaining food, there are, in fact, associated, in Insects, equally, if not more varied, structures for imbibing, seizing, masticating, and digesting nutritious substances. The patience of the anatomist is taxed to the utmost to unfold these delicate structures; but his admiration is chiefly excited by the discovery that they are so clearly referable to a common type." *

Taking the mouth of a beetle as an example of the various parts, we find † the following organs: an upper lip, a pair of upper jaws, a pair of lower jaws, and a lower lip. The upper lip (*labrum*) is a flat horny plate, represented at the top of our figure; it is jointed to the upper part of the mouth, which it partially closes. Below this are seen a pair of jaws, (*mandibulæ*) resembling strong horny teeth, often more or less notched; these, as do the lower jaws, work horizontally, not vertically, like the jaws of vertebrate animals. A second pair of jaws (*maxillæ*) are jointed into the sides of the mouth, immediately below the former; they are generally less horny, often being membranous at the tips; they differ from the upper jaws also in having a joint in the middle. Finally, the lower lip, (*labium*) which closes the mouth from below, when the jaws are not in use, consists of two parts, the true lip which looks like a third pair of jaws soldered together, and the triangular piece which is affixed to its under surface, and called the chin, (*mentum*.)

Each of the lower jaws bears one (or in some cases two) jointed member resembling an *antenna*, though consisting of but four pieces; it is articulated to the outer edge of the jaw, and projects forward. A similar pair are affixed to the lower lip. These organs are called *palpi* or feelers, though truly their purpose in the economy of the Insect is no more certainly known, than is that of the *antennæ* which they resemble.

If we look at a Gnat piercing our hand with its

* Owen's Lectures, i. 213.

† See the engraving on p. 103.

blood-sucking tube, or a Butterfly pumping up the nectar of a flower through its spiral tongue, or a Fly dissolving grains of sugar with the fleshy lips of its proboscis, we shall not very readily allow them any analogy with the apparatus of jaws and lips which we have just described. Yet, great as is the dissimilarity, it is now established, that all these forms of mouth are but modifications of the same model. The mouth of the Gnat and of the Whame-fly is composed of a sheath, which represents the lower lip, four lancets or piercers, which are the jaws, and a tubular needle, for sucking up the diluted blood. The Fly has the sheath soft and muscular instead of being horny; it folds with a double angle when at rest, and has its point dilated into a fleshy sucker. The other parts are inconspicuous. The tube with which the Bug tribe pierce the flesh of animals, and the Aphides suck the juices of our flowering plants, does not differ materially from that of the Gnat.

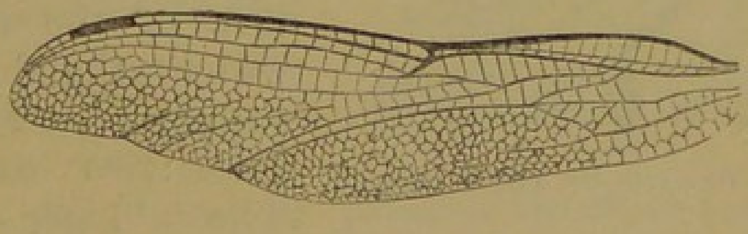
The long and slender tube of a Butterfly or Moth, coiled when at rest in an elegant spire like the mainspring of a watch, but extended at will to be inserted into the corolla of a flower,—departs still more widely from the model form. This spire, if examined, is found to consist of two tubes, placed side by side, but not connected; these are the lower jaws, drawn out to a great length; the upper jaws and the lips are traceable, but are reduced to minute rudiments; the labial palpi, however, are large and prominent, standing up on each side of the base of the spire.

Bees have the upper pair of jaws of the ordinary form, strong and cutting; but the lower jaws are lengthened out to form the proboscis, in conjunction with the lower lip, the sides of which are encased by them.

We have now to consider the members which serve the purpose of locomotion, and which, as already observed, are attached to the thorax, or central division of the body. This portion consists of three rings, each of which is again divided into an upper and an under portion, and to each of the three under portions is attached a pair of legs, consisting of several joints, a hip, a thigh, a shank, and a foot composed of several flexible pieces, and commonly terminated with hooked claws.

The upper portions of the second and third rings of the thorax bear the *wings*, organs of flight which for strength and lightness combined far excel the feathered pinions of the Eagle or the Humming-bird. Leeuwenhoek has recorded a remarkable instance in which he was an eye-witness of the comparative capabilities of the Dragon-fly and the Swallow, as relates to the perfection of their flight. The bird and the insect were both confined in a menagerie about a hundred feet long, and apparently their powers were fairly tested. The swallow was in full pursuit, but the little creature flew with such astonishing velocity, that this bird of rapid flight and ready evolution was unable to overtake and entrap it; the insect eluding every attempt, and being generally six feet before it.

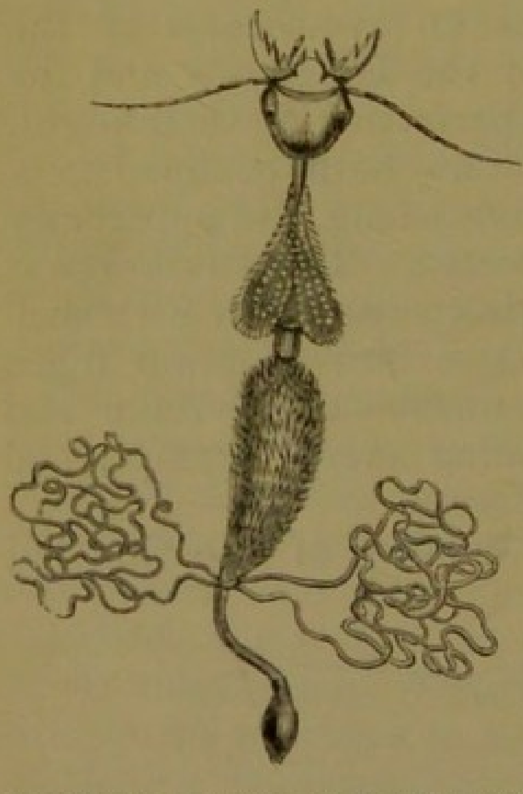
The wing of an Insect consists of two thin but



WING OF DRAGON-FLY.

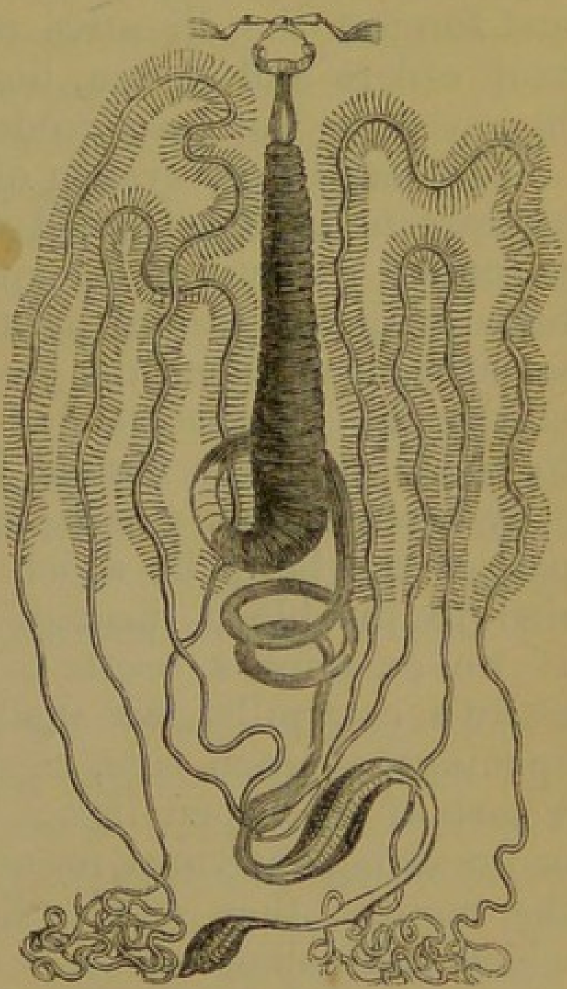
firm and highly elastic films of membrane, stretched over a frame-work of strong tubes, variously branched, as the silk of an umbrella is expanded over its ribs. These tubes are commonly called the *nervures* of the wing. In beetles, the fore pair of wings are thick and of a horny texture, and, though expanded in flight, seem of little service in motion, their chief use being that of shields to protect the broad membranous hind wings, which when at rest are folded under them, and the soft surface of the abdomen. In the Grasshoppers and Crickets, we find a similar modification, but inferior in degree. In one extensive Order called *Diptera*, the Flies, Gnats, &c., the hinder pair are wanting, their place being supplied by a pair of little round knobs set on stalks. There are other genera, very limited in number, which are destitute of both pairs of wings.

The organs of digestion are scarcely less elaborate and varied than those of the higher Classes of animals. They consist of a gullet, a craw, a gizzard, a stomach, a small, a blind, and a large intestine. All of these however are not at all times distinguishable, the gizzard, and the craw, being frequently undeveloped. The length and consequent convolution of the alimentary canal depend upon the nature of the food on which the insect is supported. Of this we give two examples. The Tiger-beetles (*Cicindela*), that run and fly and sparkle about our sandy heaths, are among the most predatory of their Class, living on other insects which they seize and master by violence. Here the course of the digestive apparatus is short and nearly straight, the food to be assimilated requiring little change. We see first a narrow gullet commencing at the back of the head, and soon widening into a capacious craw, the inner surface of which is set with rows of small cells. This terminates abruptly, and gives place to a short but muscular gizzard, which then admits the bruised



DIGESTIVE ORGANS OF TIGER-BEETLE.

food into a large oval or pear-shaped stomach, where it is converted into chyle and undergoes true digestion. Into the lower extremity open several long, slender, and much contorted tubes, which answer the purpose of the liver, and throw into the intestine a yellow bitter fluid analogous to bile. The chyle thus mingled with bile passes on through the small intestine (in this case short and only slightly bent), by the inner surface of which it is taken up, and passes at once into the cavity of the abdomen. The innutritive parts then pass into the dilated *colon*, and are rejected through the anal aperture as in other animals.


DIGESTIVE ORGANS OF COCKCHAFER.

In the Cockchafer (*Melolontha*), on the other hand, a beetle which devours the roots of grasses, and the leaves and shoots of trees, the digestive apparatus is greatly lengthened, to admit the nutriment to be extracted and assimilated from materials so crude.

The craw in this instance is short, and the gizzard scarcely perceptible, but the stomach is long, convoluted, and complex. The upper part is wide, and divided by numerous constrictions; and the lower tapers to a slender spirally-twisted tube, terminating in a small expansion where the bile vessels empty themselves. The length and structure of these tubes are very remarkable; for their secreting surface is vastly extended by the numerous minute sacs that fringe their sides for a large portion of their length. The intestines are also more developed than in the carnivorous beetle, manifesting dilatations corresponding to the *rectum* as well as the *colon* of larger animals.

Various other minor modifications in the structure and form of the digestive organs occur in the different orders and genera, but these, though interesting, we have not space to detail.

The respiratory system of Insects is peculiar, and appears to be constructed with a view to insure a perpetual renewal of the vitality of the blood, combined with the utmost lightness of body, so needful for animals of which the great majority are denizens of the air. Hence we find neither lungs nor gills, to which the deteriorated blood might be periodically brought, but a series of tubes pervading every part of the body, by which the vital oxygen is carried to the blood through each step of its course. If we examine a beetle or a grasshopper, or especially a caterpillar, we shall observe a row of oval openings on each side, capable of being closed by a sort of thickened lips. These are the spiracles or breathing apertures, for no insect breathes through the mouth; they admit the air into a main pipe which runs along on each side of the body; these are connected by smaller branch-pipes which run across the rings of the abdomen, and distribute an infinite number of smaller tubes to every part of the interior. In insects of great powers of flight, there are likewise a number of sacs in different parts which serve as reservoirs of air: these are particularly large in the body of the Bee.

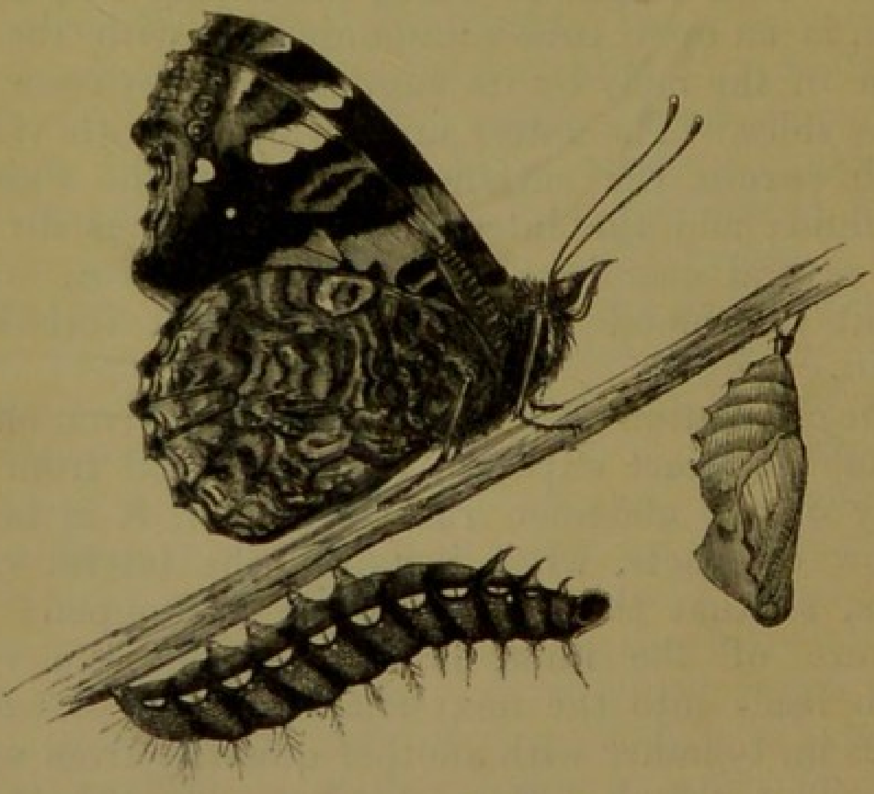
These air-tubes, which, both in arrangement and in purpose, may be likened to the elaborate organization of pipes which bring gas or water to the houses of a great city, are preserved from collapse by a most beautiful contrivance, which at the same time permits the fullest flexibility. These apparently difficult ends are simultaneously attained by lining the tube with a slender, but elastic spiral thread, of extreme delicacy, but of sufficient firmness.

The blood is not contained in a series of vessels, but fills the cavity of the body, bathing all the internal organs; and here it is mixed with the nutritive particles of the digested food, which, as we have intimated, exude through the intestine. Yet it sustains a kind of circulation by means of a long tube, running down the back, which with its pulsations may be distinctly seen in any smooth caterpillar. This singular vessel, commonly called the heart, is an open tube communicating with the interior of the body by its summit, and by apertures in its sides. The latter are furnished with valves, which permit the entrance but deny the exit of the fluid; and the interior of the tube is divided into several chambers by means of valves, which permit the blood to pass forward but forbid its return.

The circulation then is as follows. A given chamber of the heart expands, and the blood from the cavity of the abdomen rushes in until it is filled: it now contracts, when instantly the lateral valve closes, so that the passage there is stopped; the pressure of the fluid, however, opens the valve which leads into the next chamber, and part of it rushes in, together with another quantity from without. This chamber then contracts, closes both the side valve and that behind it, but in the same moment, those of its successor open, and thus, by a series of pulsations, the fluid is pushed onward towards the open extremity, thence to escape into the cavity of the body, to be afresh mixed with chyle, and to be again taken up in its turn.

Among the most curious of the phenomena connected with the animals of the Class before us, are their strange transformations. Who, that had never heard of such facts, could believe that the large butterfly which he sees sitting upon a peach, opening and shutting its broad wings of velvet-black, banded with brilliant scarlet, to the warm autumnal sun, is identically the same being as a black spiny caterpillar, which a month ago he observed, not without disgust, engaged with a dozen others devouring the leaves of some nettles in a ditch? But more than this: the creature has experienced yet another state of existence, the form and circumstances of which have been as diverse from both of these, as either of these from the other.

We select as our example the beautiful butterfly



ADMIRAL BUTTERFLY.

just alluded to, called by collectors the Red Admiral *(Vanessa Atalanta)*, for, as it is very common, the phenomena in question may be easily verified. No sooner have the unsightly and vindictive nettles thrown up their new shoots, and expanded their young leaves, in the spring, than butterflies of this and other kinds may be seen hovering over them, occasionally touching a leaf with the tip of the abdomen. These are females ovipositing; the great business of life to them, which being performed, they die. At each contact a little oblong egg is left, stuck on the plant by one end, and adhering by a gummy secretion. The egg is sculptured with elevated lines, running from top to bottom, like the meridians of a globe. A considerable number are deposited on one plant, for the caterpillars of this species are social, feeding and living in company.

In a short time we may see proceeding from this egg a minute caterpillar with a body beset with spines, furnished with six short, horny, hook-like feet near the head, and ten fleshy tubercles, which act as clinging feet, beneath the hinder parts. It grows rapidly, for it devours the substance of the leaves with incredible voracity; but at the end of about a week it ceases to eat, appears first restless, then feeble and languid, and the colour of the skin is withered and livid. After a day or two's inaction, it may be observed moving its head from side to side, as in pain, now stretching itself, now contracting, and now forcibly swelling the second and third segments of the body. At length the skin of the back splits from these violent efforts, and a new skin may be perceived beneath, distinguished by the freshness and brightness of its colour; the caterpillar pressing its body into the opening thus made, speedily extends it down the back, and towards the head, and at length, emerges from its old integument, which retains its form so unaltered that it might, at first sight, be mistaken for the larva itself. Yet the exuviation has been so complete, that not only the skin that covered the body, but that of the head, the eyes, the jaws, the antennæ, the palpi, the legs, and, as insect-anatomists of the highest name declare, that which lines the gullet, the stomach, the interior of the air tubes, and the intestines, is also left behind in the sloughed integument.

In a few hours the insect again begins to eat greedily; and the new skin, which at first is much wrinkled, in order to allow of considerable extension, gradually becomes plump, as the body increases in size. The integuments of the head are, however, unyielding; and hence, probably, the necessity of these moultings; as this part is susceptible of increase only at stated intervals, and while the skin is yet unindurated. Three successive exuviations, at intervals of a week or ten days, bring our caterpillar to its complete growth; and now it prepares once more to cast its skin, to emerge no more a caterpillar but a chrysalis. For this end it frequently draws together two or three contiguous leaves of the nettle, and connecting them with a few threads of silk, forms a capacious tent from the ceiling of which it must now hang suspended for many days.

For this purpose it spins from a peculiar organ in its mouth, a little conical knob of silk at the intended point of suspension. Into this it then insinuates the minute hooks with which the hindermost pair of clinging-feet are beset, and suffering the anterior part of the body to fall, hangs with the head downwards. Meanwhile contortions, contractions, and swellings of the fore parts go on as at the former moults, and are attended with the same results; for after about twenty-four hours the skin of the back splits, and the chrysalis appears projecting through the aperture. By continuing the tumefaction of the now exposed portion, the skin of the caterpillar splits farther and farther up towards the tail, and by the alternate contraction and elongation of the segments of the chrysalis, is at length rolled up in folds around the posterior extremity, like a stocking pushed down to the ankle. But now comes the important operation. The pupa being much shorter than the caterpillar, is as yet some distance from the silken hillock to which it is to be fastened; it is supported merely by the unsplit terminal portion of the latter's skin. How shall it disengage itself from this remnant of its case, and be suspended in the air while it climbs up to take its place? Without arms or legs to support itself, the anxious spectator expects to see it fall to the earth. His fears, however, are vain; the supple segments of the pupa's abdomen serve in the place of arms. Between two of these, as with a pair of pincers, it seizes on a portion of the skin; and bending its body once more, entirely extricates its tail from it. It is now wholly out of the skin, against one side of which it is supported, but yet at some distance from the leaf. The next step it must take is to climb up to the required height. For this purpose it repeats the same ingenious manœuvre; making its cast-off skin serve as a sort of ladder, it successively, with different segments, seizes a higher and a higher portion, until in the end it reaches the summit, where with its tail it feels for the silken threads that are to support it.* The anal extremity is produced into a little protuberance which is covered with minute hooks; these it entangles among the silk, and confirms its hold by several rapid whirlings as upon an axis; and the same motions usually displace and throw off the rejected skin.

During the hours that the caterpillar remained suspended before the change, its form had gradually become more conical, the tail being the apex; and the newly excluded pupa does not greatly differ from it in form; the abdominal segments being much extended, while the anterior parts, and especially the integuments of the future wings, are corrugated and thickened. But in the course of a few hours the proportions of these parts are reversed; the wing-covers are lengthened, are freed from wrinkles, and have assumed the form of the anterior wings of the butterfly; the thoracic segments are extended, and the abdominal ones are abbreviated and made much more compact. The integument, also, which, at first exclusion, was soft and tender as wet paper, has

* Kirby and Spence.

hardened into a crustaceous shell; and the colour, which was pellucid green, has become dusky-brown, with some spots of gold. A practised eye can now detect in this *swathed mummy,* all the external parts of the future butterfly. The eyes are marked by two prominences in front of the head; the wings are brought down on each side, in an opposite direction to that which they will assume when erect; the antennæ and legs are stretched upon the breast, and the long sucking tube, not yet in its spiral curl, is extended between them. A few days before the birth of the butterfly, which may be, in summer, about three weeks after the assumption of the chrysalis state, the approaching maturity of the inclosed insect is announced by the increasing transparency of the pupa-skin, and by the appearance of the beautiful markings and colours of the butterfly's wing, perfect, but in miniature. If, at this time we gently press the thorax with the thumb and finger, the skin will split down the back and may be readily peeled from the insect,—and this will display in a very interesting manner, the beautiful arrangement of all the organs in the pupa, as in "swaddling bands." An insect thus prematurely brought to the birth, will walk briskly about, curl up its sucking-tube, and flirt its little wings up and down, but these will not increase in size; they will remain perfect in their coloration, but no larger than they were in the pupa.

But if it be allowed to remain till Nature's own moment of exclusion is arrived, the splitting of the now fragile and filmy pupa-skin, and the stepping forth of the new-born fly drawing its limbs from their sheath, will form one of the most interesting sights that a young naturalist can witness. The hollow nerves that pervade the wings receive a fluid from the body, which is impelled through their whole course, lengthening them, and at the same time expanding the membranes which are stretched over them. The effect is soon manifest: the wings, which at first were smooth, though thick and pulpy, presently begin to crumple up in a strange manner, so as to induce the fear, in one who watches the beautiful process for the first time, that they are hopelessly spoiled. But wait awhile: they grow wider and longer; and, at the same time, more and more crumpled; at length their full dimensions are attained, and now, imperceptibly but rapidly, the corrugations one by one straighten and soon disappear, and the gorgeous wings are expanded in all their unsoiled and unruffled beauty; not a wrinkle marring their even surface, nor a single scale of the elaborate mosaic being displaced. They are still, however, soft and flaccid, like a wet cloth, and incapable of being erected; but every moment strengthens them, and in about an hour from the time when the first crack appeared on the back of the pupa, the lovely sylph begins to open and shut its broad pinions in the sun, and gathers courage to try its new-born powers in the fields of air.

We have described the metamorphoses of a common butterfly as an example of the phenomena. It must not be supposed, however, that the details are the same in all cases; variations occur in different species and genera; more conspicuously in the families; and when we compare the various orders, we find a parallelism only in the great leading facts, but endless diversity in detail. Thus the Entomologist has perpetually under his notice processes ever varying, and of the most interesting character.

Insects in modern classification are divided into those which do, and those which do not, undergo transformations. The latter, however, consist of but a few genera possessing little to recommend them to our detailed notice, as the Bristle-tails (*Thysanura*) including the little black and grey creatures that skip upon the surface of standing water, and the various species of Lice (*Anoplura*).

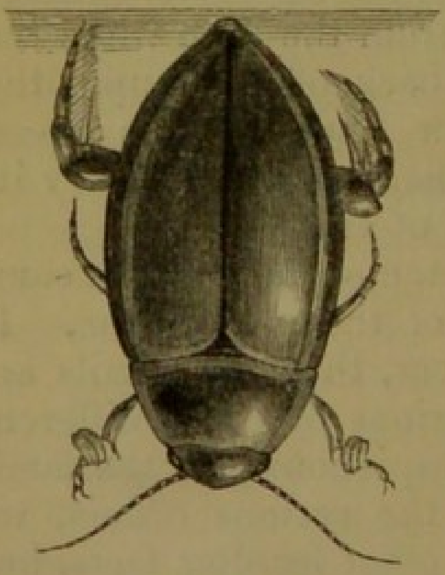
The METABOLA, on the other hand, or the Insects which are subject to metamorphosis more or less complete, are immensely numerous, and are arranged in eleven Orders.

ORDER I. COLEOPTERA.*

(Beetles.)

This vast assemblage of Insects is distinguished by the fore wings being crustaceous in texture, covering the second pair when at rest, and meeting down the middle by a straight line, not overlapping. The mouth is furnished with jaws.

The Water-beetle, the Cock-chafer, and the Lady-bird, will afford familiar examples of this great Order, by a moment's examination of which our young readers may make themselves acquainted with the characters. The first (*Dyticus*) is found in one or other of its species in almost every pool, and the larger kinds often attract notice by the mode in which they come to the surface and hang motionless down from the top until alarmed, when they dart down to the mud at the bottom, striking out vigorously with their hind pair of feet. This beetle affords an instructive example of the manner in which the form of an organ is often modified for a special purpose, while its essentials remain unchanged. Most of us have seen an ordinary beetle fallen into a tub of water, and have observed the feeble way in which it struggles, and how helplessly its slender feet cut through the water without affording it any available impulse to propel



WATER-BEETLE.

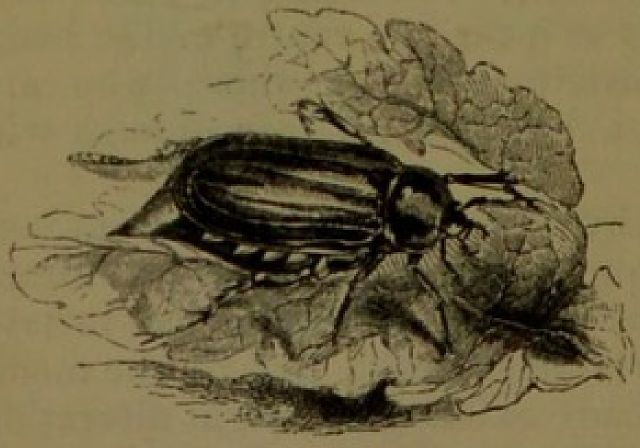
* "Sheath-winged:" from the office of the first pair of wings.

it towards the brink. But this Water-beetle is intended to live in water, and we have alluded to (what every schoolboy has seen) the forcible strokes with which it urges its rapid way through the element. Let us take it in our hand and examine the cause of the difference. Here are the ordinary number of legs found in other beetles, but their figure and proportions are altered. The first and second pairs of limbs are reduced to very small dimensions, but the hind pair are greatly enlarged. Their size, compactness, and strength are remarkable, and they are flattened out so as to present an oar-like surface to the water. Some flat spines at the end of the shank increase the breadth, and above all, each joint of the *tarsus* (or foot) is margined with a wide fringe of stiff, close-set bristles. Thus the insect seems at first sight to have but one pair of feet, and these converted into large and broad paddles; while to add to their power as effective swimming organs, they are placed (by the lengthening of that ring of the *thorax* which carries them) as near the centre of the body as possible; an advantage which those who are accustomed to row a boat with a pair of oars will easily appreciate.

Thus it is not by the creation of new organs for every fresh requirement of habit or condition, that the Allwise God has chosen to effect the variety which we see in the animal world, but by the modification of those already existing; a slight alteration of form here and there, a change of relative proportions, a stronger development of one part, a reduction almost to obliteration of another;—these contrivances effectually serve the purpose, and ought to excite in us a spirit of adoring and grateful praise to the Almighty Architect.

The great Water-beetle is bold and ferocious, hesitating not to prey with its formidable jaws upon animals much higher in the scale of nature than itself. The term Toe-biter, applied to it by children, sufficiently expresses the dangers, real or fancied, which their feet sustain when bathing, from this voracious beetle. The larva also is active, powerful, and ferocious.

Very different, both in appearance and in habits, is the Cock-chafer (*Melolontha*), which, though possessing not the carnivorous ferocity of the former, is infinitely more destructive. The grub of this beetle spends the whole of its existence beneath the surface of the soil, never exposed to the light of day, except when turned up by the plough or spade, or picked out by the strong beak of some industrious Rook. It is thick and fat, especially plump at the hinder extremity, which is doubled up upon the belly; its colour is white, with a brown scaly head and six feet. Here concealed from view, it lies on its back and pursues its insidious employment of devouring the roots of the grasses. "These creatures, sometimes in immense numbers, work between the turf and the soil in the richest meadows, devouring the roots of the grass to such a degree, that the turf rises, and will roll up with almost as much ease as if it had been cut with a turfing-knife; and underneath, the soil appears turned into a soft mould for more than an inch in depth, like the bed of a garden. In this the grubs lie on their backs, in a curved position, the head and tail uppermost, and the rest of the body buried in the mould. Mr. Arderon of Norwich mentions his having seen a whole field of fine flourishing grass become, in a few weeks,



COCK-CHAFER.

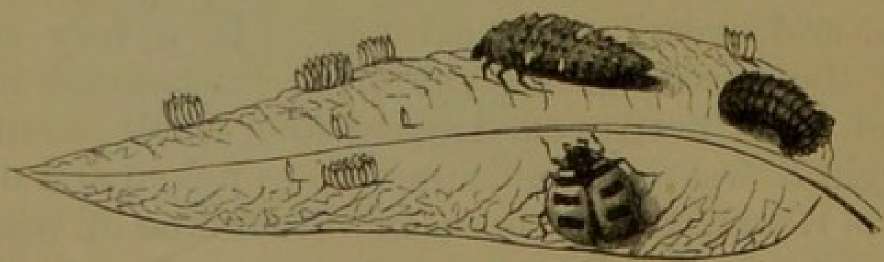
withered and as brittle as hay, by these grubs devouring the roots."*

Nor are their injurious labours confined to the four years which they spend in the grub-state; for after having undergone their change to a motionless *pupa*, and emerged from thence in the form of the perfect beetle, they commence their attacks upon the leaves of our forest and fruit trees, occasionally in such overwhelming hosts, as to denude the woods and orchards through large tracts of country of their foliage, and cause immense damage. An example of this is recorded by the author last quoted. "In the year 1688, the Cock-chafers appeared on the hedges and trees of the south-west coast of the county of Galway, in clusters of thousands, clinging to each other's backs, in the manner of bees when they swarm. During the day they continued quiet, but towards sunset the whole were in motion; and the humming noise of their wings sounded like distant drums. Their numbers were so great, that, for the space of two or three square miles, they entirely darkened the air. Persons travelling on the roads, or who were abroad in the fields, found it difficult to make their way home, as the insects were continually beating against their faces, and occasioned great pain. In a very short time the leaves of all the trees for several miles round were destroyed, leaving the whole country, though it was near midsummer, as naked and desolate as it would have been in the middle of winter. The noise which these enormous swarms made in seizing and devouring the leaves was so loud as to have been compared to the distant sawing of timber. Swine and poultry destroyed them in great numbers. These waited under the trees for the clusters dropping, and devoured such swarms as to become fat on them alone. Even the native Irish, from the insects having eaten up the whole produce of the ground, adopted a mode of cooking them,

* Bingley; Anim. Biog. iv. 5.

and used them as food. Towards the end of summer they disappeared so suddenly, that, in a few days, there was not a single one left."*

We turn from one species shunned for its fierce boldness, and another dreaded for its destructive voracity, to an universal favourite, as useful as it is pretty. The Lady-birds (*Coccinella*) are readily recognised by their semi-globular shape, and by their peculiar pattern of colouring, which is generally black spots on a yellow or red ground, or the reverse. They feed exclusively on the plant-lice or *Aphides*, that are so annoying in our green-houses and gardens, infesting our choicest flowers, as the roses and geraniums, rendering them unsightly, and depriving them of their juices; and that are still more hurtful in the injury they produce on the hop-plantations of the farmer, and the beans of the gardener. To the reduction of these insect-pests the whole efforts of the Lady-bird are devoted. Its eggs are laid in little patches on the leaves of plants, each patch comprising many oblong eggs placed close together and set up on one end. When these are hatched they give birth to a rather long larva, with a small head, and a thick but tapering



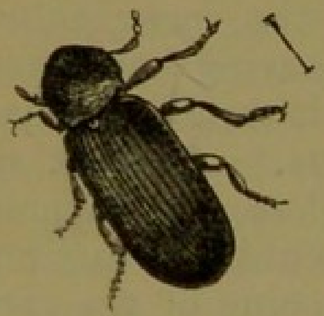
LADY-BIRD IN ITS STAGES.

body, which crawls actively about by means of six feet near the fore parts. Its colour is usually a dark bluish-grey with black spots, and a few orange spots of larger size. It riots among the Aphides, like a lion among a flock of sheep, devouring one after another with insatiable appetite; until its full growth being accomplished, it glues its hinder part

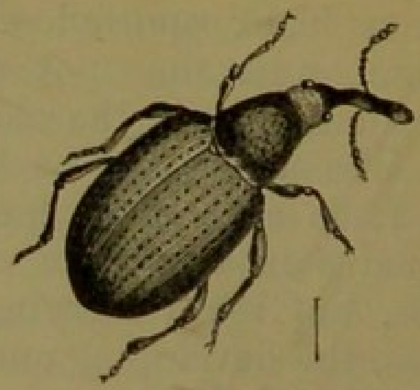
* Anim. Biog. iv. 6.

upon a leaf and awaits its change. In a day or two the skin cleaves down the back, and the pupa bursts through, which is white at first, but soon becomes black spotted with red and yellow. It does not quit the spot where the *larva* adhered, but remains there; the old skin having been pressed down like a stocking as far as it would go, lies in little folds around its hind parts. A week more it remains in this state motionless and apparently lifeless, but really carrying on within an important process, the developing and hardening of the various organs that belong to the perfect Lady-bird. At the end of that time, it in turn bursts the skin of the pupa, and crawls out. Its wing-cases are small and crumpled at first, but they soon enlarge and become smooth and shapely, though they remain for a time whitish or pale yellow, without any trace of the spots on any part of the body, that afterwards are so beautiful. In the course of a few hours, however, the rich colours begin to appear, and the various distinctive marks give the creature its character and its beauty. At the same time it has acquired firmness and vigour, and leaving its cast-off garments behind, departs on its fresh travels, to make war again on the Aphides, and to seek the company of a mate.

To write the history of those beetles alone, which inhabit this country, would fill volumes with details of high interest; but this pleasing task we must at present decline. The drowsy Dorr (*Geotrupes*) that wheels around our heads, or dashes in headlong flight into our faces in our summer evening walks;—the Rose-chafer (*Cetonia*) that blazes in green and gold as it whirrs round the blossoming fruit-trees in early June;—the Glow-worm (*Lampyris*) that lights its tiny lamp to twinkle, half hidden, half displayed, amidst the fragrant herbage of the hedge-bank;—the Book-worm (*Dermestes*) that penetrates the recorded wisdom of sages, by boring round holes through and through their volumes, untaught by all the learning it digests; —the Death-watch (*Ptinus*), that, by the blows

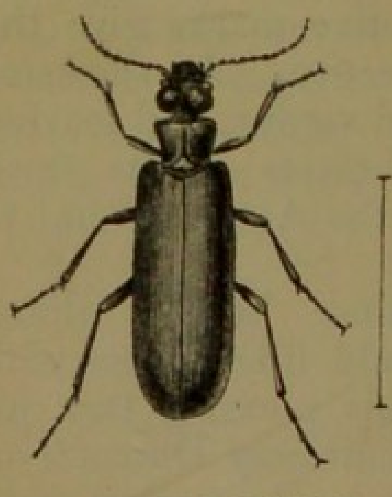


DEATH-WATCH BEETLE.



COPPER-COLOURED WEEVIL.

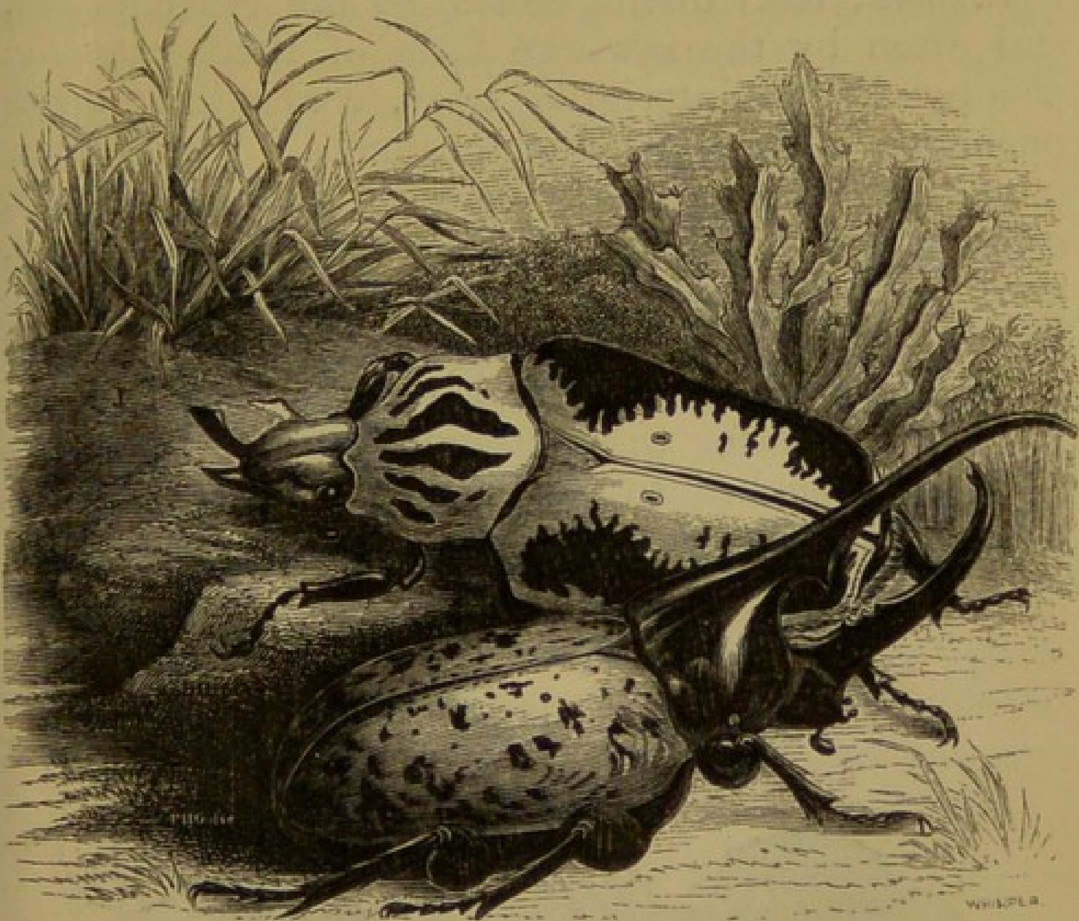
of its head against the wood to call its mate, was wont to terrify our grandmothers;—the Weevil (*Curculio*) that inserts its long snout into the young apple or nut, and there deposits an egg that soon grows to a fat and lazy maggot, luxuriating in the midst of plenty;—the Spanish fly, or Blister beetle, that affords relief to thousands tossed with fever, by its power of raising blisters upon the skin; these and many others that might be named belong to the great Order *Coleoptera*.



BLISTER BEETLE.

The foreign species are on many grounds worthy of far more notice than we can bestow on them. Many of the tribe to which the Cock-chafer belongs are distinguished by curved projections from the thorax and head, often of vast length and size, and of the most singular forms; and among these are some of the largest beetles known, the giants of the Insect race. We may mention the Hercules (*Dynastes Hercules*), nearly six inches long, and two or three broad. The species of

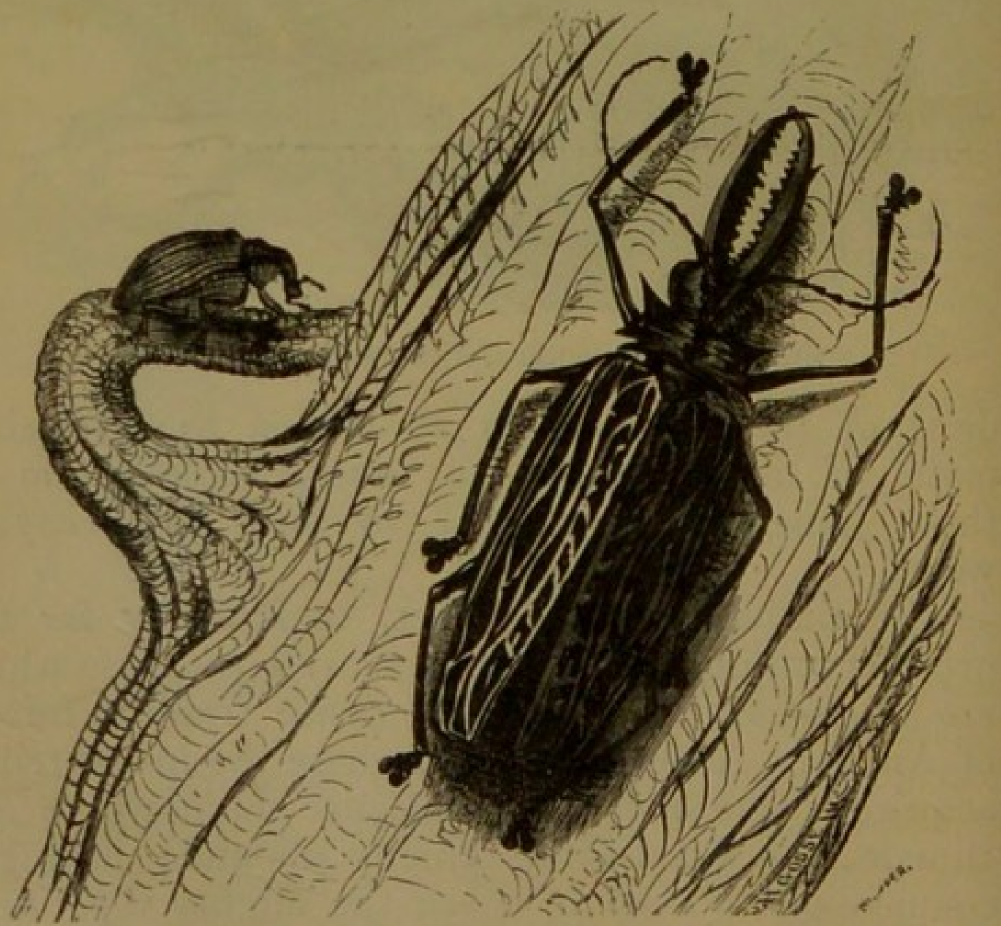
Goliathus are also remarkable, some for their gigantic bulk, as the species figured below; others for the horn-like excrescences with which they are armed, and still more for the glittering splen-



THE GOLIATH BEETLE, AND HERCULES BEETLE.

dour of their bodies, as if mailed in burnished metal of the most brilliant hues. The larvæ of these genera are believed to feed on decaying wood.

The timber-eaters, in fact, include by far the greatest number of Beetles, as well as those which are of largest size. In the dense tropical forests of America, Africa, and Asia, where the insect tribes acquire a size and a magnificence unknown to our climate, the wood-eaters chiefly abound; having a commission to keep in check the mighty vegetation of those teeming regions by devouring the trees, almost as soon as their noble heads have bowed to the storm. The magnificent genus *Buprestis* is one of these, whose species shine with the most gorgeous radiance; blue, purple, green, and crimson, alternately flash from their sculptured elytra, accompanied by a golden splendour that no colouring can imitate. The Long-horned Beetles (*Prionus*, *Cerambyx*, &c.) distinguished by the great length, and often by the saw-like form of their *antennæ*, also live in the interior of trees, which their *larvæ* perforate in long winding channels. The former genus contains the very largest Beetles known, some of them, as the *P. giganteus*, *P. cervicornis*, &c., being of enormous size. The mandibles also are often of great length and thickness. A South American species, the Harlequin (*P. longimanus*), is remarkable for the extreme length of the first legs, and the beautifully fantastic arrangement of colours,—grey, red, and black,—on the *elytra*.



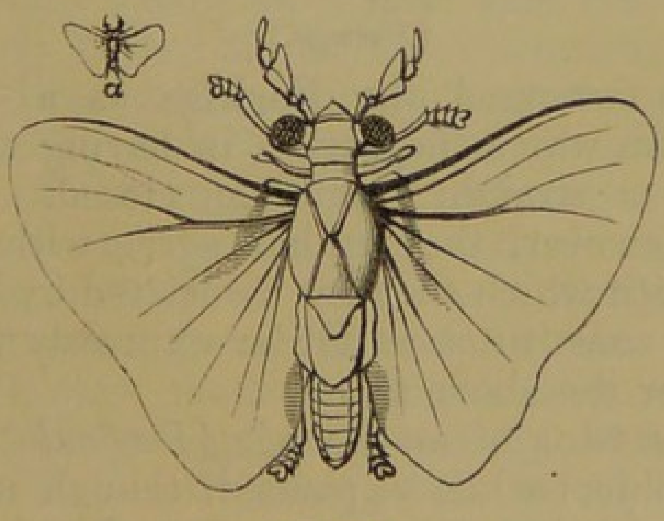
THE STAG-HORNED PRIONUS, AND DIAMOND BEETLE.

The extensive genus of Weevils is one of great beauty. Several of our native species, though small, appear covered with glittering dust, but many of the Brazilian kinds have a most gorgeous magnificence. To this genus belong those Insects known by the name of Diamond Beetles (*Curculio imperialis*, &c.), whose *elytra*, when placed beneath a microscope, seem studded with clustered fragments of rubies, sapphires, and emeralds.

ORDER II. STREPSIPTERA.*

(*Bee-parasites.*)

We have seen an extensive Class of animals residing habitually within the bodies of other animals, and drawing their sustenance from the juices of their living habitations. Several genera of Insects have a similar habit, and in particular the whole of those which constitute the Order before us. The name by which they are distinguished was applied to them by Mr. Kirby, from the cir-



STYLOPS.

cumstance of the fore wings being very small and twisted. The hind wings, on the other hand, are very ample, filling nearly the quadrant of a circle; in form they resemble the expanded wings of a butterfly, if the fore and hind wing were united

* "Twisted-winged;" in allusion to the form of the fore-wings.

into one. The thorax and the head are largely developed, but the abdomen is small. The eyes are of great size, divided into very large facets, and set upon a sort of pillars.

The Gadfly's larva inhabits tumours in the backs of cattle, and that which is known as the Bot revels in the intestines of the Horse; but these *Strepsiptera* select as the dwelling place of their young, the bodies of Bees and Wasps, to which two families they are entirely confined. The larvæ are found in spring, between the overlapping rings of the abdomen of these insects, from which they have been seen to emerge. Mr. Kirby's account of his first discovery of one of these singular creatures is very interesting.

Very few species have been discovered, and these are rarely seen.

ORDER III. DERMAPTERA.*

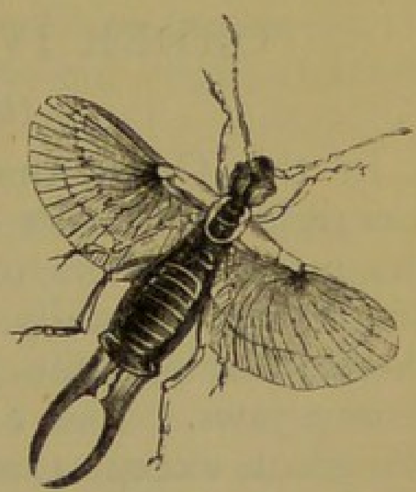
(*Earwigs.*)

Linnæus arranged the Earwigs as a genus of Beetles, with which they agree in having the elytra divided by a straight line when closed. In many respects, however, they rather agree with the *Orthoptera*, with which they are associated by Latreille. Mr. Kirby constitutes an Order expressly to receive them, under the above title.

The hind wing of an Earwig (*Forficula*) is a very beautiful object when expanded, though many persons are probably not aware that this insect has wings. They are in fact commonly hidden beneath the small elytra, curiously folded up into a sixth part of their ample breadth. It is a difficult operation to open the wing for examination, but it is worth the trouble. It is most readily done, immediately after the insect is killed, which must be full grown, as the *larvæ* and *pupæ*, which are desti-

* "Skin-winged;" from the leathery texture of the *elytra*.

tute of these organs, are very much in appearance like the adult. Take the Earwig by the thorax, holding it firmly between the thumb and finger; then with the point of a blunt pin, lift the little wing-case, and unfold the wing upon the top of the fore-finger, smoothing it down gently with the pin, and sliding the thumb over it. It should now be cut off with small scissors, and after having been pressed for a few seconds before the thumb is lifted, to straighten the folds, it is ready for examination, either with the naked eye, or with a low magnifying power.



EARWIG ON THE WING.

The notion that Earwigs creep into the ears of sleeping persons, and produce deafness is without any foundation in truth, though it is widely spread. The names by which this familiar insect is popularly known in various countries, as Perce-oreille, in France, Ohr-wurm in Germany, Earwig in England, &c., show the universality as well as the antiquity of the supposition. The injury which it inflicts upon our garden-fruit, and on the petals of our favourite flowers, particularly Carnations and Dahlias, is much less equivocal. Hence it is much disliked; though the maternal solicitude with which the eggs and young are guarded, and as it were sat upon, is a redeeming trait in its character; especially as the phenomenon is almost without a parallel in insect economy. The care and apparent foresight of parental instinct is indeed manifested by these little creatures in a thousand various ways, for the safety and well-being of the future progeny; but this, in almost all other cases, is confined to the selection of a suitable situation in which to place the eggs, and in some cases to the storing up of provision for the need of the future young. With the exception of some Plant-bugs, and the well-known cases of the Social *Hymenoptera*, we are not aware of any other insect which personally guards its offspring.

ORDER IV. ORTHOPTERA.*

(*Crickets, Locusts.*)

In this Order the fore wings are leathery, but less rigid than those of Beetles; the one folds over the margin of the other longitudinally. The hind wings are generally ample, and fold together in the manner of a fan. The mouth is furnished with strong jaws. The earlier stages resemble in form the adult, except that the wings, which are wanting in the *larva*, appear only as rudiments in the *pupa*. The insect is active and voracious in all its states.

To this Order belong two visitants of the kitchen, which are regarded with very different feelings. The Cockroach (*Blatta*) supposed to have been originally an importation from Asia, now swarms in many houses in this country, especially in the underground kitchens of London and other large cities. Their antennæ are of great length and consist of numerous joints; their legs also are long, and hence their activity in running is great. The wings are of a thin horny texture, rather brittle, overlapping slightly; in the female they are merely rudimentary. They devour all kinds of provisions, and even gnaw flannels and cloths; and, what is worse, they leave a rank disgusting odour attached to every thing over which they have been scampering. They are nocturnal, coming out of their holes after all has become dark and quiet, and that in such swarms, that if a candle be suddenly brought into the room, the floor will sometimes appear quite black with these annoying intruders; yet a few moments are sufficient for the whole to disappear.

* "Straight-winged" insects.

The egg-case of this insect, a curious production, is frequently met with in crevices of walls, behind shutters, and in similar places. The eggs, sixteen in number, are regularly arranged in rows, in an oval compressed case, white when first laid, but soon becoming hard and brown; one edge of it is toothed like a comb. This box the female carries about for some time, attached to her body; at length she affixes it to the selected spot by means of a sort of gum.

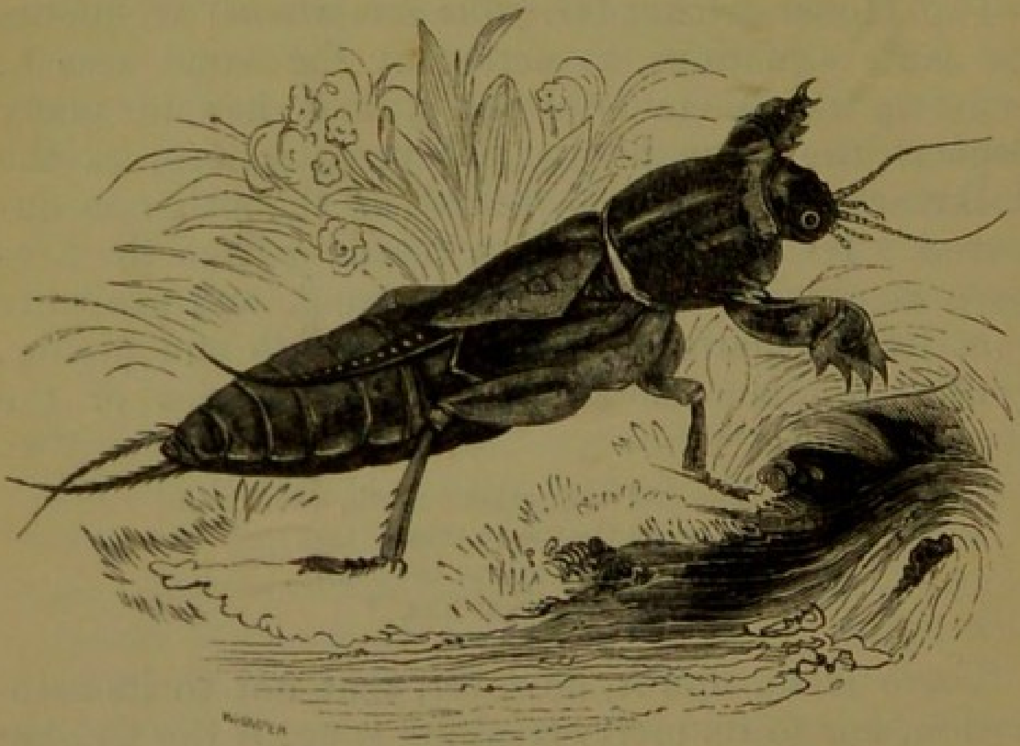
The House-cricket (*Gryllus domesticus*) frequents the same situations, is active at the same season, feeds on the same substances, and has in many respects the same habits and predilections, as the Cockroach; yet it is favoured as the other is abhorred. Its ringing crink proceeding from the fire-place is considered a cheerful sound, and probably from its association with genial warmth and plenty, is often enumerated among the amenities of the fireside.

> "Around in sympathetic mirth,
> Its tricks the kitten tries;
> The Cricket chirrups on the hearth,
> The crackling faggot flies."*

There is no doubt, however, that not to its association, nor to its merry crinking song, is the Cricket solely indebted for its favour, but largely to a popular superstition which regards it as a token of plenty and good fortune, and any injury done to it as productive of "bad luck." We frequently hear this and similar superstitions characterized as *harmless;* but this is a mistake. They are remnants of old Pagan or Popish darkness, and originated in the supposition that the good or ill that befals man depends on the wayward will of imaginary spiritual beings (demons, fairies, or what not), instead of upon the unerring righteousness and truth of God. Let our young readers remember, that there is no such thing as good luck, or bad luck, or fortune,

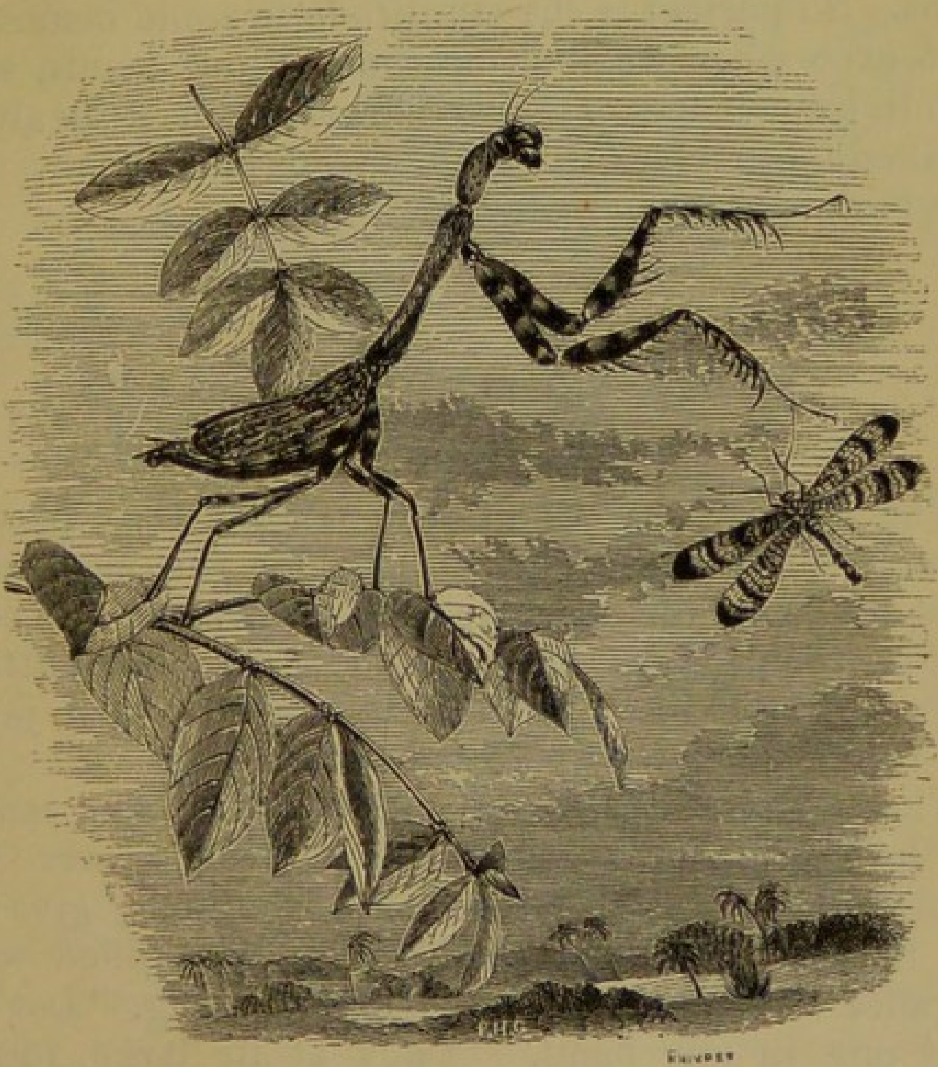
* Goldsmith's "Edwin and Angelina."

or chance; but that everything in providence is ordered by God, and that if we truly seek to please Him and to know His will, we shall be sure of His favour; the free gift of His beloved Son is such a proof of His willingness to bless us as nothing can exceed. "He that spared not his own Son, but delivered him up for us all, how shall he not with him also freely give us all things?"—(Rom. viii. 32.)



MOLE-CRICKET.

To this Order belong many other interesting Insects. The Mole-cricket (*Gryllotalpa*), is a burrower not inferior to the Mole after which it is named, in the singular adaptation of its structure to the habits assigned to it. Like that animal, it has the fore limbs shortened, flattened, and enormously strengthened; while their extremities are formed into broad hands turned obliquely outwards, and armed with stout tooth-like projections. Altogether a more efficient apparatus for digging can hardly be imagined. The Mole-cricket digs a neat little chamber in the earth, with smoothly polished walls, in which it deposits from a hundred to three hundred eggs, much like sugar plums. Intricate winding passages lead from this retreat to the surface of the bank, and in its mouth the old Cricket sits and chirps cheerfully all day long.



MANTIS.

Among the foreign members of this Order we may mention the Locust, that minister of Divine chastisement upon nations. It resembles a great Grasshopper, but migrates in countless armies that eat up every green herb, and leave behind them a desolate wilderness. And we should not omit the Mantis, a carnivorous insect of great ferocity, which catches other insects as they fly by, with its long sabre-like arms, set with strong and sharp spines;

and frequently maintains desperate and fatal battles with its own species.

Some species allied to these, found principally in tropical countries, are remarkable for the extraordinary resemblance which their wings, legs, &c. are made to bear to withered twigs, and to different leaves, either green or dry, with all their ribs and veins. So perfect is the similitude in some instances, that even when we look at them in our hands, with a full knowledge of their nature, it is difficult to persuade ourselves that they are animal and not vegetable productions.

ORDER V. NEUROPTERA.*

(*Lace-winged Flies.*)

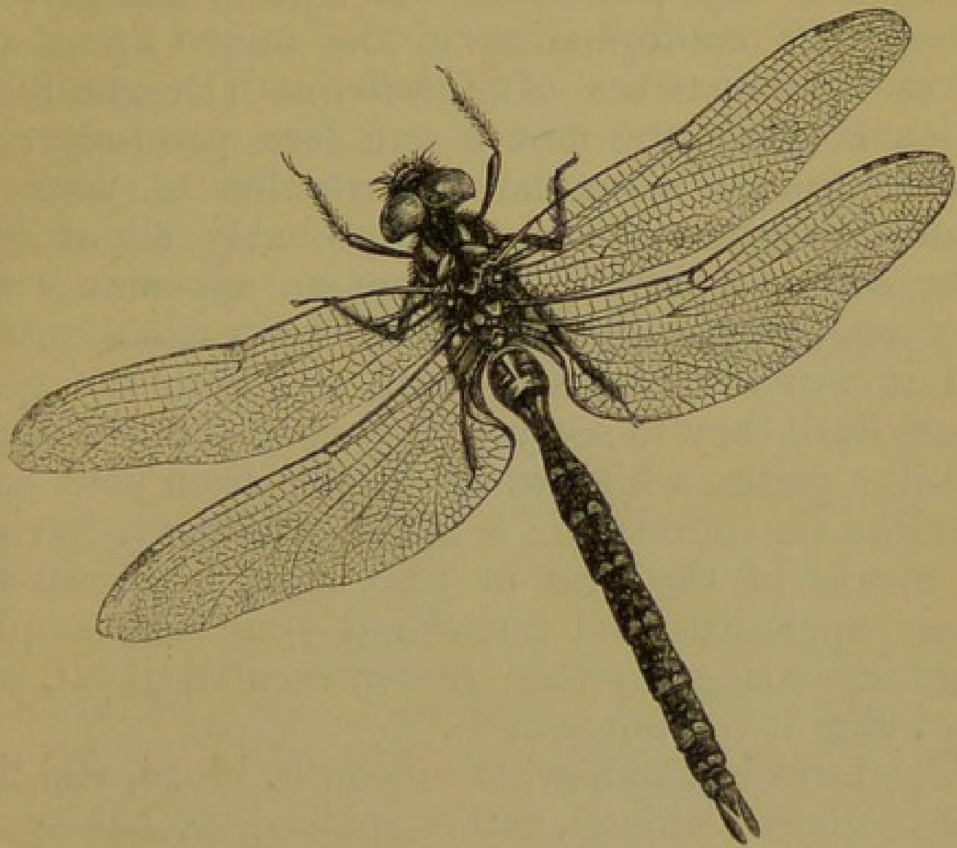
The character of this Order is that they possess transparent membranous wings, for the most part of equal size; the nervures are numerous, and connected together so as to form a network pattern more or less close. The mouth is armed with jaws, but the body is not furnished with a sting.

The brilliant Dragon-flies (*Libellula*), that career on flashing wing through the lanes and over the ponds in the warmest weather of summer, give us the highest idea of insect power, combined with elegance of form and beauty of colouring. Let us take one in our hand. Look at its large round lustrous eyes, each set with twelve thousand polished lenses: there is not a point in the whole sphere of sky or earth that is not commanded by some of these sparkling eyes. Look at its burnished corslet shining in green and gold, and its long, lithe, and slender body, elegantly spotted with green and black, admirably jointed, contracting and expanding alternately, as if panting with its exertions. And look at these gorgeous wings, these broad expanses, these delicate films of living glass, stretched over a net-

* "Nerve-winged" insects.

work to which the finest lace that ever adorned a fair lady's neck is but a sorry piece of workmanship.

Nor is the structure of this insect less singular



GREAT DRAGON-FLY.

than its exterior is beautiful. The eloquent historian of these interesting animals thus speaks of the mouth of the Dragon-fly in its larva-state :—

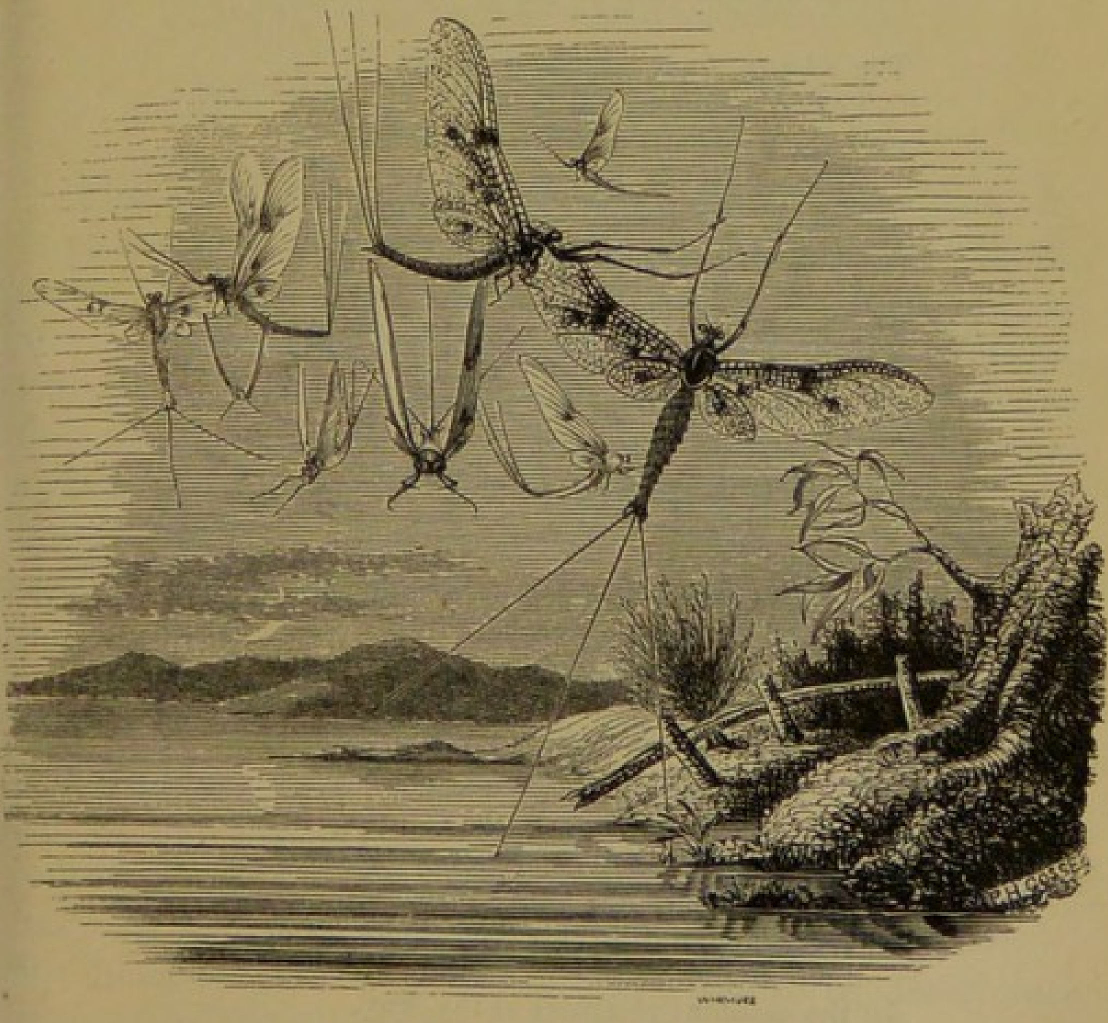
"Conceive your under lip to be bony instead of fleshy, and to be elongated downwards, so as to wrap over your chin and extend to its bottom; that this elongation is then expanded into a triangular convex plate, attached to it by a joint, so as to bend upwards again, and fold over the face as high as the nose, concealing not only the chin and the first-mentioned elongation, but also the mouth and part of the cheeks: conceive, moreover, that to the end of the last-mentioned plate are fixed two other convex ones so broad as to cover the whole nose and temples; that these can open at pleasure transversely, like a pair of jaws, so as to expose the nose and mouth, and that their inner edges, where they meet, are cut into numerous sharp teeth and spines, or armed with one or more long and sharp claws;—you will then have as accurate an idea as my powers of description can give of the strange conformation of the under lip of the larvæ of the tribes of *Libellulina* (Dragon-flies), which conceals the mouth and face precisely as I have supposed a similar construction of your lip would do yours. You will probably admit that your own visage would present an appearance not very engaging while concealed by such a mask: but it would strike still more awe into the spectators were they to see you first open the two upper jaw-like plates, which would project from your temples like the blinders of a horse; and next, having, by means of the joint at your chin, let down the whole apparatus, and uncovered your face, employ them in seizing any food that presented itself, and conveying it to your mouth."*

The larva is a somewhat uncouth, broad, and flat, olive-coloured animal, rather spider-like, having six sprawling legs, which crawls about the mud at the bottom of ponds, or glides by a singular mechanism through their waters. The hinder extremity of the body is furnished with several leaf-like processes capable of being brought close together or opened at pleasure. These close the orifice of a cavity, whose sides are very muscular. When the Insect wishes to move rapidly it opens this cavity, which thus becomes filled with water; then, by a contraction of the walls of the cavity, the water is forcibly ejected in a stream as from a syringe, and by the re-action produced by the impact of the *jet d'eau* upon the surrounding fluid, the creature shoots ahead, with its legs closely packed along its sides.

The *pupa* differs not from the *larva* in its locality, form, colour, habits, or food; but only in the budding out of little rudimentary wings on the thorax.

* Kirby and Spence. Intr. to Entom. iii. 125.

Both are active and voracious, the successful tyrants of the pool, devouring with ferocity other insects, tadpoles, small newts, and even fishes. These predatory habits are continued in the perfect insect, whose sanguinary propensities are no less correctly expressed by our term *Dragon-fly*, than its elegance and grace by the French appellation *Demoiselle*. It pursues gnats and flies in the air, eating them on the wing; it has been seen to catch and devour butterflies; and we have reason to believe, from personal observation, that even the fry of fishes are sometimes pounced on by it when swimming at the surface.



MAY-FLIES IN SUNSET DANCE.

To this Order belong the delicate and beautiful May-flies (*Ephemera*) which are used by anglers; and which, seen in their aerial dance, alternately rising and falling over a stream in the sweet evenings of spring or incipient summer, form so pleasing an object of rural contemplation. The brevity of existence allotted to these sylph-like insects, some of which live only a few hours, and none more than two or three days, has afforded many a simile to the poet, and many a point to the moralist. Both are embodied in the following beautiful stanzas:

THE MAY-FLY.

"The sun of the eve was warm and bright,
  When the May-fly burst his shell,
And he wanton'd awhile in that fair light,
  O'er the river's gentle swell;
And the deepening tint of the crimson sky
Still gleam'd on the wing of the glad May-fly.

The colours of sunset passed away,
  The crimson and yellow green,
And the evening star's first twinkling ray,
  In the waveless stream was seen;
Till the deep repose of the stillest night
Was hushing about his giddy flight.

The noon of the night is nearly come,
  There's a crescent in the sky;—
The silence still hears the myriad hum
  Of the insect revelry.
The hum has ceas'd—the quiet wave
Is now the sportive May-fly's grave.

Oh! thine was a blessed lot—to spring
  In thy lustihood to air,
And sail about on untiring wing,
  Through a world most rich and fair,
To drop at once in thy watery bed,
Like a leaf that the willow-branch has shed.

And who shall say that his thread of years
  Is a life more blest than thine!
Has his feverish dream of doubts and fears,
  Such joys as those which shine
In the constant pleasures of thy way,
Most happy child of the happy May?

For thou wert born when the earth was clad
  With her robe of buds and flowers,
And didst float about with a soul as glad
  As a bird in the sunny showers;
And the hour of thy death had a sweet repose,
Like a melody sweetest at its close.

Nor too brief the date of thy cheerful race;
'Tis its use that measures time;
And the mighty Spirit that fills all space
With His life and His will sublime,
May see that the May-fly and the Man,
Each flutter out the same small span.

And the fly that is born with the sinking sun,
To die ere the midnight hour,
May have deeper joy, ere his course be run
Than man in his pride and power,
And the insect's minutes be spared the fears,
And the anxious doubts of our threescore years.

The years and the minutes are as one:
The fly drops in his twilight mirth,
And the man when his long day's work is done,
Crawls to the self-same earth.
Great Father of each! may our mortal day,
Be the prelude to an endless May!"

The Caddis-flies (*Phryganea*) which are used by anglers like the May-flies, and which, like them, sport over the surface of still water in the twilight, are usually placed among Neuropterous Insects, though the nervures of their wings can scarcely be described as forming a network. Some authors constitute an Order for them under the name of TRICHOPTERA, or Hairy-winged Insects. Their economy in the earlier stages is curious; for the larva, which is not unlike a caterpillar, forms a tubular case for its residence, of minute shells, stones, seeds, bits of stick or bark, fragments of the stems of water-plants, and similar matters, which it arranges bit by bit, fixing them by means of a glutinous silk which also lines the tube. Numbers of these cases may often be seen at the bottom of pebbly streams, the head and feet of the larva protruding from one end, crawling about with a straggling irregular motion. When fully matured, the larva crawls up the stem of some aquatic plant, till the mouth of its case just reaches the surface of the water; it then spins a curious open net of silk across the mouth as a protection, and goes into the pupa state. At the appointed time, the pupa bursts through the silk, crawls out of the water a few inches, casts off its skin, and becomes a winged Caddis-fly.

ORDER VI. HYMENOPTERA.*

(*Bees*, *Wasps*, &c.)

The technical distinction between the insects of this Order and those of the last, is, that these possess, at least in one sex, a horny tube at the extremity of the body, which is sometimes connected with a poison-bag, and is called a sting, and at others is simply an instrument for the piercing of animal or vegetable substances in order to deposit eggs in them. But a much more obvious difference is found in the character of the wings, which are so shaped that the hind pair seem as if cut out of the fore pair, with which they interlock by means of small hooks during flight, and might readily be mistaken for a single pair. The nervures are commonly stouter, and form a wider net-work, and the membrane is generally less delicate than in the preceding Order.

To treat of all the interesting tribes that constitute the Order HYMENOPTERA would swell this work far beyond its present limits. Instincts, connected with the care of their offspring, and provision for their need, are here developed as we meet with them in no other Insects. Many of these are exceedingly curious, and have been long celebrated; and others, though less familiarly known, are scarcely less wonderful. The curious mechanism of saws and files by which the Saw-fly (*Tenthredo*) cuts the crevices in the ribs of plants in which its eggs are to be deposited; the burrowing habits of the Sand-wasps (*Sphegidæ*, &c.) with the correspondent modifications of structure; the parasitical mode of life of the Cuckoo-flies (*Ichneumonidæ*) that in the earlier stages of existence dwell in the living bodies of

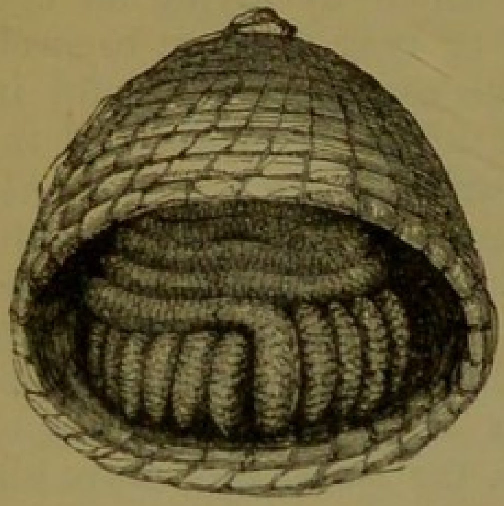
* "Membranous-winged" insects.

caterpillars and chrysalids, feeding on their substance; the equally singular instincts and powers of the Gall-flies, (*Cynipidæ*,) which by laying an egg beneath the skin of a leaf or twig, cause it to swell into an enormous fruit-like excrescence, useful in the arts;—all these would afford beautiful and instructive lessons of the varied wisdom of the Almighty Creator. But even these would be thrown into the background by the architectural skill, the almost reasoning combination of cause and effect, the parental care and forethought, the social organization, the industry, and a thousand particulars of the economy of the Wasps, the Ants, and above all, the Bees.

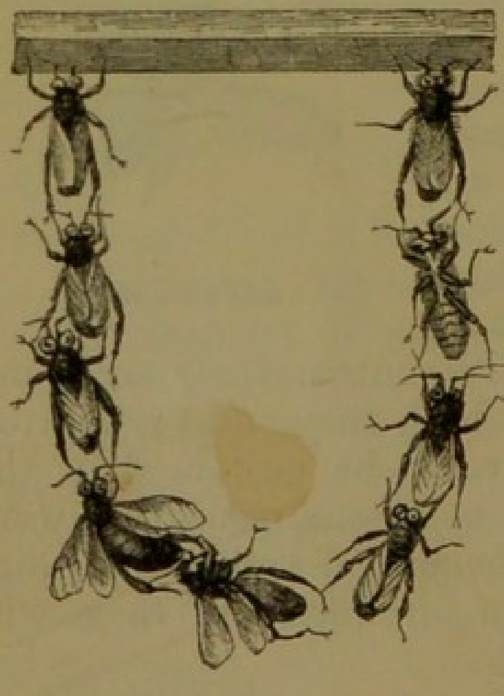
We must content ourselves with a few notes of the Honey Bee (*Apis mellifica*). This is not known with us in a wild state, but has been kept from time immemorial in a state of domestication. The society of a hive consists of workers, or females in which the sex is not developed, of drones or males, and of a single queen or developed female, besides a large number of larvæ in various stages of advancement, and of pupæ. To contain the young, and to hold the food by which both they and the mature inhabitants of the hive are to be sustained, is the object of the *comb* with its hexagonal cells, that wondrous exhibition of mathematical precision, which has always called forth the admiration of those who have observed it.

HONEY-BEE.

The comb consists of a great number of cells of six sides, the walls of which are all of the same thickness, placed regularly side by side, and arranged in two series, so that the bottoms of one series are in contact with the bottoms of the other. Several of these combs are contained in each hive, separated from each other by a space just sufficient to allow the bees to pass with ease. The substance of which the cells are composed is called *wax;* which is not collected from flowers as has been supposed, but is secreted by the insects when needed, in the form of thin scales, appearing between the rings of the abdomen. Some only of the workers devote themselves to the formation of wax; others act as nurses of the young. The proceedings of the wax-workers are highly curious: "Having taken a quantity of honey or sugar into the stomach, they suspend themselves to each other, the claws of the fore legs of one being attached to those of the hind pair of another, until they form themselves into a cluster, consisting of a series of festoons or garlands, which cross each other in all directions, until they form a dense curtain, in which most of the bees turn their back upon the observer. In this position the wax-makers remain immovable for about twenty-four hours, during which period the secretion of wax takes place. At last one of them is seen to detach itself from the rest, and to make its way to the top of the hive, where it turns itself round, and clears a space of about an inch in diameter. It then seizes one of



INTERIOR OF BEE-HIVE.



FESTOON OF WAX-MAKERS.

the plates of wax with a pincer, formed at the joints of the leg, and drawing it forwards, one of the fore legs takes it with its claw and carries it to the mouth. The insect then proceeds by means of its mandibles and its proboscis to reduce the plate to a riband of wax, which it softens with a frothy liquor. During this operation the proboscis is sometimes flattened like a spatula, then like a trowel, at other times it is like a pencil, terminating in a point. The liquor mixed with the wax gives it a whiteness and ductility which it had not before, the object being to make it fit for working into any shape.

THE PROBOSCIS.

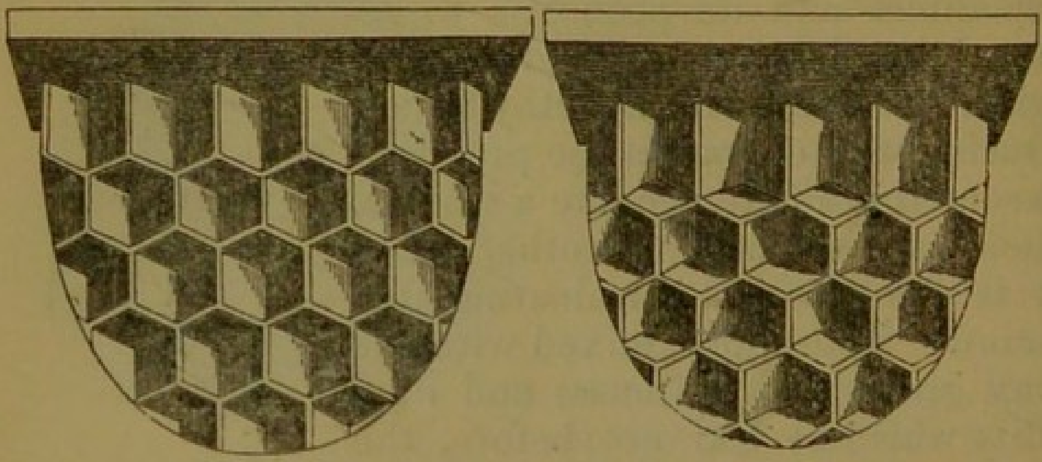
"The parcels of wax thus prepared are applied against the vault of the hive, the little builder arranging them in the direction she wishes them to take: when she has thus employed the whole plate that she had separated from her body, she takes a second, and proceeds in the same manner. At length she leaves her work, and is lost in the crowd of her companions. Another succeeds, and resumes the employment; then a third: all follow the same plan of placing their wax: and if one by chance gives it a contrary direction, another coming after, sets it right."*

LAYING FOUNDATION OF CELL.

After a while, a considerable block of wax having been laid down, another set of labourers, called sculpturers, commence their work. They excavate the cells out of the block, depositing the particles removed around the edges; and they work on opposite sides of the block, the centre of one being opposite a point exactly midway between the centres of two others.

* Insect Manufactures, 82.

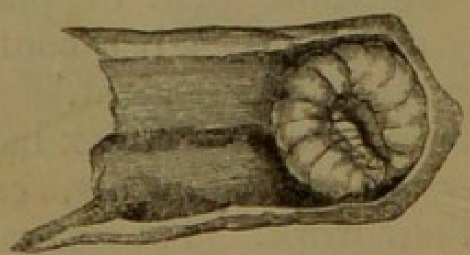
As the block enlarges by the continual deposition of wax, the cells become deeper and deeper, and the instinct of the sculpturers enables them to reduce the walls to the greatest possible thinness in every



FRONT AND REVERSE VIEW OF CELLS.

part, without ever breaking through. Hence the cells of necessity take a six-sided form, with three-sided bottoms.

The first use of these cells is to receive the eggs which the queen-bee deposits. The egg, about a twelfth of an inch long, is stuck to the bottom of the cell, where it soon hatches into a white maggot. This is then carefully fed by the nurse-bees, with a mixture of pollen and honey, partially digested in their stomachs, the proportion of honey increasing as the grub grows older. When it is full-grown, the cell is closed with wax, and the inclosed



GRUB IN CELL.

PUPA.

grub, having spun a lining of thin silk, becomes a motionless pupa, the limbs of the future bee appearing in a rudimentary state, folded down upon its body.

The development of sex, which constitutes a queen, seems to depend not on the egg, which does not differ from that destined to form a worker, but on its being deposited in a larger pear-shaped cell, and on the larva's being fed with a more pungent food.

Another use of the cells is to receive the honey, which, being collected in large quantities during the season of flowers, is stored up. It is collected by means of the proboscis, which is not a tube, but a flat cartilaginous tongue, used for lapping. The

BEES GATHERING HONEY.

honey or nectar is conveyed to the stomach, whence it is disgorged into the cells. Each cell, as it becomes full, is sealed up, and is never opened for the purpose of using the contents, except upon the greatest emergency.

ORDER VII. LEPIDOPTERA.*

(*Butterflies, Moths.*)

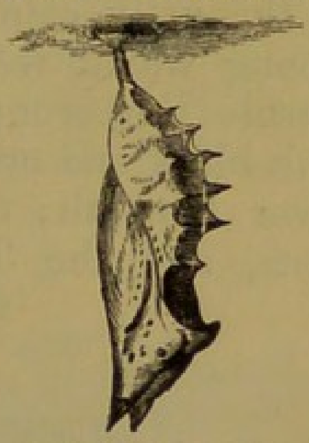
For lightness of form and beauty of colouring this Order is unrivalled. The Sphinges and Moths possess these qualities in a lower degree, it is true; though many of these display great elegance and richness, and even the softened and sobered hues of others are chastely and delicately pencilled; but the Butterflies, true children of the sun, are arrayed in the most gorgeous hues; their four ample fan-like wings being painted with every variety of brilliant tints, arranged in patterns the most diverse, often resplendent with metallic glosses, often flushed with rainbow hues that play over the surface in the changing beam, and often presenting that peculiar charm that results from the association of colours that are complemental to each other.

These various hues, so characteristic of the Order, depend on the presence of minute feather-like scales, with which the wings are thickly clothed. To the naked eye they appear to form a fine dust, easily rubbed off with the finger, but under the microscope they are seen to be thin, flat, transparent films, each attached by a short stalk to the surface of the wing, set side by side in close array, one series overlapping the next, like the tiles of a house. The structure of the mouth in these insects we have already described.

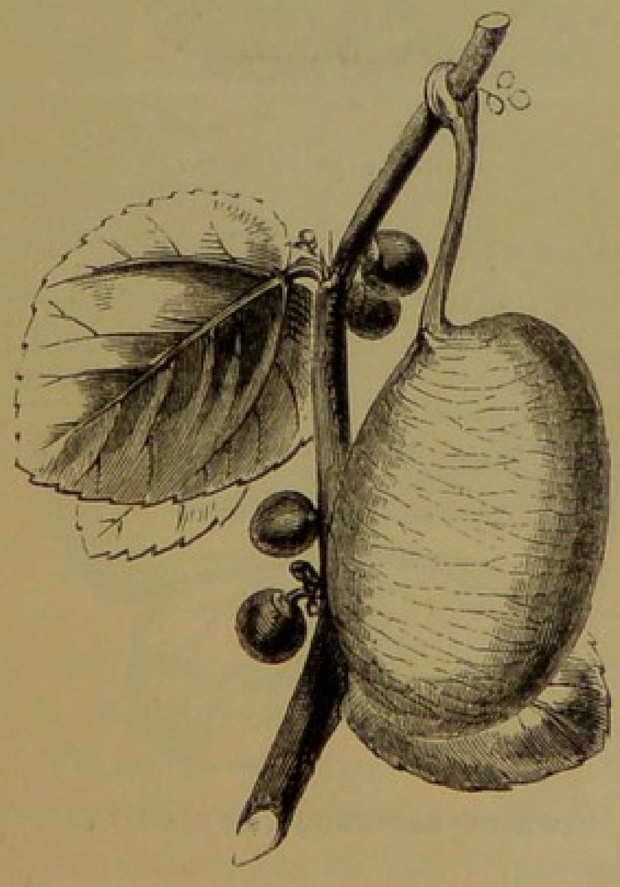
The *larvæ* are commonly known by the name of caterpillars; they have a soft cylindrical body, three pairs of horny feet, and from four to ten false feet, or clingers, on the hind parts of the body, each composed of a circle of minute hooks on a fleshy projection. Some are covered, more or less thickly, with hairs, others are set with spines, and others are quite smooth. In most cases they feed on the leaves of plants; a few devour the wood of living trees, in

* "Scaly-winged" Insects.

which they burrow; and some eat wool, fur, skin, fat, and wax. The *pupa*, called a chrysalis, is motionless, except an occasional slight wriggling of the abdomen, having the limbs folded down and covered with one common skin; their position and shape, however, can in most cases be traced. Butterflies pass their *pupa* state without any external protection; most of them being either suspended loosely by the tail in a perpendicular position from a little button of silk, or having, in addition to this support, a girdle of silk passing round the body, fastened on each side, on which the chrysalis hangs horizontally or obliquely. Many Moths are protected in this



PUPA OF VANESSA.

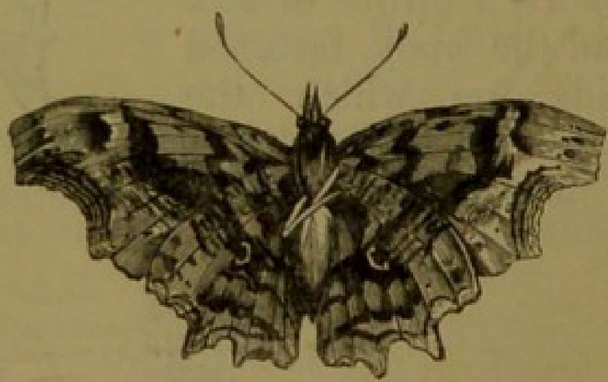


COCOON OF TUSSEH SILKWORM.

state by an oval cocoon, more or less dense, composed of silk spun by the caterpillar just before its change, but a large number undergo their change in the earth, destitute of any protection.

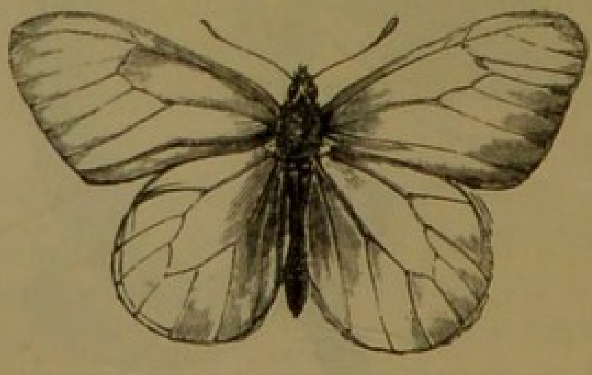
The *Lepidoptera* consist of three great tribes, the Butterflies, the Sphinges, and the Moths. These are also known as daylight, twilight, and night-fliers.

Many of our British Butterflies are very beautiful, as the gaily coloured species of the *Nymphalidæ*, among which we may mention the richly glossed Purple Emperor; the Fritillaries, chequered above with black and orange, and spotted or splashed with silver beneath; the Peacock, with its large eye-spots, and the Tortoiseshells and Commas, with



COMMA BUTTERFLY.

their varied carpet-like patterns. The common Whites of our gardens and woods are inconspicuous for beauty, but some of these are troublesome on



WHITE HAWTHORN BUTTERFLY.

account of their depredations on our pot-herbs. The Yellows, allied to them, are more gay, but are much more rarely seen; their wings are commonly bordered with black; and, to mention no more, the minute but refulgent Blues and Coppers of our heaths may vie with some of the most lovely of the tropical Butterflies for the metallic splendour of their gorgeous hues.

Among the twilight-flying Sphinges or Hawk-moths, we have many fine British examples, such as the Unicorn Hawk, the Privet Hawk, the Eyed Hawk, the Humming-bird Hawk, and the delicate little Clear-wings, so like Hymenopterous flies, as to be readily mistaken. But the largest native, and

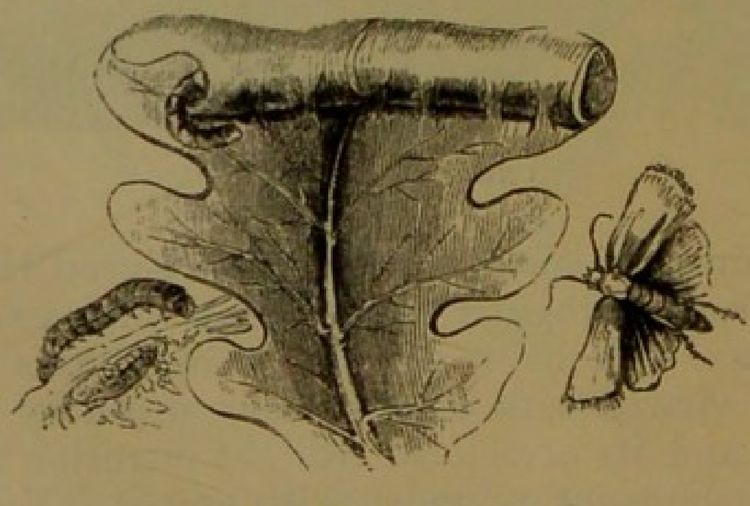
UNICORN HAWK-MOTH.

even European species is the Death's-head Hawk, so called from a singular mark, resembling a skull, on its thorax. Probably on this account, this fine insect is viewed with superstitious dread by the ignorant, and its occasional twilight intrusion into the house is an event regarded with horror. Yet it is a harmless creature, except that it will sometimes make its way into a bee-hive, and regale on the honey; the bees, in some way not understood, being disarmed by its presence, though they might readily sting it to death. The larva of this species is very

DEATH'S-HEAD MOTH.

large, attaining a length of five or six inches; it feeds on the potato-plant, and on jasmine, and burrows in the earth to undergo its pupa-change.

The Moths are a far more numerous division than either of the foregoing, for nearly two thousand species are enumerated as British. Many of these are very beautiful, many more are highly interesting for the elaborate structures which their larvæ form, and others are hurtful for the damage they do to our property. A group of small species is named

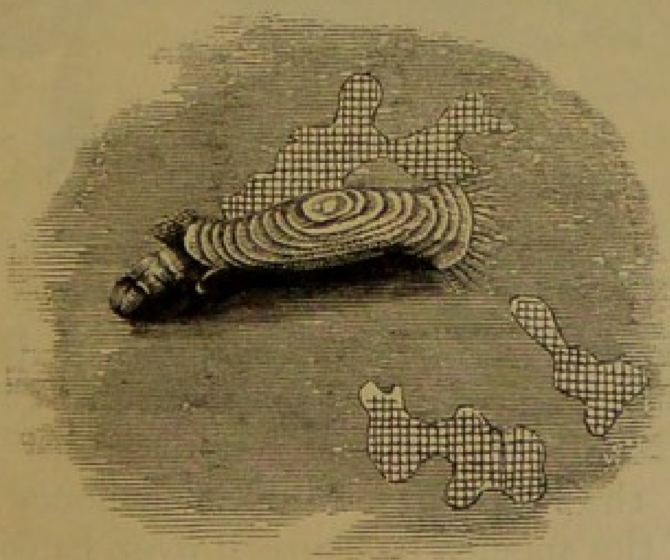


LEAF-ROLLING CATERPILLAR.

Tortrices, or Rollers, from their habit of rolling up the edges of leaves in various forms, and so fastening them with silk as to make compact tubular cases, in which the larvæ dwell. Others having made a little tent of a portion of leaf, set it upright on the leaf, of which instances may be frequently seen in our

SUSPENDED LEAF-TENTS.

woods and hedges. Others again, having made a house by uniting the two edges of a leaf, or two



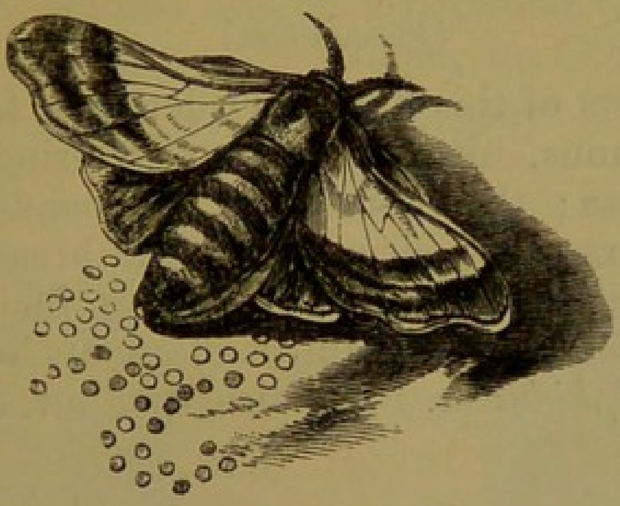
LARVA OF CLOTHES-MOTH IN ITS CASE. (*Magnified.*)

leaves by means of silk, suspend the tent so formed at the end of a silken thread from a twig, in which the little caterpillar lodges securely in a cradle rocked by the wind "at the tree-top." Some, as the various kinds of Clothes-moths, devour the fibres of woollen fabrics, the hairs of fur, the beards of feathers, and similar materials; forming a tubular case out of the same substances as those on which they feed. The mischief done by these tiny depredators is sufficiently familiar.

But if the intrusive attacks of these species on our property occasionally provoke our displeasure, we must not forget the immense benefits we derive from the labours of another species, in the pro-

SILKWORM ON MULBERRY-LEAF.

duction of silk. The Silkworm is the larva of a Moth (*Bombyx mori*), originally from China; the eggs of which were first introduced into Constantinople in the reign of Justinian, whence the cultivation of the species has spread over Europe. The mode in which the caterpillars are reared, the cocoons of yellow silk which they spin, the unwinding and reeling of the thread from these, and the plain appearance of the soberly clad Moth, are all so well known to every child that we need not dwell upon these particulars, but shall conclude the Lepidop-



FEMALE SILKWORM MOTH AND EGGS.

terous Order with the following pleasing reflections on the species under review.

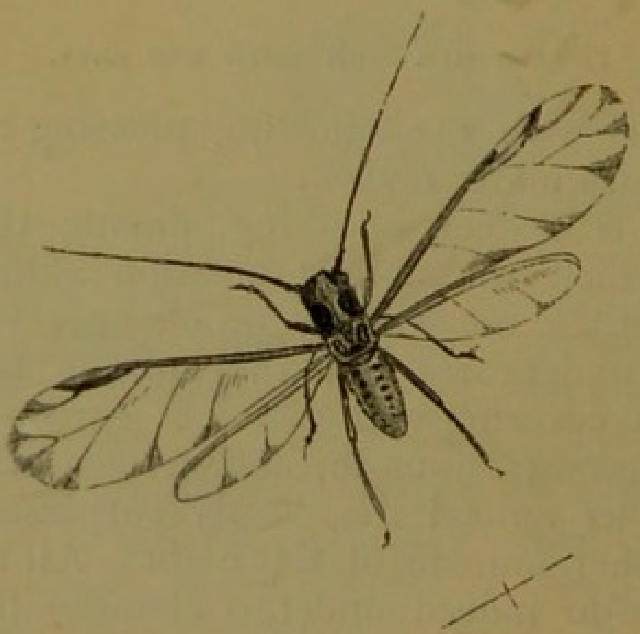
"There is scarcely anything, among the various wonders which the animal creation affords, more admirable than the variety of changes which the Silkworm undergoes; but the curious texture of that silken covering with which it surrounds itself when it becomes a moth, and arrives at the perfection of its animal life, vastly surpasses what is made by other animals of this class. All the caterpillar kind do indeed undergo changes like those of the silkworm, and the beauty of many of them in their butterfly state greatly exceeds it; but the covering which they put on before this change into a fly is poor and mean, when compared to that golden tissue in which the silkworm wraps itself. They indeed come forth in variety of colours, their wings bedropped with gold and scarlet, yet are they but the beings of a summer's day; both their life and beauty quickly vanish, and they leave no remembrance after them; but the silkworm leaves behind it such beautiful, such beneficial monuments, as at once record both the wisdom of their Creator, and His bounty to man."*

* Pullein on the Culture of Silk.

ORDER VIII. HOMOPTERA.*

(*Plant-suckers.*)

The Insects of this limited Order have four wings, all membranous, unequal in size, covering the body during repose; the mouth, by the bending of the head, appears to be situated on the breast; it is a sucking instrument, the jaws being inclosed in a tube, through which the juices of plants are pumped up. The *Aphides* or Plant-lice that infest so many



LIME-TREE APHIS.
(*The lines under the figure show the actual size.*)

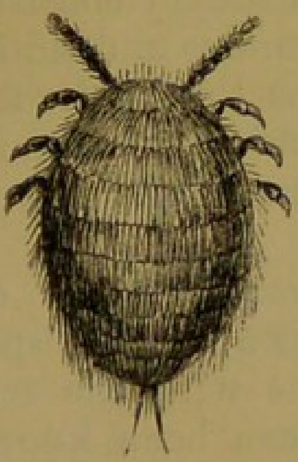
of our flowering shrubs and trees, belong to this group; as do also the Tree-hoppers (*Cicadadæ*), a specimen of which may be found in the Cuckoo-spit, or the masses of white froth that surround the stems of lavender, and other plants in spring. Each little mass of froth conceals the larva or pupa, from whose body it exudes, serving the purpose of a protection

* "Like-winged:" the fore and hind wings in this Order being similar in texture; unlike the *Hemiptera*, from which it was separated.

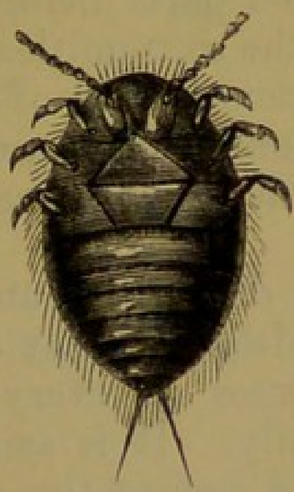
against the beams of the sun. Another example of this Order we select for its usefulness in the arts. It is the Cochineal Insect, a native of South America, which feeds on the Nopal, or *Cactus opuntia.*

MALE COCHINEAL INSECT.

(*Magnified.*)



Upper surface.



Under surface.

It resembles a minute red scale until the last transformation, when the male assumes two large wings, beneath which a small rudimentary pair is concealed. The female, however, remains wingless, and fixes herself to the surface of the plant, whence she never moves; but lays her numerous eggs beneath her own body, and dies, leaving her dried, scale-like corpse as a shell for the protection of the young brood. The juices of the cactus are elaborated by these insects into a substance of the richest crimson hue, which forms one of the most valuable dyes, not only for that colour, but also for scarlet, by the agency of an oxide of tin. The possession of the insect was for a long time jealously guarded by the Spanish colonists of America, and so high a value was set upon it, that the East India Company offered a reward of six thousand pounds sterling to any one who should be so fortunate as to introduce it into their possessions. It is now, however, cultivated with various success in several distant parts of the globe.

ORDER IX. HEMIPTERA.*

(*Bugs, &c.*)

THE repulsive insects which constitute this Order have the fore pair of wings curiously heterogeneous; the basal parts being of a stiff, leathery consistence, while the extremities are membranous and thin; the membranous part of one overlaps that of its fellow. The mouth is a piercing and sucking tube, as in the last Order, but proceeds from the front part of the head.

The disgusting and bloodthirsty creature called the Bed-bug (*Cimex lectularius*) is a wingless species, but agrees in every other point with the rest of its family. It is said not to have been known in England before the great fire of London, in 1666, but to have been imported in timber used for the rebuilding of the city. The term "Bug" signified any terrifying thing,† and was applied to the newly imported insect on account of the terror inspired by its nocturnal bites.

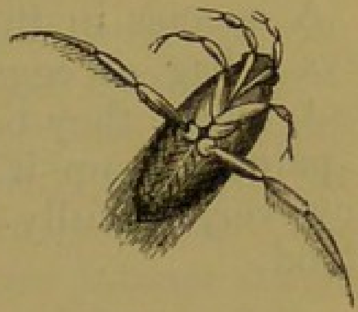
The tribe of Bugs is very extensive, and many of the species are large and richly coloured: they lurk about plants to prey upon hapless insects, into whose bodies they plunge the piercing sucker and extract the juices. They are all distinguished by an insufferably rank odour.

The Water-scorpion (*Nepa*) an inhabitant of every pool, is not very dissimilar to the bugs: its sharp and strong sucker is capable of piercing the hand, and of inflicting a painful wound, inflamed, as it appears, by the infusion of a poisonous fluid. Another tribe, likewise aquatic, is that of the Water-boatman

* "Half-winged;" the fore wings being half membranous, and half crustaceous in texture.

† This sense of the term is preserved in the word "Bugbear." In an old version of the Bible, the word is used for "terror."—"Thou shalt not be affrayed for any bugges by nyghte." Psalm xci. 5.

(*Notonecta*) which swims swiftly with the back downward, using the long hind feet, which are strongly bristled, as powerful oars; these are commonly carried stuck out at right angles to the body. The *Notonecta* flies by night, and we have reason to believe, from personal observation, that its aerial motion is performed like its aquatic, back downward.



WATER-BOATMAN.

ORDER X. APHANIPTERA.*

(*Fleas.*)

The wings in this Order are represented by four minute scaly plates, two of which lie close to each side of the body: the mouth is a piercing and sucking tube; the body is much compressed or flattened sidewise; the legs are long and formed for leaping.

The common Flea is well known; its polished coat of mail, its blood-sucking propensities, and its extraordinary powers of leaping, have made it familiar to every one. It must not be supposed that the Fleas which are found upon the dog and cat are identical with that which practises *phle*-botomy on the human frame; for these animals are found to be infested with their own peculiar species, as are also the mole, the mouse, the swallow, and other animals.

The female Flea is said to lay about a dozen eggs, which are of a whitish colour, and somewhat glutinous; each egg produces a long, slender larva, which is destitute of feet and of eyes; but is furnished with small antennæ. When about to undergo its change into the pupa state, it spins a little silken

* Insects with the wings not apparent.

cocoon around its body, from which, in the course of a few days, it emerges in the perfect state.

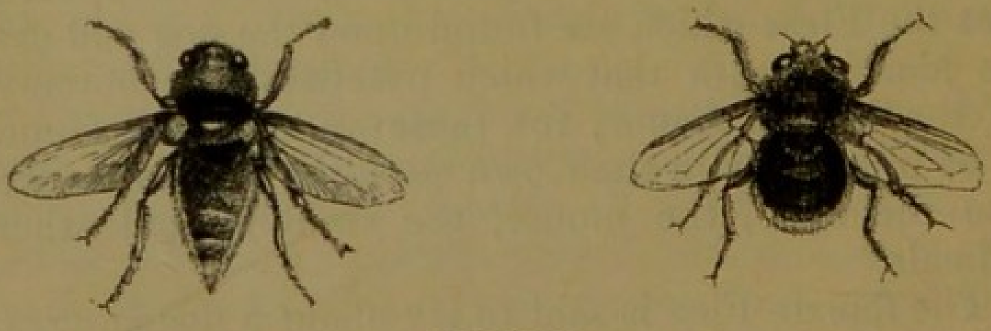
A species in the West Indies, called the Jigger, lays a bag of eggs beneath the skin of the human foot, where they hatch and soon increase, producing a painful lump if not attended to. The negroes, however, skilfully extract the whole without drawing blood.

ORDER XI. DIPTERA.*

(*Flies, Gnats, &c.*)

In this Order the fore-pair of wings alone is found; these are membranous, veined, without folds; the place of the hind wings is occupied by a pair of slender filaments with a knob at the end, called poisers, the presence of which seems more essential to flight than even the second pair in four-winged insects; as, if they are cut off, the fly has no longer the power of sustaining itself in the air. The mouth forms a tube, commonly enclosing several piercing or cutting instruments, as already mentioned.

The *Œstri* or Gad-flies have no proboscis, the mouth being obsolete. These are parasitical flies,



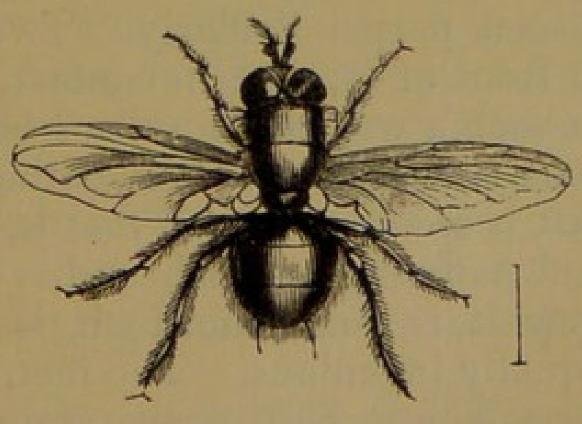
GADFLIES.

the larva deriving their nourishment from the bodies of quadrupeds, in which they live. Thus the Horse Gad-fly inhabits in its larva state, the stomach and intestines of the horse, constituting, when in great

* "Two-winged" Insects.

numbers, the disease called "Bots;" the Sheep-fly resides in the cavities of the skull, and the Ox-fly in the interior of tumours on the backs of our horned cattle. The artifices employed by the parent insects to deposit their eggs in suitable situations for the grub to reach its destined position are curious points in the economy of these flies. The two latter species appear to produce intense terror in the animals, when they are seeking a foster-parent for their progeny; the horse is less susceptible of alarm from this source, though not entirely free from it.

The larvæ of other species of this Order, as most of the genus *Musca*, the Flesh-flies, feed upon flesh in a state of decay. How annoying these are in warm weather, and how difficult it is to exclude them from the larder and pantry, every housewife knows; for the continuance of the species is the great object of insect existence, and the efforts made to effect this are most persevering. The odour of tainted meat seems to convey to these flies the intimation of a suitable provision for their offsprings, and hence their smell must be acute; it is a curious example of instinct at fault, that Flesh-flies have been known to deposit their eggs on some flowers, the smell of which resembles that of putrid flesh, but which can afford no nutriment to the maggots. Linnæus asserted that three Bluebottle-flies will devour a dead horse as quickly as a lion could do it; and when we consider that each fly is the parent of twenty thousand voracious maggots, each of which, for five days, is incessantly occupied in eating, and which increase in weight two hundred times in



DOMESTIC FLY (*Magnified*).

twenty-four hours, we may think the assertion less absurd than it at first appears. The grey or chequered Blow-fly brings forth its larva already hatched. The common House-fly is believed to spend the earlier stages of its existence in dunghills; it is said, that in Venice, where there are no horses, the House-fly is never seen.

Others of this extensive Order, as the Gnats, Whame-flies, &c., suck the blood of the larger animals, and for this purpose are provided with a most effective apparatus of knives, lancets, probes, needles, and tubes, which are inserted into the flesh; so fine and sharp are these, however, that the puncture would scarcely be felt, were it not that a poisonous fluid is injected at the same time to dilute the thick blood, and render it capable of being pumped up through the slender sucker.

The transformations of the common Gnat (*Culex pipiens*) are well worthy of observation; and as the insect inhabits, in its progressive development, every water-butt, peculiar facilities are afforded to our youthful readers for examination. The female Gnat descending from her aërial dance in the slanting beam of sunset, alights cautiously on the surface of the water, where the lightness of her body, and the expanse covered by her slender feet, prevent her not only from sinking, but even from becoming wetted. Crossing her hind feet, she now lays an egg in the angle; it is of an oblong form, and is placed perpendicularly. Two others are then laid in front of it, but in contact, and others are added, in such a way that a raft or boat of eggs is gradually constructed, capable of floating on the surface. This raft is spindle-shaped, that is, swelling in the middle and tapering to each end. We have already seen how it is commenced; it is finished in a manner equally ingenious. The feet, when the little structure is just half done, are uncrossed, and crossed again in front of the raft, so that, when accomplished, the latter half shall just fill the angle newly formed. The mass is safely left to float about the surface, for such is its power of repulsion, that even if a drop of water fall on it, it will not sink. In about two days they are hatched, and the larvæ may be seen like minute fishes with great heads moving through the water with a wriggling agility, now descending, now slowly rising to the surface, where they hang, as it were, suspended by a little tube, which serves the purpose of respiration. In about a fortnight they change into pupæ, equally active, but very different in form. They somewhat resemble a lobster, for the thorax is very large, the abdomen slender, bent under the body, and terminated by broad membranous swimming flaps. Instead of the respiratory tube near the tail, the pupa has two in the form of little horns, on the summit of the thorax, which serve the same purpose.

When the time of the final change arrives, and this aquatic pupa is to give birth to an animal inhabiting the air, whose filmy wings would be spoiled by the least contact of water, the process is most interesting. The pupa having risen to the surface elevates its thorax above the water, the skin of which soon drying, splits, and exposes the fore-parts of the Gnat, which are quickly protruded. "At this critical period, the old skin acts as a life-boat to the little animal; the observer, who sees how this little boat sinks closer and closer to the margin, feels interested for the safety of the insect; for should it upset, the tiny mariner would certainly be drowned. But the Gnat having fixed itself perpendicularly, draws first its two anterior legs out of their case, and moving them forward, proceeds to do the same with the next pair; then resting for an instant on the surface of the water, the wings unfold themselves, are dried, and the insect flies away to enjoy its new existence."*

Such are a few only of the varied forms of Insect

* Kirby and Spence.

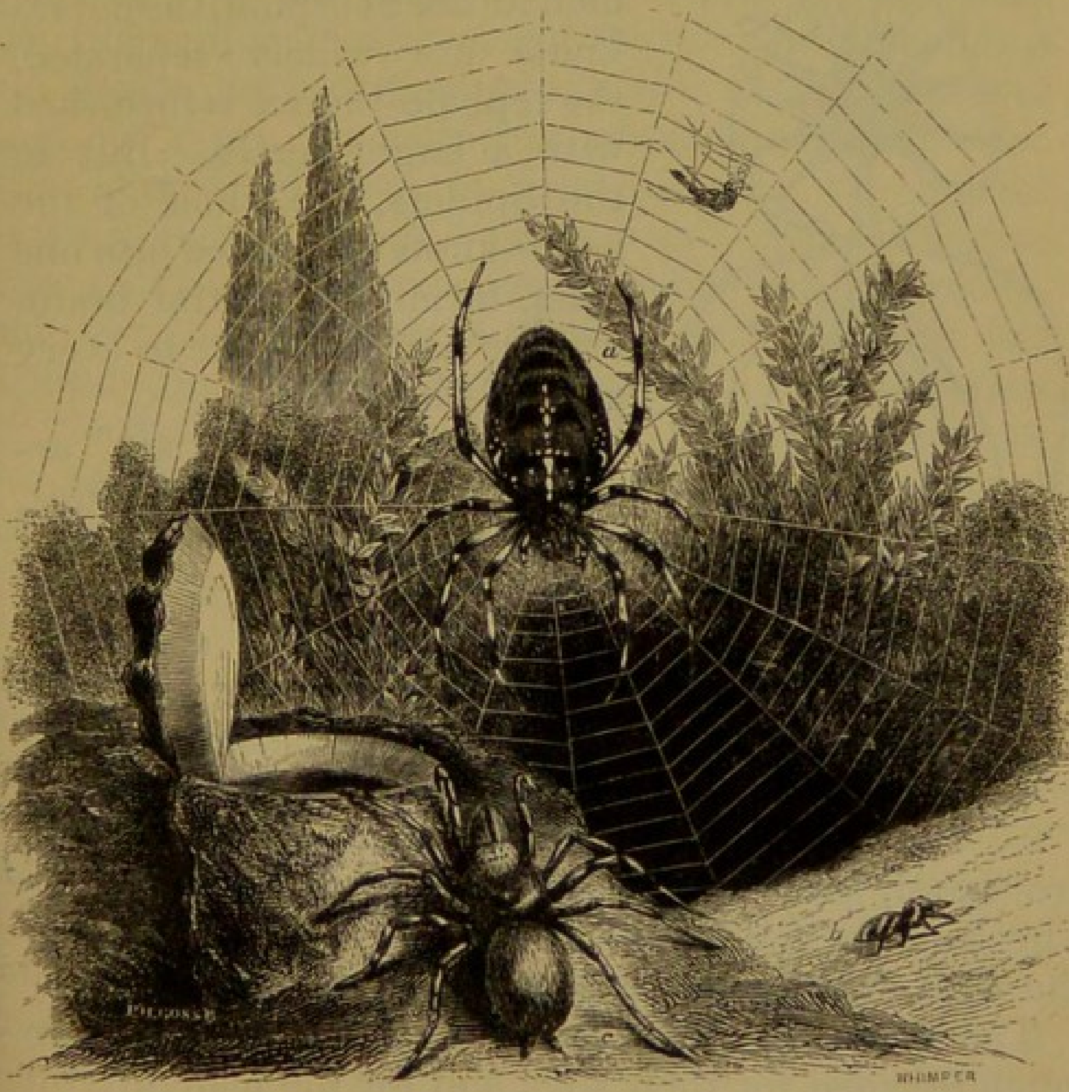
life; of the small, but multitudinous tribes that creep upon the earth, or dart through the waters, or wing their way through the air. To describe the whole, in their forms and colours, their instincts and their habits, would be the labour of many lives; and the mere enumeration of the names of such as exist in the cabinets of the British Museum, would fill a large volume. Yet every individual of this vast host, every little Gnat that adds its tiny hum to the chorus of the twilight-dancing swarm, every sordid grub that works its darkling way beneath the turf, is known to God and cared for by Him: "He openeth His hand, and satisfieth the desire of every living thing."

CLASS IV. ARACHNIDA.

(*Spiders, &c.*)

The Spiders, Mites, and Scorpions, as well as the Crabs, Lobsters, and Shrimps, were all comprehended by Linnæus in the Order *Aptera* of Insects; but a more intimate acquaintance with anatomical structure has shown the necessity of separating these animals from the Insects, and of constituting them two Classes, equal in rank, though not in extent, to the vast group we have just dismissed.

The Class before us presents a further advance in that condensation of form, to which we have before alluded. The three-fold division of true Insects was a great advance upon the many-jointed Centipedes, but now we find two of these divisions consolidated into one, the head being soldered, as it were, to the thorax; and the animal now presenting only two distinct parts, this *cephalo-thorax*, and the *abdomen*. In addition to this distinction we find an increase in the number of legs, in which particular there is a retrograde tendency towards the *Myriapoda;* for while no perfect Insect has more or less than six legs, the Spiders and Scorpions have eight. The *antennæ*, those curious organs, which we have traced through the whole Insect tribes, are now no longer

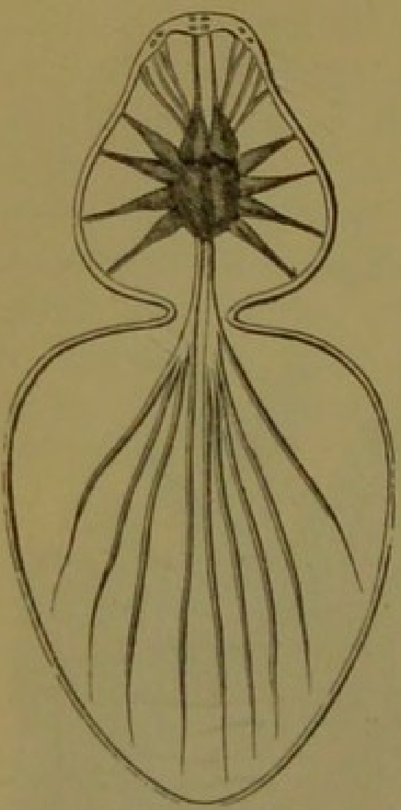


SPIDERS.

found, nor are the compound eyes, which formed so remarkable a peculiarity in the preceding Class.

With the exception of the Ticks and Mites, in which a system of air-pipes resembling those of Insects indicates a connection with that Class, the process of breathing is carrried on in the animals before us by means of a sort of lungs, composed of bags, the sides of which are so disposed in folds, as to present a large surface to the air. Into these sacs the air is admitted through narrow orifices, resembling the breathing-holes of Insects.

The nervous system also shows an increased concentration; for though in the long-jointed tail of the abdomen in the Scorpion, the nerve-knots are widely separated, the cephalo-thorax is furnished with a larger series. But in the Spiders, the whole of the nerve-knots are united into one mass, forming a central brain, whence nerves radiate to every part of the body.



NERVES IN SPIDER.

The ARACHNIDA are arranged in three groups, the Mites, the Scorpions, and the Spiders. The first of these comprises minute creatures, many of which are parasitic upon other animals, of which the Dogtick, and the Mites that infest the common Dorr, are examples. Others feed on provisions, as the Cheese-mite, and others live beneath the surface of the water, as the pretty scarlet Water-mite.

The Scorpions,* chiefly found in hot climates, are much dreaded for their size, and for the malignity of their venom, which is formidable, if not fatal, to the larger animals, and to man. A prominent feature in these creatures is the pair of maxillary palpi, which are developed into long and strong limbs, armed with a forceps at the extremity, like a lobster's claw. The abdomen is lengthened, and the hinder segments are distinctly jointed, and being slender, constitute a flexible tail, ending in a sharp hooked point, which is tubular, and gives emission to a powerful poison.

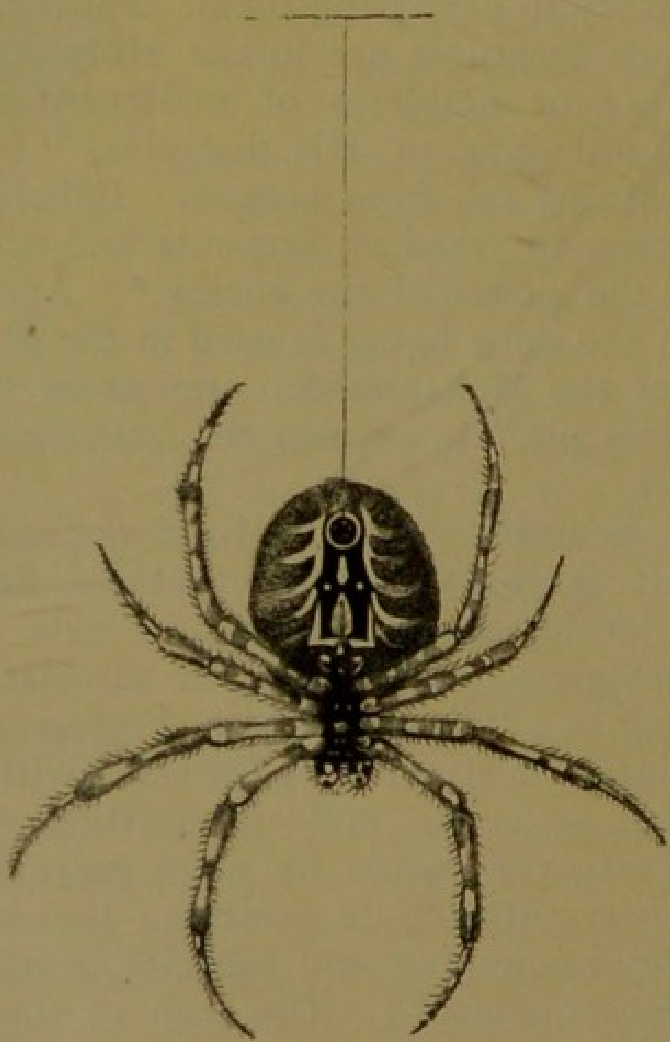
* See the Engraving on page 98.

Scorpions usually lurk under stones, in ruined buildings, caves, &c.; but run with swiftness, with the tail curved over the back, and the pincers extended in a threatening attitude. With their stout pincers they catch large Beetles, Locusts, &c., which they sting by bringing the tail forwards, and thus kill, preparatory to devouring them. These insidious and venomous creatures are in the Holy Scriptures used as types or emblems of malignant Spirits: Thus the Lord says to His disciples, "I beheld Satan as lightning fall from heaven. Behold I give unto you power to tread on serpents and scorpions, and over all the power of the enemy.* And in the Apocalypse, the same figure is used in the prediction of the rise of the Mohammedan imposture "out of the bottomless pit," to express the fatal character of its doctrine.†

Both the Scorpions and the Spiders feed on insects, but it is in the latter that we find pre-eminently developed, the instinctive arts and ingenious stratagems, that are often associated with predatory habits. "Spiders," says Professor Jones, "are appointed destroyers of insects, with which they maintain a cruel and unremitting warfare. That the destroyer should be more powerful than the victim, is essential to its position; that it should excel its prey in cunning and sagacity is likewise a necessary consequence."‡ The web of the Spider has been admired in all ages as an ingenious and beautiful production of insect art, elaborate in its construction, and most effective for its purpose. The geometric nets which in autumnal mornings we see in our gardens, stretched across every corner between the spikes of the railings and palisades, and among the twigs of the bushes, are the work of the great Garden Spider, (*Epeira diadema*,) one of the most beautiful, as well as largest, of our native species. It is

* Luke x. 18, 19. † Rev. ix. 3, 5, 10.
‡ Gen. Outline, p. 314.

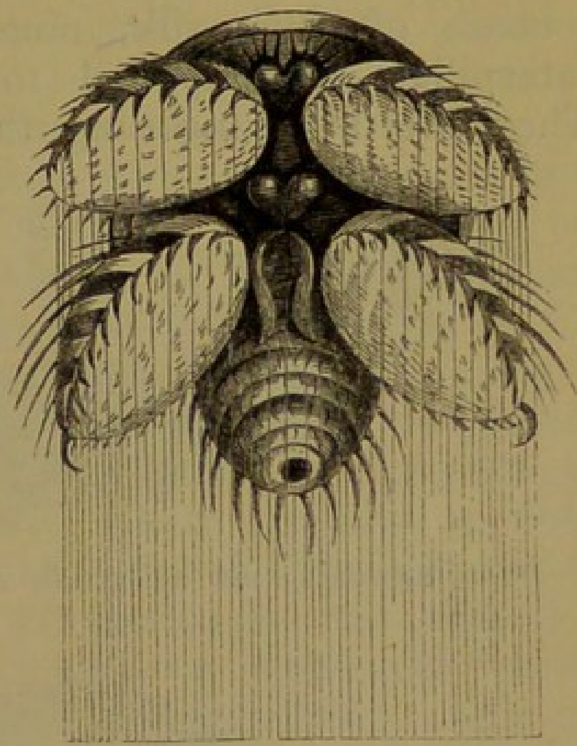
not commonly known that these nets are composed of two sorts of threads; the frame-work, which is first formed, consists of straight rays diverging from a centre; these are not adhesive; but over these, the Spider then travels, weaving a spiral thread round



GARDEN SPIDER.

and round, which is the true net; for this thread, which is much more elastic than the other, is studded all over with minute globules of a gummy substance, by which it is rendered adhesive. This explains why, if we throw a fly against a spider's web, it will sometimes rebound without the least retention, while at others, it is held irresistibly by the slightest contact.

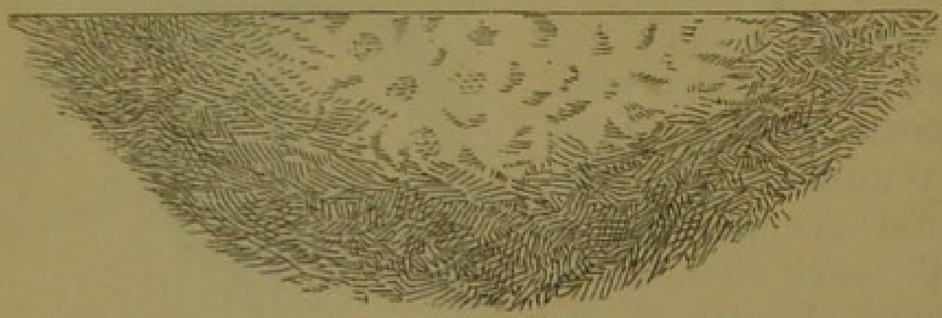
The apparatus whereby the Spider's web is formed consists of an internal and an external portion. The former includes the glands that secrete the gum, the reservoirs that hold it, and the tubes that convey it to the external organs, when wanted. The latter consist of four spinnerets, or teat-like projections, each of which is studded with minute points, about a thousand to each. These are perforated, and each emits a thread of gum of inconceivable fineness, which presently drying in the air becomes a highly elastic silk. At a short distance from the spinnerets the whole of these threads unite, and together constitute the thread of which the web is made, and which, instead of being single, as commonly supposed, is thus seen to be a rope composed of four thousand strands.



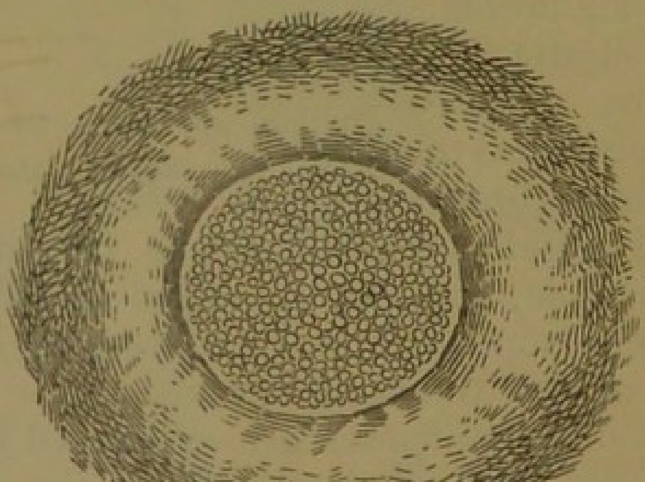
SPINNING APPARATUS OF THE SPIDER.
(*Greatly magnified.*)

Various other purposes are subserved by the silk of the Spider. Some species have the faculty of shooting out threads in diverging lines into the air, which being lighter than the atmosphere, form a sort of balloon on which the little aëronaut mounts above this lower world and rides at will among the clouds. Mr. Blackwall supposes that the Spider is able to do this by the action of the wind alone, which carries the thread out as it is spun, and that many being entangled together are carried into the air by the upward current caused by the rarefaction of the stratum near the heated ground. This principally occurs in the middle of the day, but during the night the earth being cooled, the air descends, bringing with it the accumulated webs, which, lying thick upon the herbage, are called gossamer.

Most, if not all, of the Spiders weave nests or cocoons of thick silk, much resembling those of caterpillars, but applied to a different purpose. They are bags inclosing the numerous eggs, and



SPIDER'S NEST ATTACHED TO A FLAT SURFACE.



SPIDER'S NEST LAID OPEN.

doubtless are intended both for protection and warmth. Some kinds carry about their egg-bags wherever they roam, maintaining the possession of them with remarkable pertinacity; others content themselves with choosing a situation of concealment and safety in which to leave them. "Even in water these webs are turned to many singular uses; and ropes, nets, and even diving-bells, are at the disposal of aquatic species furnished with this extraordinary spinning machinery."*

"In the Ionian islands, and also in the West Indies, [as well as in the south of France, and in Corsica,] there are found certain Spiders, (*Cteniza*) commonly known as Trap-door Spiders, which make a cylindrical nest in the earth, and cover the entrance with a door of their own construction, framed of alternate layers of silk and earth, and fastened to the opening by a hinge of stout silk. These Spiders also line their nests throughout with numerous layers of silken web to the thickness of stout cartridge paper, and finish it with the greatest care. This beautiful lining is yet further strengthened in particular parts, where the nest is likely to be exposed to danger. But the greatest amount of skill and care is bestowed upon the trap-door and its silken hinge. This door is about the eighth of an inch thick, rough on the outside, not much unlike an oyster-shell, which it also resembles in being thick and strong near the hinge, but thinner

TRAP-DOOR SPIDER.

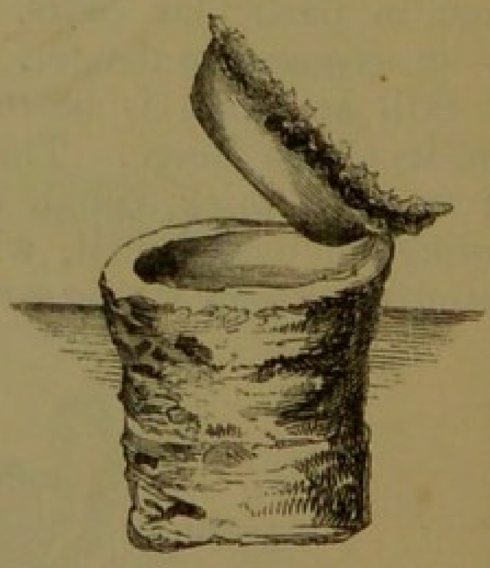
towards the circumference. The breadth of this hinge is various, but sometimes it is very considerable, as shown in the accompanying figure. It also possesses great elastic force, so that on

* Prof. Jones.

being opened, it closes again of itself. This is principally accomplished by a fold or doubling of the web, at each end of the hinge, which permits the door to be opened nearly to a right angle with the aperture, but no farther, unless violence be used. The under side of the door is perfectly smooth and firm, being shaped so as to fit accurately, and yet to offer no resistance when pushed open by the insect.

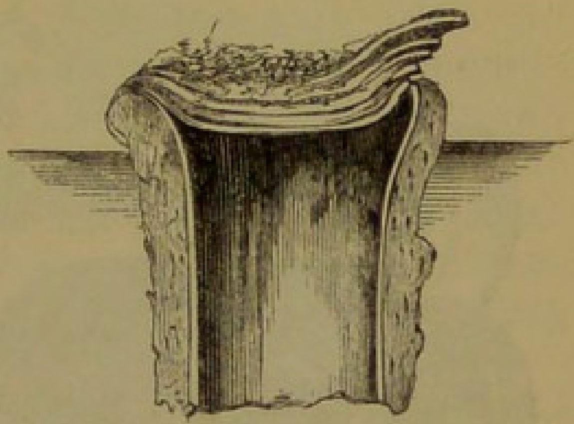
"As might be expected, there are varieties in the shape and size of these nests. Some specimens found in the island of Zante had the silken layers of the lid extended into a sort of handle or lever

NEST OF TRAP-DOOR SPIDER.



TRAP-DOOR OPENING BY A LEVER.

just above the hinge, on pressing which in ever so slight a degree the trap-door opened. From this it would appear that the entrance to such a nest could be effected as easily by the enemies of the Spider as by the Spider itself: this, however, is not the case; for repeated observation has shown that the Spider keeps guard at the entrance, and actually holds the door with her fore feet and palpi, while the hinder feet are extended down the side of the nest, and the mandibles are thrust into the opposite side near the door. By this means the insect gets such power as to resist with considerable force the opening of the door. If it be asked how this is known, we are able to refer to the experiments of careful observers, who extracted a number of nests from the ground, and opening them at the lower end, looked up, and saw the Spider so occupied. A sectional view of the nest will show that the curved form of the cover, and the shape of the side walls, must favour this method of keeping the door shut. In some cases, small hollows were formed round the interior edge of the lid, into which the Spider thrust its feet when keeping guard. It is a curious fact, that when several of these Spiders enclosed in their nests were kept as a matter of curiosity in a box of earth, and the doors frequently opened to examine their proceedings, one or two of them, as if wearied at these repeated interruptions, effectually closed their doors by weaving a piece of silken tapestry, which was spread over the interior of the opening, and rounded like the inside of a thimble. This was so strongly attached to the door and to the side walls, that no opening could be made without destroying the nest."*



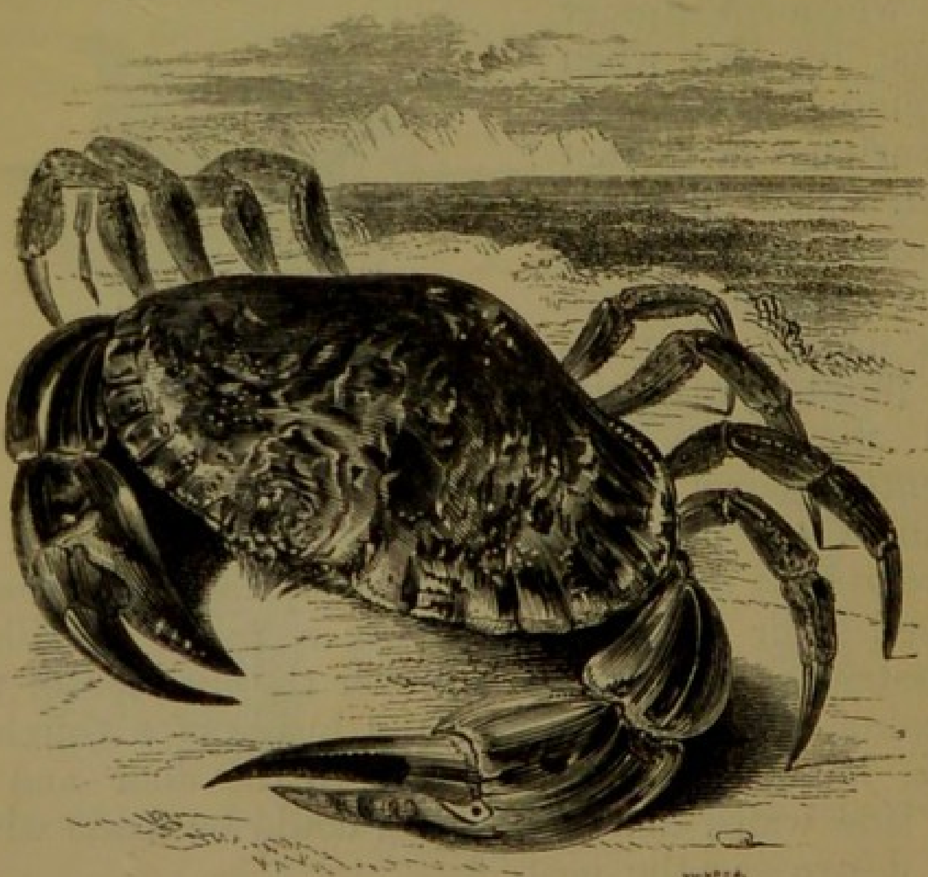
SECTION OF NEST.

* Insect Manufactures, p. 64, et seq.

CLASS V. CRUSTACEA.*

Crabs, Lobsters, &c.

We must not suppose that we can proceed through the vast series of animated beings in a continuous chain, every link of which is higher and lower than the one which precedes, and the one which follows it. In many instances, by following one thread of



COMMON CRAB.

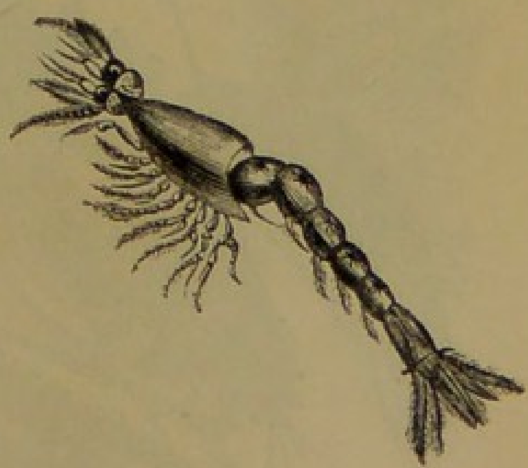
insensible gradations, we soon perceive that we are leaving behind other forms, which were before us when we commenced, but which we cannot by any means bring into the line we are tracing. It is so with the great Class CRUSTACEA. The many-ringed, lengthened bodies of the Centipedes we left behind,

* Animals covered with a "crust," as distinguished from a "shell," which term is applied to the stony covering of the Snail, or the Oyster.

as we advanced through the gradual concentrations of form and structure in the varied Insect tribes, but we have now to take up a mighty host of creatures, the lowest of whose forms is in the closest alliance, both as to figure, external members, organs of sense, and nervous system, with the MYRIAPODA, while, by a regular and uninterrupted succession of steps, these connect themselves with creatures, manifestly higher in the scale of being than the most developed Insects.

The Armadillo Woodlouse can scarcely be distinguished, without a minute and critical examination, from the Pill Millepede; both are oval, both are convex, both consist of many shield-like segments, both have many pairs of short feet, and both roll themselves up in the form of a little ball. Yet the former is a Crustacean, the latter, a Myriapod. Both these little creatures are common in gardens, in hotbeds, and under stones, where they feed on decaying vegetable substances.

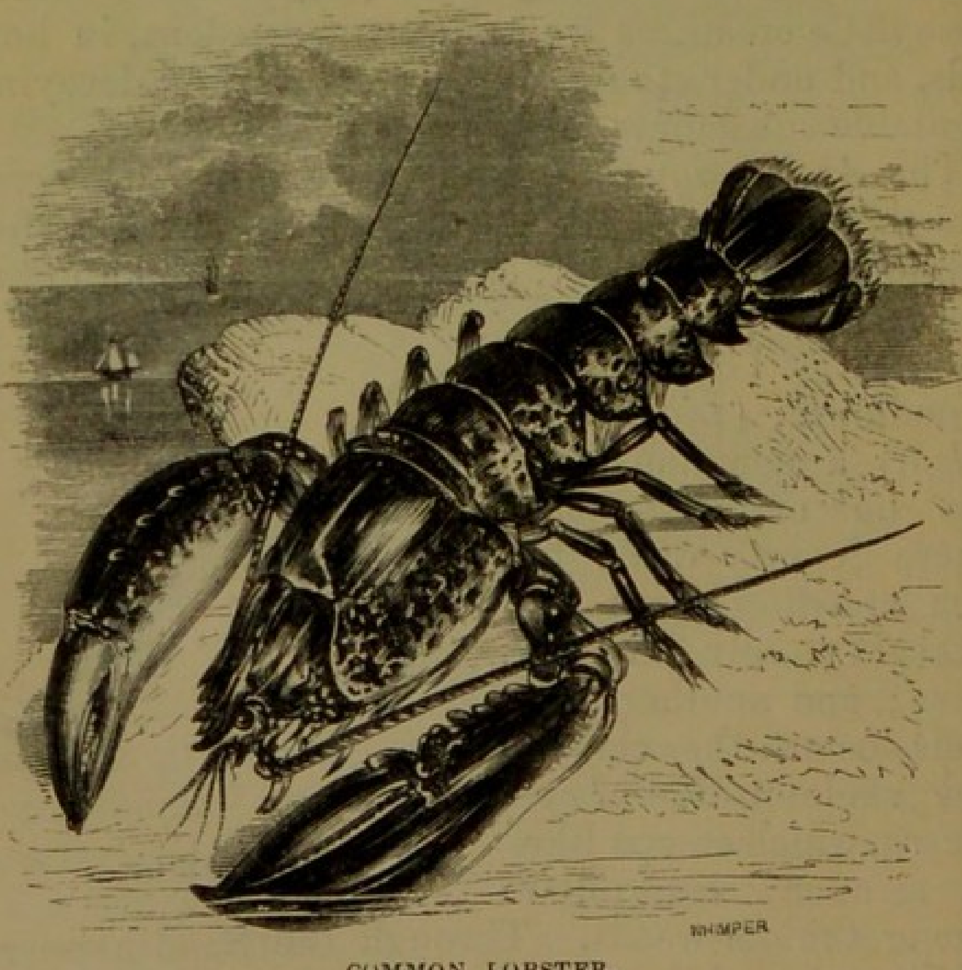
The *Asellus aquaticus* again, an active little creature that crawls nimbly about the bottom of ditches and pools of fresh water, closely resembles in appearance a Centipede in miniature. The Marine Woodlouse, (*Ligia oceanica*,) a common species on our sea-coast, where it may often be seen crawling about the rocks, is closely allied to these; and another step leads us to the clawed and skeleton-like *Leptomera*, which creeps like a slender caterpillar among the sea-weeds. Through the Sand-hoppers, (*Talitrus*,) myriads of which may be seen bounding over the sands at the water's edge, and the minute Freshwater Shrimp, (*Gammarus*,) so common in every



OPOSSUM SHRIMP.

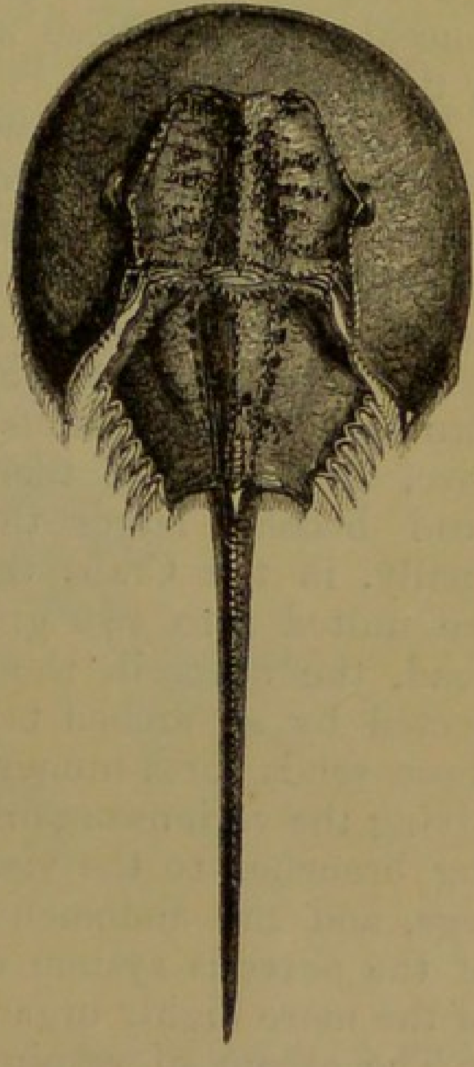
brook, swimming with much agility by a series of short jerks, commonly on its side,—we are brought to the Mantis Shrimps, (*Squilla*,) the most carnivorous of their Class, and the Opossum Shrimps, (*Mysis*,) remarkable for having a pouch in which the female carries her eggs and young; hence, the transition is easy to the true Shrimps, the Prawns, the Lobsters, and the Crabs.

The CRUSTACEA, then, must be considered as a group of Articulated animals, parallel to the Insects and Spiders, of which they form the aquatic, and with few exceptions, the marine representatives. In many of their characters, they agree with those Classes, and the whole of them, together with the ARACHNIDA, were actually included by Linnæus in his wingless Order of Insects.



COMMON LOBSTER.

These animals are divided into rings or segments, twenty-one in number; of which seven belong to the head, seven to the thorax, and seven to the abdomen. These, however, are consolidated or soldered together, in various degrees, so that in the great majority of cases, only a few of these divisions are obvious. Thus, in the Lobster, the whole head and thorax are united into one great shield, on the under side of which, however, the divisions can be traced; in the Crab, the consolidation of these parts is still further developed, and the segments of the abdomen are small, and folded up beneath the enormous thorax; while in the remarkable King-crab, or Horse-foot of warm climates, (*Limulus*,) the divisions of the abdomen are lost, the body being covered with two large shields, terminating in a long sharp spine.



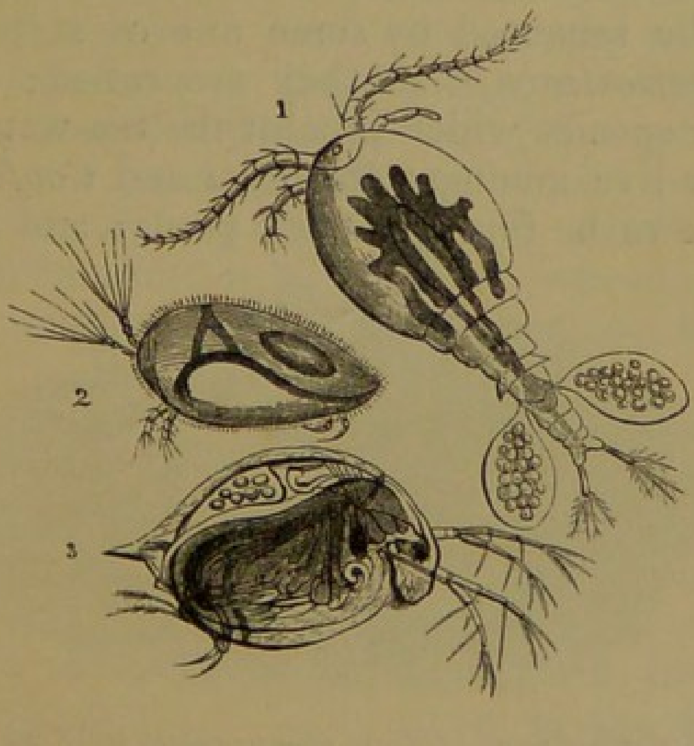
KING-CRAB.

This is a very curious form: viewed from above we see nothing but these two convex bucklers moving along on the shore, no limbs being visible. The front shield is rounded, with a pair of simple eyes in front, and a pair of compound facetted eyes at the sides; the hinder edge is deeply hollowed to receive the abdominal shield, the sides of which are notched and armed with moveable spines. The stout sharp spine at the extremity is moveable also; it is hard and dense in structure, and in the hands of savages proves a formidable weapon. But on turning over this singular creature, we discover six pairs of well-formed feet, the basal joints of which, armed with teeth and spines, serve the extraordinary purpose of jaws, to masticate the food and force it into the mouth, which is situated between them. Behind these are six other pairs of feet of very different structure; they are leaf-like, and perform the office of gills, each carrying on its outer edge a series of thin plates like the leaves of a book, which separate oxygen from the water for respiration: the first pair of these gill-feet are very large, and overlap all the others, so as to protect and conceal them. These animals are sometimes two or three feet long.

In the CRUSTACEA we find the nervous system developed in very varied degrees. In some of the lowest genera, two parallel lines of minute nerve-knots, set far apart and equal to each other, remind us of the lowest of the ANNELLIDA; but as the genera advance in development, the two lines unite into one, the nerve-knots approach each other lengthwise, and some of them coalesce, those near the head become larger than the hinder ones, until finally, in the Crabs the whole of the nerve-knots are united into two great masses, the one in the head, the other in the centre of the thorax, connected by an arched band on each side. Each of these sends forth numerous nerves, the former supplying the various organs of sense, the latter furnishing branches to the viscera, the numerous pairs of legs, and the abdomen or tail. This arrangement of the nervous system closely approximates to that of the more highly organized MOLLUSCA.

The organs of respiration in this Class are, more or less obviously, connected with the feet. If from a Crab we lift off the thoracic shield commonly called the *shell*, we see a number of leaf-like organs pointing to the centre. Each of them is wide at the base and tapers to a point, and consists of a central stem, covered with a multitude of thin plates. These are the gills; and as they are attached to the bases of the legs, and of the foot-jaws, every motion of these members brings the surface of the gills into contact with a fresh portion of the surrounding fluid. In the Lobster the structure is essentially the same; but the gills are composed of filaments instead of plates. In the Squills, some of the feet are actually changed into gills, being expanded into broad feathery leaves: while in the Water-fleas all the feet present the form of flat and fringed plates, the whole surface of which abstracts the oxygen used in respiration.

The little animals to which we have just alluded are interesting forms of Crustacea. Every one who has ever pulled up a pinch of the common duck-weed from a ditch, and looked at it in a phial of water, is familiar with a variety of tiny but most

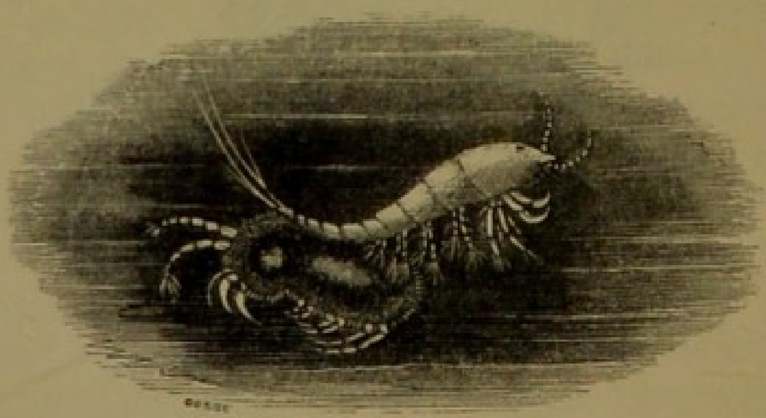


WATERFLEAS: 1. *Cyclops communis*; 2. *Cypris unifasciata*; 3. *Daphnia pulex*.

indefatigable living atoms, that proceed through the water by short quick jerks, or dart to and fro with a rapidity that the eye can scarcely follow. The jerking ones are species of *Daphnia*, the more fleet darters are of the genus *Cyclops*, and another tribe, still more varied in form, that keep chiefly near the bottom, and creep nimbly more than they swim, are the *Cyprides.* All these under a microscope are exceedingly beautiful. Their bodies are contained between two plates united over the back, and resembling a bivalve shell; this is usually more or less transparent, and in some is delicately tesselated or marked with an intricate network of raised lines. The antennæ are often curiously branched and appear to be used as oars. It is a remarkable character of almost all these pretty little *Water-fleas*, that they have but a single eye, which is generally of a bright crimson hue, sparkling like a little ruby, and is set in the front of the head. In the *Daphnia*, however, the eye is of a bluish-black hue, and appears as if surrounded by brilliants.

Every little collection of fresh-water is almost sure to be tenanted by some one or more of these tiny *Entomostraca*,* as they are called; but there are other species which inhabit the sea-water.

"They live amongst the *Fuci* and *Confervæ*, &c., which are to be found in such pools; and the natu-



MARINE ENTOMOSTRACA (*Cythere albo-maculata* and *Cyclops chelifer*).

ralist may especially find them in abundance in those beautiful clear little round wells which are so often to be met with, hollowed out of the rocks on the shores of our country, which are within reach of the tide, and the water of which is kept sweet and wholesome by being thus changed twice during

* That is, "Insects with shells."

every twenty-four hours. In such delightful little ponds, clear as crystal when left undisturbed by the receding tide, these interesting little creatures may be found, often in great numbers, sporting about amongst the confervæ and corallines which so elegantly and fancifully fringe their edges and decorate their sides, and which form such a glorious subaqueous forest for myriads of living creatures to disport themselves in."*

The organs appropriated to the circulation of the blood in this Class, display the same gradation in their development that we have already noticed in other points of structure. In the lower forms, the heart is a long dorsal vessel resembling that of Insects, but in the higher forms, as the Lobster and the Crab, it is an oval muscular chamber, with valvular openings from the veins, and to the arteries. The blood, collected from all parts by a system of veins, is conveyed to capacious reservoirs near the bases of the gill-tufts. A series of arteries distributes it over the extensive surface of the gills, by which it receives oxygen, and is renewed; other veins then transmit it to the heart, whence it returns through another system of arteries to the whole body.

All the senses of higher animals are possessed by the CRUSTACEA in considerable perfection. The organs of vision in all are present at some period of their existence, and in the majority of species are of a very complex structure. We find both simple and compound eyes, similar in principle to those of insects; both of these forms occur in the King-crab (*Limulus*): and there are eyes of an intermediate character, such as that of the Water-flea (*Daphnia*), where several clustered lenses and eye-cells are covered by a single smooth and transparent *cornea*. But in the higher forms of Crustacea, the true compound, or facetted eye is alone the organ of vision. The facets are not always six-sided, as in Insects,

* Dr. Baird, in Mag. Zool. and Bot. ii. 141.

but are sometimes square, as in the Crayfish (*Astacus fluviatilis*). Sometimes the eye is immoveable; but in many species it is placed at the end of a jointed footstalk, of various length, capable of being pointed in different directions; and we often find, in connexion with these stalked eyes, a furrow in which they can be laid flat, and thus protected from injury.

The organ of hearing is a cavity closed by a delicate membrane, situated at the base of the second pair of antennæ, in the Lobster and similar forms. In the Crabs this is replaced by a small, moveable, shelly disk, pierced with a hole, over which an elastic membrane is stretched. A vessel filled with fluid in each case conveys the vibrations of sound to the proper nerves.

There can be little doubt that the higher CRUSTACEA are guided to their food by a sense analogous to that of smell; but where its seat is placed zoologists are not determined; the probability is that it may be connected with the first pair of antennæ.

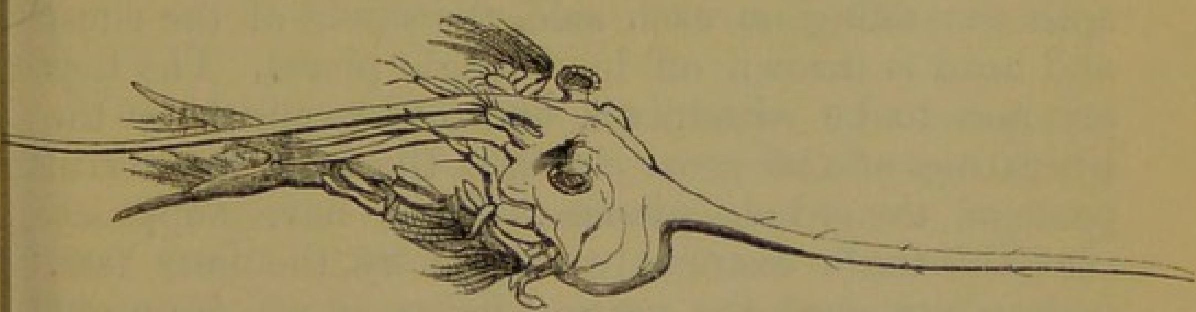
Similar observations may be applied to the perceptions of taste; the sense doubtless exists, and its organ is supposed to be the delicate membrane that lines the mouth and the throat.

It is commonly considered that the sensations of touch can be but very feebly, if at all, conveyed through the hard calcareous crust with which these animals are clothed; and that this sense can hardly exist except in those parts which remain soft and undefended by the crust.* But we have seen a Swimming-crab (*Matuta*) hold its prey in one claw, while with the other it picked off morsel by morsel of the flesh, and conveyed it to the mouth, in a manner which sufficiently evidenced the sensation of touch in these organs: and we have watched a beautiful West Indian Crab (*Goniopsis ruricola*) feeding itself in the same manner, picking up now with one claw, now with the other, minute atoms of food, from the

* Owen.

surface of the mud over which it marched, with a rapidity and a precision which seemed to indicate that a very delicate sense of touch resided in those shelly claws.

The CRUSTACEA have been recently discovered to pass through a series of transformations analogous to those of Insects. The eggs of the common Crab (*Cancer pagurus*), which are carried about under the bent abdomen (called *pocket* and *tail*) of the female until they are hatched, produce little swimming animals, as unlike the parent as can well be imagined. The body is long, slender, and jointed, terminating behind in two bristled spines. The back is hemi-



YOUNG OF CRAB.

spherical, and its summit rises into a long, erect spine; the eyes are very large, and between them another long spine projects like a beak; the feet terminate in several bristles. After a while, the little creature moults, and appears now like a Crab; but the *post-abdomen*, or tail, still projects behind; and it is not until a subsequent moult has taken place that this portion of the body is bent up under the thorax; and the appearance of a Crab is truly displayed. Even still, however, much modification of details is required before the adult form is perfectly attained.

The moulting, or casting of the skin, in these creatures has been known much longer than their changes of form. The manner in which this process is performed, is not, however, even yet perfectly understood. It seems to take place commonly in warm weather. The animal retires on the approach of its change into clefts of the rocks, holes, and similar places, to be free from interruption and danger during its helpless state. Remaining for some time without eating, it becomes thin; and meanwhile a new skin—the future shell, but yet soft and expansible—is secreted between the old shell and the body. When this is fully formed, the animal becomes violently agitated, and throwing its body into various postures, rubbing its feet against each other, endeavours to loosen the old shell in every part. The *abdomen* is now forcibly inflated; and at length, after great exertion, the membrane which connects it with the *thorax* bursts, and the split extending on each side, the shield of the chest and head is thrown off in a single piece. The legs are now to be withdrawn, and this, particularly the liberating of the great claws, is the most wonderful part of the whole process. Some have supposed that the flesh, extremely wasted by the long fast, is drawn through the narrow joints as we draw our feet from our boots; but this seems hardly credible, though the joints of the cast-off shell are certainly not split, nor separated from each other. It has been conjectured that the whole claw splits lengthwise to admit the withdrawal of the limb, and then closes again with so much accuracy, that no trace of such a division can be discovered. But this is more marvellous than the former conjecture. Mr. Jones mentions, that in a very recent specimen of a cast shell, which had come into his possession, "each segment [of the claw] was split in the neighbourhood of the joints, and the articulating ligaments ruptured,"* a fact which seems to us rather to favour the former notion. However, in some mysterious manner the limbs are extricated; and after arduous exertions, the belly and tail are likewise freed, and the old skin remains sometimes in an unbroken piece, with the exception of the shield, an

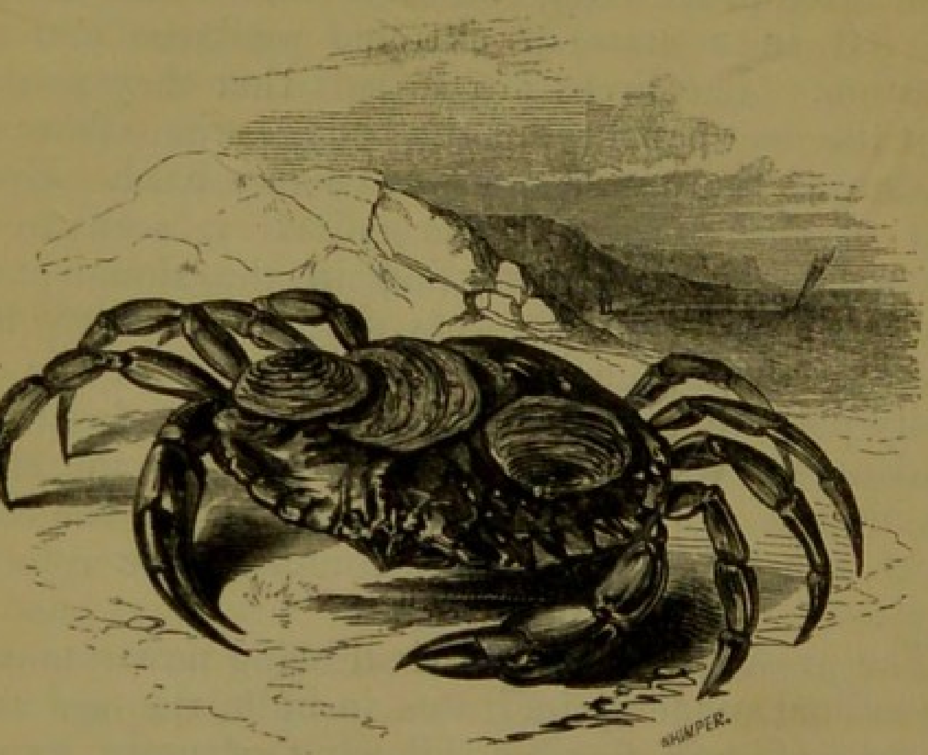
* Gen. Outline, p. 328 (*note*).

exact counterpart of the perfect animal. It may readily be supposed that an operation so critical must often prove fatal, and even those which survive are left in a state of extreme weakness and exhaustion. The limbs are so soft that they may be bent like wet paper; but the body, perhaps from the tension of the muscles, is remarkably hard. Every part of the surface of the animal is seen to be renewed; nothing is wanting in the slough; the antennæ, the jaws, the eyes are there,—every hair is a case which enclosed another hair! Even the shelly plates from which the muscles originate, the tendons by which they are inserted into the shell, the internal skin of the stomach, and even the teeth which are hidden there, are found in the rejected shell!

The pressure of the old shell being now removed, the animal suddenly increases in bulk, the new skin, as yet soft and flexible, allowing of great expansion; but it rapidly hardens, a stock of shelly matter having been for some time accumulating in its stomach, in the form of two hard balls, commonly called *crabs' eyes*. This substance is now taken up and distributed to the surface, so that when the new crust has again acquired consistence, the balls are no longer found. This takes place in from one to three days.

It is a remarkable fact that in the case of the common Cray-fish, no metamorphosis takes place; the young being hatched in the form of the adult, needing only to be developed. Hence some naturalists have too rashly attempted to set aside the evidence of the transformations of other CRUSTACEA; evidence, however, which we must consider as irresistible.

On the other hand the supposition that the moulting in these animals takes place every year, must probably be restricted to the period of growth, beyond which the process would seem to be unnecessary. A specimen of the common Crab has been taken, the crust of which was covered with oysters of six years' growth, besides *Actiniæ* and



CRAB COVERED WITH OYSTERS.

other parasites. The Crab was full grown and in perfect health, and it is clear that it could not have cast its shell for six years previously.

The Class is divided into two great sections, PODOPHTHALMA, and EDRIOPHTHALMA, from the character of their eyes; the former term signifying that these organs are set on moveable stalks, the latter, that they are sessile, or stalkless, and therefore immoveable. Of the former, the great majority of species belong to the Order DECAPODA,* so called because they have five pairs of true feet, besides others which are so modified as to act as jaws. These, again, are either Crabs (BRACHYURA†) or Lobsters (MACROURA‡). The remainder of the stalk-eyed species are arranged in the Order STOMAPODA,§ in which the feet are for the most part placed near to the mouth. This Order includes the Squills, the Opossum-shrimps, and that curious

* "Ten-footed." † "Short-tailed." ‡ "Long-tailed." § "Mouth-footed."

oceanic form, the Glass-leaf (*Phyllosoma*), which is no thicker than a piece of paper, and is as transparent as glass.

The CRUSTACEA with sessile eyes are arranged in several Orders, which are sufficiently represented by the Sand-hoppers (*Talitrus*), the Wood-lice (*Asellus*, *Oniscus*, &c.), the King-crab (*Limulus*), and the minute Water-fleas (*Daphnia*, *Cyclops*, &c). All of these have been before alluded to.

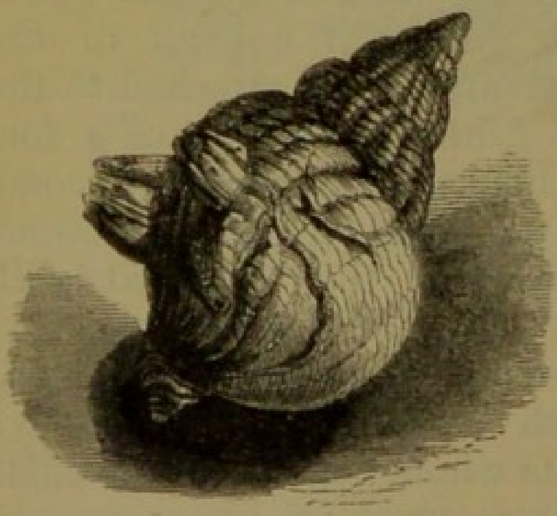
Besides the above, there is a tribe of animals bearing so much resemblance in structure to the lowest CRUSTACEA, as to be included in the Class, by some zoologists, while in other respects they manifest no small affinity with the Intestinal Worms, and have been raised to the rank of a Class under the name of EPIZOA.* Most, if not all of the species, are parasitic, and are found attached to the gills, or other parts of fishes, by means of a formidable apparatus of hooks and suckers; some species seem permanently fixed to their victims, but others are able to relax their hold at will, and change their place.

As an example we mention the Sprat-louse (*Lernæa monilaris*), which attaches itself to the eye of the Sprat, plunging its whole head into the coats of that organ, where it is retained by means of barbed projections. It is luminous in the dark; and the fishermen are accustomed to call the unfortunate fishes thus infested, *lantern-sprats*.

* Creatures which live "upon," as the *Entozoa* live "within" animals.

CLASS VI. CIRRIPEDIA.*

Some of our readers, when collecting shells among the rocks of our shores, may have observed that many are incrusted with a singular sort of stony warts, often accumulated in masses closely huddled together. On examining them more attentively, they are seen to be rude hollow cones, formed of many pieces, firmly fixed to the shell, or stone, or sea-weed, or piece of wood, that may chance to serve as a foundation, by a layer of shelly matter, so dense as with difficulty to be removed. They are familiarly known as Acorn-shells, from their form; and the naturalist distinguishes the genus to which they belong, by the name of *Balanus*. Each of these stony cells is inhabited by an animal of singular formation; in many respects it resembles the CRUSTACEA, but the divisions of the body are less distinct. Its most remarkable characteristic is that it possesses twelve jointed limbs, elegantly curled and fringed with bristles, besides eight others which serve as swimming feet. These curled organs are all together thrown out of the shell, and drawn in, in regular succession; forming a sort of net, cast at random, to entangle any substance or animal that may be floating or swimming near, and drag it to the mouth to be devoured.



ACORN-SHELLS ON A WHELK.

Our young collectors, however, will discover no-

* "Fringe-footed:" animals whose feet take the form of a curled fringe.

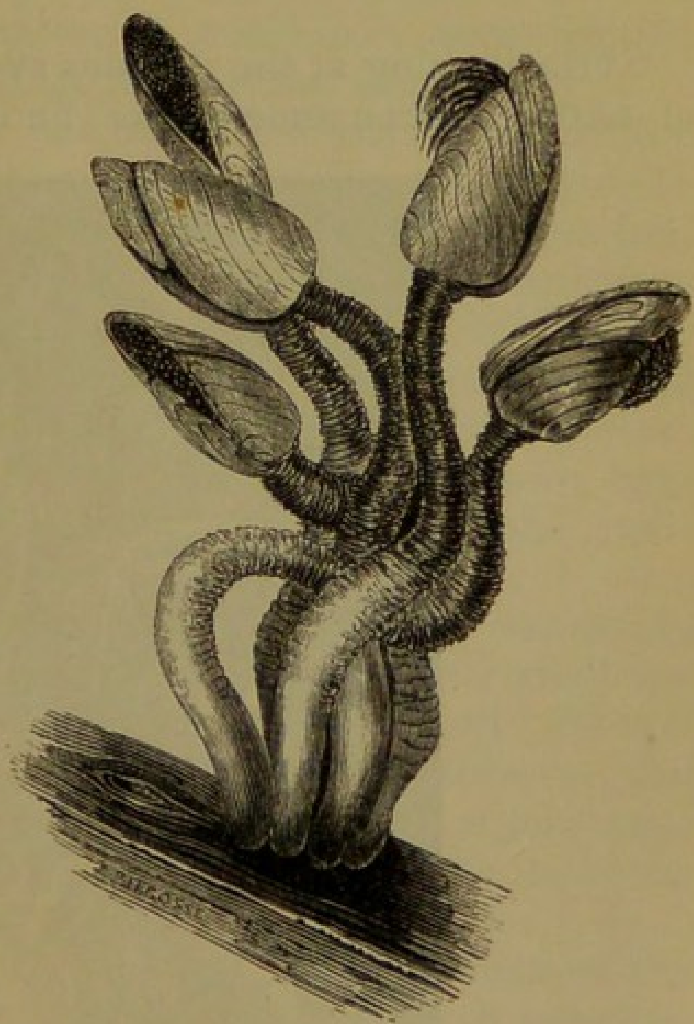
thing of this elegant apparatus by looking at the Acorn-shell out of its proper element; for the mouth of the shell, which is placed at the summit of the cone, is closed by a stopper within composed of four shelly plates. To observe it in operation, we cannot do better than follow the instructions given by Mr. Patterson in the following words, which we quote for the sake of the pleasing reflections with which they are accompanied.

"The cheapness of the pleasures which natural history affords, should of itself form a reason for the general cultivation of such pursuits. They are within the reach of the most humble, and are not dependent on costly or complicated apparatus. By means so simple as a glass of sea-water, we have caused the *Balani* or acorn-shells, to exhibit a series of movements, which we have never shown to the youth of either sex, without hearing from them expressions of the most unfeigned delight. Let the reader try the experiment. Go at low water to a rock on the beach, choose a few of the oldest and largest limpets, left uncovered by the receding tide, and encrusted with the acorn-shells. As the enclosed animals have then been without nourishment for two or three hours, they will be quite ready for another meal. Throw the limpet-shells into the glass of sea-water, and in a minute or two the acorn-shells upon them will begin to open. Presently a beautiful feathered apparatus will be extended, then withdrawn. It will again be put forth and again retracted; but with such grace, regularity, and precision, that the eye regards it with ever new delight. And when the same exquisite mechanism is exhibited by every one of them, either in succession or simultaneously; and when we consider that it thus ministers, at the same moment, both to respiration and nutrition, a train of ideas is excited, which rises from the humble shell to HIM by whom it has thus wondrously been fashioned."

The Class of which the Acorn-shell stands as one of the representatives, though very limited in species, is interesting to the zoologist as forming a beautiful link of connexion with the MOLLUSCA, which we shall presently have to describe. The stony shell, consisting of several valves, with which almost all the species are furnished; the fleshy mantle which invests the body; the absence of any distinct head, of eyes, and antennæ; the fixed position, the shell being either, like the oyster, soldered by its own shelly substance to the rock on which it rests, or else, like the mussel, enjoying only such a limited degree of freedom as an elastic cable will permit;—all these and other peculiarities manifest an affinity to the lower Mollusks. Yet on the other hand, the symmetrical form; the jointed limbs arranged in pairs; the mouth with its triple series of jaws; and, above all, the existence of a true metamorphosis, bring these animals within the pale of the HOMOGLANGLIATA, and in close alliance with the Class which we have just dismissed. The nervous system agrees with the latter rather than the former; for while there is a mass of nerve-knots above the gullet, which represents the brain, there is on the ventral side a double chain of ganglions, united with each other and with the brain by nervous chords.

The existence of the CIRRIPEDIA under forms widely differing from the adult condition, and the possession by the youthful animals of senses and powers denied to them in mature age, were the valuable discoveries of Mr. J. V. Thompson, to whom modern science has been so greatly indebted. This zoologist found that the young of the *Balanus* is an active little creature, transparent as glass, about $\frac{1}{10}$ of an inch in length, enclosed in a bivalve shell; from the front of which project two strong limbs, provided with a sucker and hooks, while the hinder part of the opening gives egress to six pairs of jointed legs, each terminated by a pencil of bristles. These limbs move in unison, so that the motion of the little creature, as well as its appearance, greatly resembles that of the little *Cyprides* of our pools. A pair of stalked compound eyes are placed near the fore parts.

The young of the Barnacle (*Lepas*), which we shall presently notice, is rather more like a *Cyclops*. It has a single eye, three pairs of feet, two pairs of which are double, and an ample transparent shield, of triangular form, running off into three long slender spines.



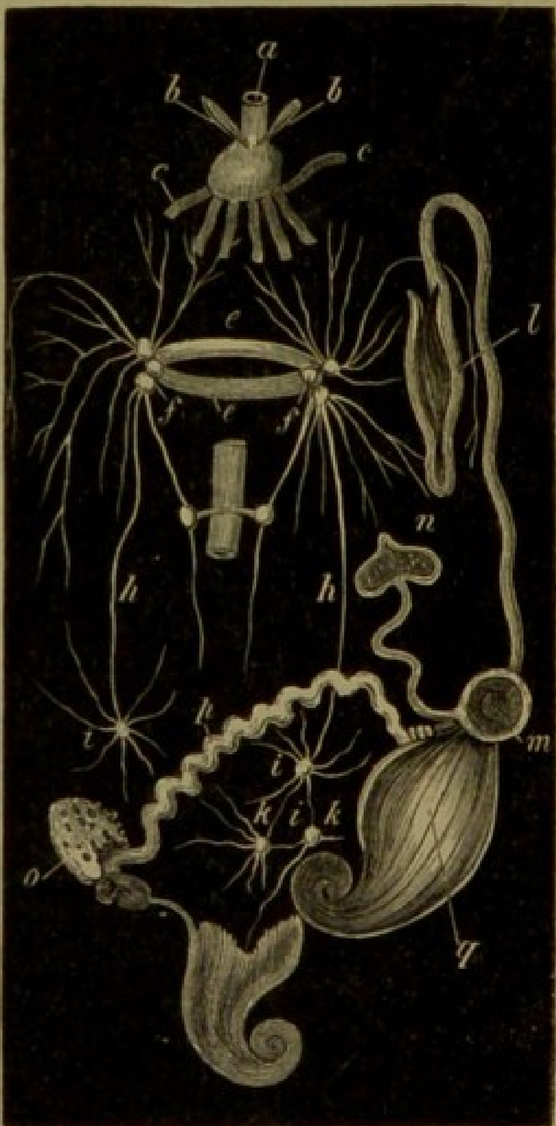
COMMON BARNACLE.

The CIRRIPEDIA are arranged in two divisions, the sessile, or those which are destitute of any stalk, as the Acorn-shells, and the peduncled, or those in which the shell is placed at the end of a cartilaginous, but flexible stalk, varying in length, as the Barnacles. The accompanying engraving will represent the form of these latter animals, which do not present any peculiarities of structure sufficiently diverse from the Acorn-shells to require any more detailed notice.

SUB-KINGDOM IV.

HETEROGANGLIATA.*

STILL looking at the nervous system as the ground of natural arrangement, we find a large group of



NERVES OF SHELLED MOLLUSCA.

animals in which the nervous matter, though accumulated in knots or ganglions as in the Articulated

* Animals having "dissimilar" or "unsymmetrical nerve-knots."

Classes, is not arranged, as in them, symmetrically. The principal mass of nervous matter takes the form of a thick ring or collar, surrounding the gullet, whence threads are sent off in an unsymmetrical manner to other parts of the body; several ganglions being placed around the collar, and others dispersed in other parts, so as best to supply the most important organs. This scattered condition of the nervous matter is commonly accompanied by an equally irregular form of the whole body.

Professor Owen has remarked that whereas the development of the Articulate Classes is chiefly conspicuous in the organs peculiar to *animal* life, such as the powers of locomotion, and the instincts which are so various and so wonderful in Insects, —in the animals before us the organizing energies seem to have been expended chiefly in the perfection of the *vegetal* series of organs, or those concerned in the immediate preservation of the individual and the species.

The HETEROGANGLIATA are more commonly known by the term MOLLUSCA; which we shall occasionally use as less repulsive in its aspect; though from its expressing an unimportant character, the *softness* of the bodies, it is inferior in significance to that which describes the condition of the nervous system.

It is probably to compensate for the softness of the bodies of these animals, as well as the low development of their powers of perception, that in the great majority of cases they are furnished with the protection of a dense calcareous *shell.* This, which is often of a stony hardness, is secreted from a thick skin which invests the body more or less completely, and is commonly known as the mantle.

The organs of respiration are well developed; and in many instances take the most elaborate and beautiful forms; the blood is colourless, or of a pale blue tint, and is subject to a double circulation.

The majority of the MOLLUSCA are inhabitants of the ocean, but many tenant the freshwaters, and not a few crawl freely on the land, chiefly however in moist situations. The food consists for the most part of vegetable substances, but there is one Class, that which most nearly approaches a superior type, which is eminently carnivorous.

The animals before us vary considerably in the development of their structure. Some, thence called *headless* (ACEPHALA), have no head, nor any organs of the higher senses; no tongue, teeth, or true mouth; but simply an opening of the gullet, or digestive canal. Others, named ENCEPHALA, are furnished with a head, and for the most part, soft tentacles or feelers, eyes, and a mouth armed with teeth. Each of these groups contains three Classes.

CLASS I. TUNICATA.*

As we traced up the chain of being through the articulated forms, till we arrived at the Beetle, the Spider, and the Crab, it was manifest that we had made a great advance in the structure, power, and intelligence, which are characteristic of animal life, and distinguish it from that of a plant. "Yet, having attained these different summits of the Articulate branch of organization, the inquirer still finds himself at a great distance from any of the Vertebrate forms of animal life. How vast the hiatus which separates the worm from the apodal fish, the crab from the tortoise, and the flying insect from the bird or bat!"†

We cannot, however, pursue our course upward in the same direction; we must retrace our steps, and descending to a low point of the scale which we had left far behind, take up another series, or chain, and by it ascend to a still higher grade of organization than any we have yet attained. The animals

* Animals clothed with a "tunic," or coat. † Owen.

of this Class are closely related on the one hand with the Polypes, and on the other with the Oyster and other bivalved MOLLUSCA. If we suppose one of the BRYOZOA already described to have its crown of arms reduced to mere rudiments, to have the orifice of the gullet greatly enlarged, and its interior to be covered with vibrating cilia, it would, in fact, be converted into an *Ascidia*, one of the most common forms of the TUNICATA. But the resemblance does not end here; for as the BRYOZOA produce offspring which have the power of swimming freely through the sea, yet after a while become permanently fixed and stationary, so do the *Ascidiæ;* and as the former congregate together in groups, and become compound animals, so, strange as it seems to find such a plant-like condition of life in so high a group, many of the TUNICATA, after having enjoyed freedom and locomotion for a brief period, root themselves, as it were, upon foreign substances in companies, the individuals united together by a common living integument. Yet in the details of their organization the structure and arrangement of their viscera, their nervous, respiratory, and circulatory systems, the TUNICATA are evidently very nearly allied to the MOLLUSCA of bivalve shells.

The name of the Class is derived from the animals being inclosed in a tough gristly or leathery skin, which may be considered as representing the shells of a bivalve. The exterior surface of this is commonly rough and warty, but the interior is remarkable for its beautiful smoothness and delicacy. The lower extremity is generally affixed to some extraneous substance, as a stone, a shell, or a piece of wood, while its upper part terminates in two openings, one of which admits food as well as water for respiration; the other serves for the discharge of the excrement, and of the ova. If the tunic be cut away, another investing coat of skin is discovered, which is the mantle, capable of strong muscular contraction. A large portion of the body is occupied by a capacious cavity communicating with the receiving orifice; the interior is covered with minute blood-vessels branching over the whole surface in a beautiful network, while over the surface play innumerable *cilia,* set in transverse rows. This mechanism is for the purpose of respiration; the water is freely admitted into the cavity, and is dispersed and ever changed by the constant vibration of the cilia; thus the blood in the innumerable veins is brought into communication with the oxygen in the water, and is renewed for the support of animal life.

But the supply of food is provided for by the same singular apparatus. The animal is fixed, and cannot seek for prey, nor has it any arms to grasp it; but the water constantly brought into the breathing cavity, carries with it particles of animal or vegetable matter, which the currents formed by the *cilia* carry steadily downward to the very bottom of the cavity, where the opening of the gullet is placed; into this canal they are whirled, and conveyed to the digesting stomach.

Several forms of these creatures are common on our own shores; some of which are fixed, others swim at liberty; some are so delicately transparent as scarcely to be discerned in a vessel of water; some are solitary, others aggregated. Among the most interesting is the genus *Pyrosoma,* which consists of a gelatinous tube, open at both ends, composed of an infinity of small buds, set close together on every part of the surface, each of which is an individual animal. In the tropical seas, immense hosts of these tubes are seen, sometimes forming a compact mass of a mile in extent, and darting forth a phosphorescent light of unusual splendour. "Nothing," observes Mr. Kirby, "can exceed the dazzling light and brilliant colours that these floating bodies exhibit,—colours varying in a way truly admirable, passing rapidly every instant, from a dazzling red, to saffron, to orange, to green and azure, and thus reflecting every ray into which the prism divides the light, or which is exhibited by the heavenly bow."*

CLASS II. PALLIOBRANCHIATA.†

This a very limited group, the members of which might readily be supposed at first sight to belong to the ordinary bivalved MOLLUSCA; yet their structure offers some remarkable peculiarities. They are contained within a pair of shells, more or less resembling those of the Common Cockle. One shell, however, is larger and more convex than the other, and is commonly pierced with a hole near the hinge. The shells are, for the most part, firmly fixed to some rock or other object by a fleshy stalk; but in one genus (*Orbicula*) the lower valve itself is soldered to the rock.

The name of the Class is intended to express that the mantle, consisting of two leaves lying on each other, itself composes the respiratory organ. Its edges are set with numerous cilia, whose vibrations perpetually impel currents of water over the surface, where blood-vessels branching in a dense network distribute the vital fluid, and bring it into contact with the oxygen. Another peculiarity is that on each side of the mouth, which is placed at the bottom of the fold of the mantle, extends a fleshy arm, fringed with long *cilia*. In some species these arms are of great length, and can be thrown out from the shells, or retracted into elegant spiral folds at pleasure. It is supposed that the use of these curious organs, is to produce eddies in the water, and thus bring particles of food within reach of the mouth. These long arms are hollow, and contain a fluid, which being acted on by a series of spiral muscles, is

* Bridgewater Treatise.

† "Mantle-gilled." The term is explained in the text.

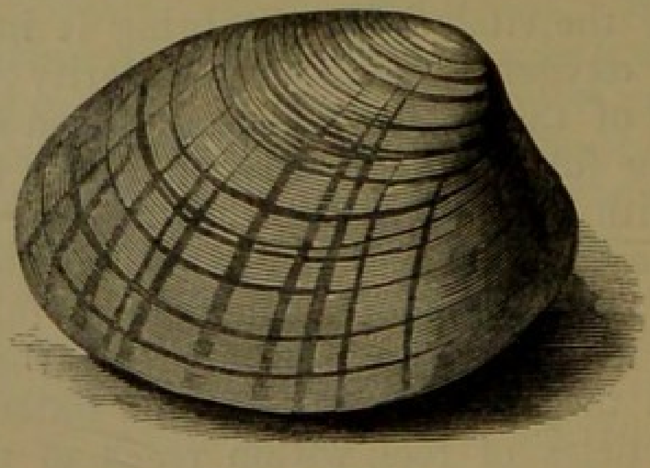
forced toward the extremities, and thus they are rapidly extended.

Many fossil species of this Class are found, but the living species known, are not very numerous; many, however, may exist, with which we are not acquainted, as they live in very deep water, and are fastened to the bottom. Some are dredged up on our own coasts. The *Crania personata* has been brought up from a depth of two hundred and fifty-five fathoms. That the feeble organs with which they are furnished should be able to agitate the water under the enormous pressure of such a mass, is indeed surprising; yet their Allwise Creator who has appointed their habitation there, supplies them with everything needful for the enjoyment of existence.

CLASS III. LAMELLIBRANCHIATA.*

(*Bivalves.*)

The members of this Class present claims upon our notice superior to those of the obscure species which we have yet noticed. The shells of many species



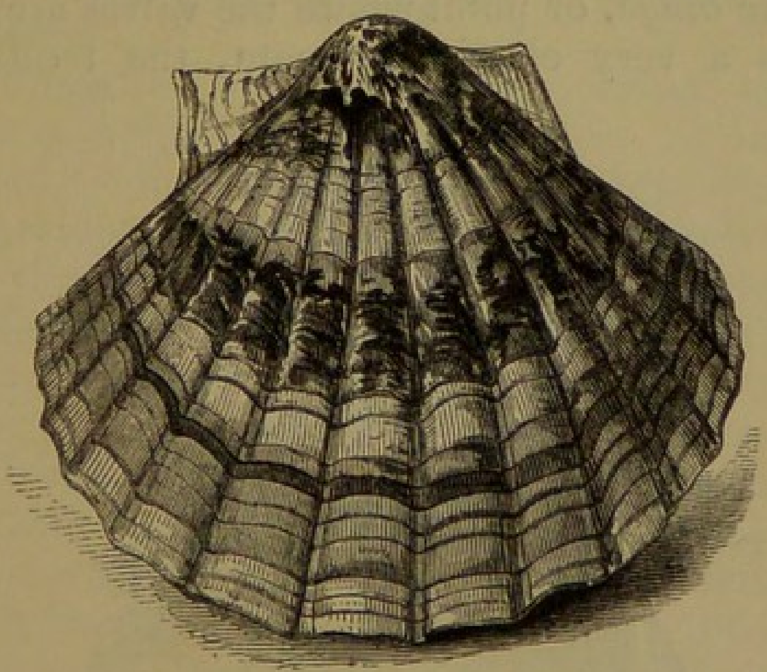
VENUS CHIONE.

have for ages attracted admiration for their beauty; the rich hues of some of the *Uniones*, the rainbow

* "Leaf-gilled."

flushes of their pearly interior, the papery delicacy of the *Tellinæ*, and in particular, the porcelain-like gloss, and beautiful bands and markings common to many species of *Venus*, have given a value to these shells independent of their scientific interest. Pearls, the ornaments of female beauty, and of royal diadems, are the productions of several of these animals, and are the subjects of an important branch of industrial occupation;—while the immense amount of human food derived from this source, imparts an interest and a value to our native species which we can still more fully appreciate.

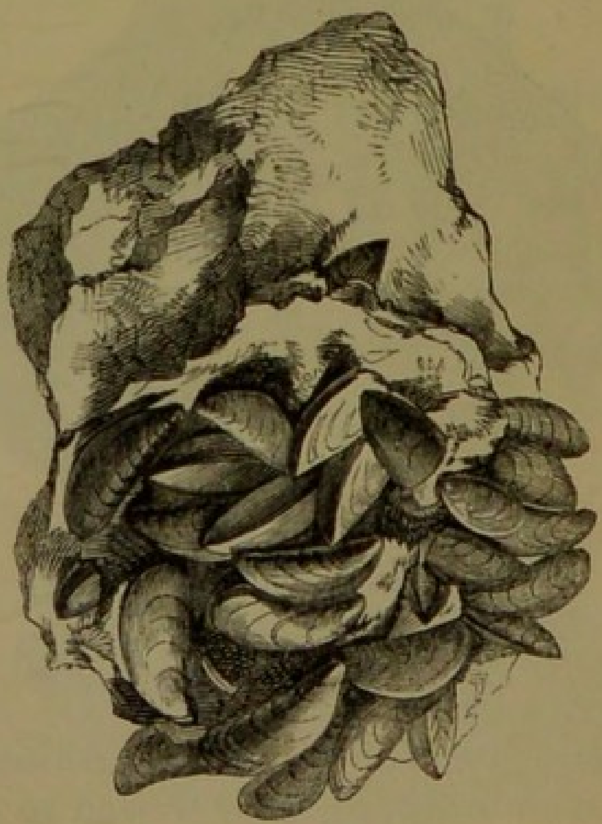
The structure of the animals composing this Class may be readily seen by examining any of the species commonly used as food. We will select the Great



GREAT SCALLOP.

Scallop (*Pecten maximus*) often exposed for sale in the markets of our sea-port towns. On opening the shell, we see inside each valve, first, a thin and semi-transparent membrane, the pair united to each other, near the hinge. This is the mantle. Its edges are thickened, and surrounded with a delicate fringe of very sensible fleshy filaments: they are studded with glands, which in many cases secrete colouring matter agreeing with the tints on the shell: the shell being enlarged by these glandular fringes, in a manner to be presently described. Between the two leaves of the mantle are placed the lungs or gills, four in number, composed of fibres pointing outwards, of exquisite structure, free at their outer edges, so as to float loosely in the water. The mouth is placed between the two inmost gills, where they unite; it is a simple orifice, without anything answering to teeth, but having four thin membranous lips on each side of the aperture. Near the mantle is placed a fleshy organ, somewhat resembling a finger, capable of enlargement and contraction, called the foot, which, though small in the Scallop, becomes, in some genera, of large dimensions, and assumes functions most important and interesting.

At the *hinge*, or point where the valves are united, there is a very elastic ligament, the tendency of



MUSSELS.

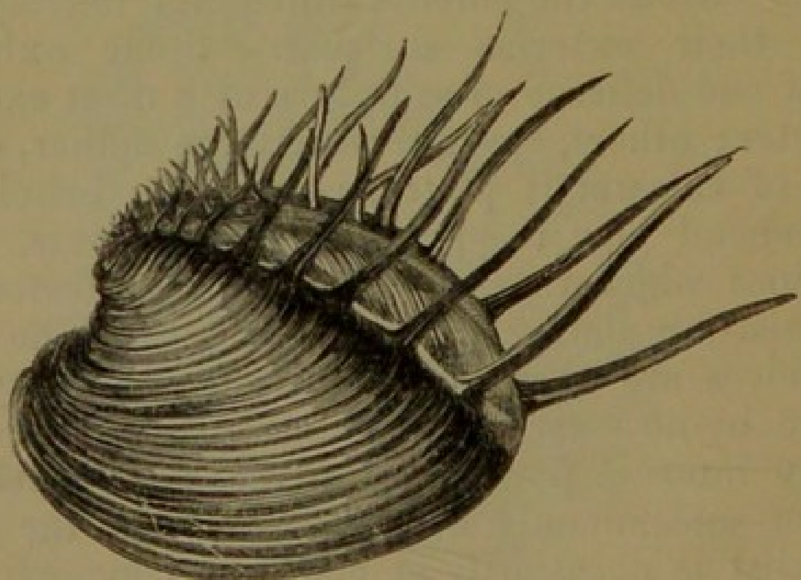
which is to force them apart; to counteract this tendency, a stout, compact, and very powerful muscle proceeds from near the centre of one valve to that of the other, which by its contraction draws the valves together and keeps them closed. When the animal wishes to open its shell, it relaxes this muscle, and the elastic force of the ligament, which had been compressed, does the rest. It is the contractile force of this muscle, which renders an Oyster so difficult to open; the inserted knife cuts through the muscle, and it opens immediately. In a large number of genera there are two of these muscles placed far apart, as in the common Mussel. The hinge also in many is much more complicated, presenting a curious array of notches and teeth, depressions and elevations, which lock into each other. The ligament in these cases is placed outside the hinge, and opens the shell by its contraction, not by its expansion.

The formation and progressive increase of these shells is a subject of great interest. "Intensely diversified," observes Professor Jones, "are the forms presented by their testaceous valves, and equally various the colours which not unfrequently adorn their external surfaces. Some exhibit a beauty and delicacy of sculpture of a most exquisite character; others, covered with large spines, or festoons of calcareous plates, puzzle the beholder to comprehend how the growth of such parts, in the situations which they occupy, can be effected with so much regularity of arrangement. The shells themselves are absolutely deprived of vitality, permeated by no vessels, and as incapable of expansion by any internal power as the rocks to which they are not uncommonly attached; so that the young naturalist is necessarily at a loss to conceive either the mode of their formation, or the origin of all the gaudy tints and external decorations that render them the ornaments of our cabinets."*

The sole agent in the formation of shell is the mantle; but the parti-coloured exterior and the pearly interior are formed by two processes, and by

* Gen. Outline, 385.

two distinct portions of that organ. When, on account of the increasing size of the animal, it finds it expedient to enlarge its shelly habitation, it projects the thick and glandular margins of the mantle, and bending them round, embraces the edges of the shell. Immediately a copious secretion of calcareous matter is poured from its glands, which is deposited all around the existing edges, and presently hardening, constitutes a border of new-made shell. If spines, or other irregularities of surface be proper to the species, these are formed by the margin of the mantle being protruded into the form required, and secreting the shelly substance within its folds. We have said before, that some of these glands secrete colouring matter; wherever these occur, the paint is deposited along with the shelly matter, leaving a permanent patch or stripe of colour (according as the secretion of colour is intermittent or constant) upon the colour of the shell. The formation of shell is not a process continually



SPINED VENUS.

going on, but is performed at intervals; in most species, the concentric lines, more or less evident (as in the beautiful Spined Venus figured above), show how often the process has taken place.

The shell thus deposited, however, is but the exterior surface, and consists of merely a thin layer. To give it firmness and thickness the general surface of the mantle is called into operation. Calcareous matter of another kind, dense, white and pearly, is secreted from this part, which is deposited in successive layers over the whole interior of the shell, which is thus continually increasing in solidity and thickness. No colouring matter is ever mixed with this deposit; which is commonly called nacre, or-mother-of-pearl; the beautiful rainbow tints that play over its surface are produced by the decomposition of the rays of light, and are dependent upon parallel lines of microscopical minuteness, with which the pearly matter is indented.

Under local irritation, the mantle secretes the pearly matter in greater abundance. The shell is sometimes perforated by little boring ANNELLIDA, to remedy which the mantle coats the orifice again and again with nacre, until a little button more or less globular is produced, which is a true adherent pearl. At other times a grain of sand, or other minute extraneous body, accidentally getting within the shell, irritates the mantle, which, acting in a similar manner, incloses it in successive layers of nacre; thus free pearls are formed, which are so highly valued.

Pearls are produced by many species of bivalve MOLLUSCA. The Pearl *Oyster*, as it is called, of the eastern seas is a species of *Meleagrina*, and nearer the Mussels than the Oysters; the *Uniones* and similar shells, belonging to the Family *Naiadæ*, also produce them in our own rivers.

In the old curious translation of Hector Boetius, by Bellenden (Edin. 1541), the following notice occurs of British pearls:—"In the horse-mussillis are generit perlis. These mussillis airlie in the morning (when the lift is cleir and temperate) openis thair mouthis a little above the watter, and maist gredelie swellis the dew of heaven, and efter the measure of the dew thay swellie they conceive and bredis the perle."

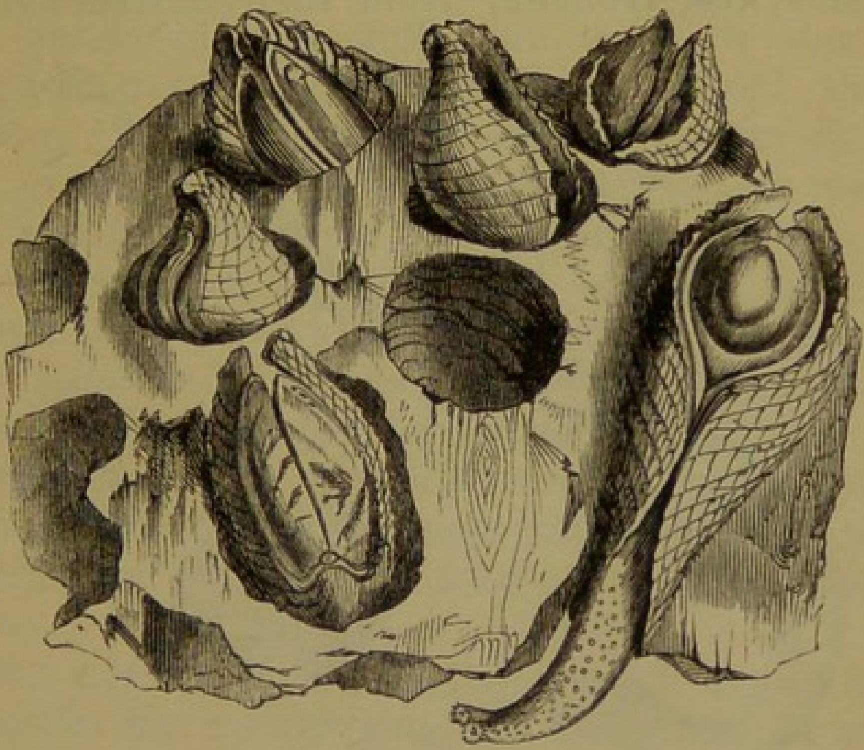
This account of their origin is more poetical, if it be less correct, than the one we have given above.

Many species, like the Oyster, are affixed to the rock on which they were born, by the under valve of the shell, the surface of which is, as it were, firmly cemented to the rock, so as to prevent any possibility of motion. Others are attached in an equally effective, but very different manner, being moored like a ship with one or more cables of strong silky threads, called *byssus*. The common Mussel (*Mytilus edulis*) is a familiar example; but the large triangular shells of the genus *Pinna* produce threads of greater strength and length, and of a silky texture, which have been woven into gloves and stockings. The great Clamp (*Tridacne gigas*) of the Indian Ocean, forms a cable of *byssus*, so stout and compact that it can be divided only by repeated strokes with an axe.

But if some species are stationary, others have considerable powers of changing their locality. In our description of the Scallop, allusion was made to a small organ called the foot; in the common Cockle (*Cardium*) this is developed to a large size, and is used for burrowing in the sand. Like the human tongue, it is capable of assuming various lengths, shapes, and degrees of firmness; it is alternately an awl to bore the hole, a hook to draw in the shells, a pole to shove the animal over the ground, or a spring to throw it forward through the air. The long tube-like Razor-shell (*Solen*) so common on our sandy beaches, is a still more effective burrower than the Cockle.

RAZOR-SHELL.

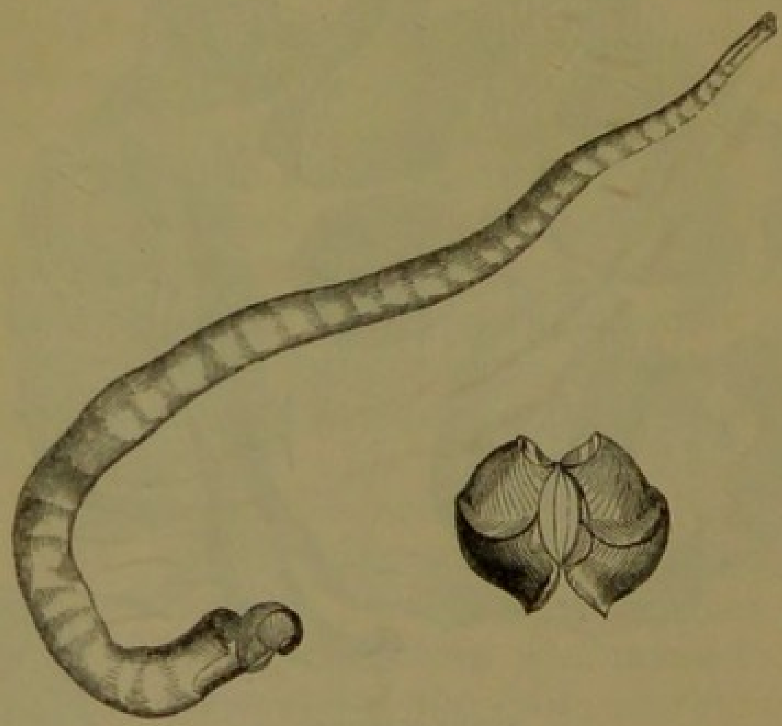
If we are astonished at the facility with which the Solen buries itself in the sand, so as to elude all the activity of the fisherman, what shall we say to the Stone-borer (*Pholas*) which eats its way, as it were, into solid blocks of oak, into hard chalk, and even into limestone rock? The shells are found in the holes thus self-formed, accurately fitting the cavity; but by what operation the surprising task is accomplished, whether by rasping



STONE-BORERS.

with the file-like edges of the shell, by wearing away the hard substance by the constant action of the ciliary currents of water, by pouring out some strong chemical solvent, or by absorbing the particles in the way of food, we are yet ignorant. The ravages committed by these animals on the piles of wharves, and similar submerged structures are often causes of alarm and danger: the Breakwater at Plymouth has suffered from this cause.

But the ravages of the *Pholas* are slight compared with those of the terrible Ship-worm (*Teredo*), which Linnæus called "calamitas navium." The mantle in these bivalves is excessively lengthened into a sort of tube, while the valves are minute, so that the appearance is rather that of a Worm than of a Mollusk. It bores holes in all directions through wood lying in the sea, lining the interior of the cavity with a shelly crust. Unfortunately it is very common in our seas; the piles of piers and wharves, the gates of docks, and the bottoms of ships are soon pierced and riddled by these animals; and it is said that serious fears are entertained for the safety of Holland, from their destructive in-



SHIP-WORM AND SHELL.

dustry upon the floodgates and woodwork of the dykes. A few weeks' immersion of a piece of fir wood suffices to bore it through and through; and even the hardest oak is not able to resist the insidious destroyer. The best resource is to drive a number of broad-headed nails into the wood, which soon form a dense and continuous coat of rust, that these creatures cannot penetrate.

CLASS IV. GASTEROPODA.*

(*Univalves.*)

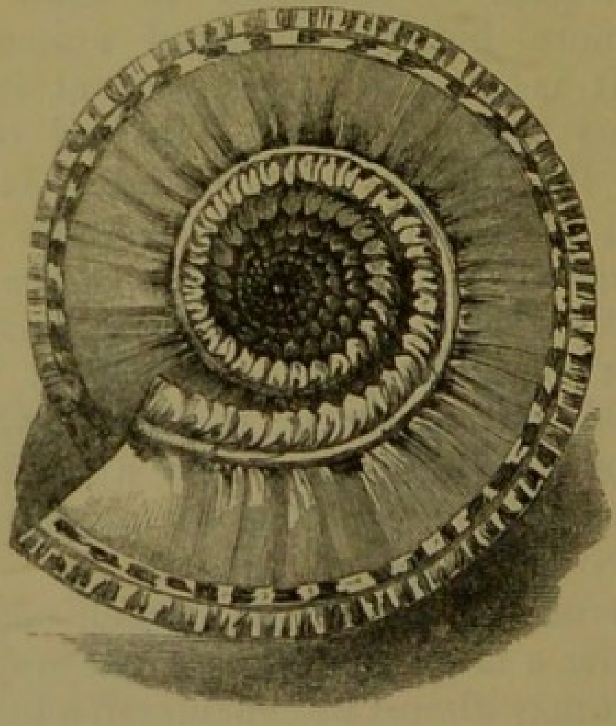
A cursory glance at a Snail as it glides along the garden-path is sufficient to show that it is a much more highly organized animal than an Oyster. It is capable of roaming at its pleasure, and of thus seeking its food instead of receiving that which is brought to its mouth. It has a distinct head, and two pairs of tentacles capable of being extended or withdrawn; these are manifestly very sensitive, and the upper pair carry at their extremity two perfect organs of vision. Its mouth is furnished with a sharp, toothed jaw, admirably adapted for cutting leaves, and a tongue no less suitable for passing the food so prepared into the throat.

The nervous system is also much concentrated: the collar has a large ganglion on the upper part, so large that it may almost be considered a brain, whence nerves radiate to all parts of the head and body.

It is not all the GASTEROPODA, however, that are so highly organized as the Snail. Some species present a simplicity of structure but little elevated above that of the ACEPHALA. The peculiarity on which the name is founded, belongs, however, with some slight modifications, to all:—the inferior surface of the body is spread out into a broad fleshy disk or *foot*, on which the animal crawls with an uniform gliding motion. The back is covered with a mantle, more or less completely, which in the great majority of species secretes a shell. In some, as in several of our native Slugs, the shell is very small, covering the lungs only, and is concealed within the substance of the short mantle. But in general, as in the Snail and Whelk, the shell

* "Belly-footed."

is capacious, capable of receiving and concealing the whole body; its form is commonly that of a long cone, twisted in a spiral manner upon itself. The shell is deposited and increased in the mode already described, the coloured exterior by the margin of the mantle, and the pearly interior by its general surface.



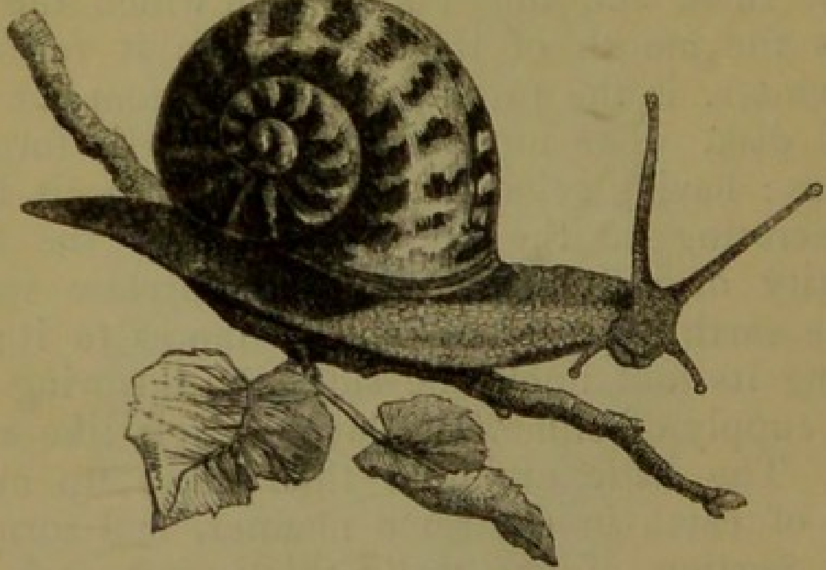
STAIRCASE TROCHUS.

The same organ is used to repair any accidental injuries. Most of our readers may have seen Snails, whose shells have been cracked or crushed, in which the mischief has been remedied, at least so far as that the part is firm and hard, though the marks of the fracture remain. Professor Bell informs us how this is effected. "I have," he observes "at different times cracked the shell, removed small portions, and drilled holes through it at different parts; and I have found that if the injury were within the reach of the edge of the mantle, it was always drawn up to repair it. I drilled a hole in the shell of *Helix pomatia* in the last whorl but one, thinking that it could not draw the edge of the mantle high enough to repair it in the usual way; however, it effected this immediately by protruding the foot to make room for the mantle being drawn high up into the shell, and as soon as the edge came in contact with the injured part, it was passed repeatedly over the hole, leaving a layer of calcareous matter each time until it became opaque; and in a day or two, on examining it, I found the newly-formed part apparently as strong as the rest of the shell."*

The thick and tough skin with which the Snail closes the mouth of its shell, when it retires for the winter, is the production of the foot, or broad fleshy disk. The mode in which this is formed is curious: having selected a suitable place, it begins by secreting on the under surface of the foot a quantity of very thick slime; it presses its foot to the earth, a layer of which adheres to it; then turning its foot upon one side, and throwing out a fresh supply of slime, the layer is left like a little wall. The little architect then takes up another layer of earth in the same manner, and forms another portion of the wall, thickening each as it proceeds, and deepening the cavity in proportion as it enlarges the walls. The thick slimy secretion with which the earth is stuck together and lined, renders the walls of this habitation strong, durable, and smooth. Having raised the walls, the Snail proceeds to construct a dome or arched roof of the same materials, the foot, with the successive layers of earth, being applied to the upper part until the walls meet in an arch. If a portion of this be now very carefully removed, we may see what follows. The Snail is lying with the mouth of the shell facing the roof in a perfectly horizontal position; the foot is contracted within the shell; the thick edge or collar of the mantle is expanded over it, and is very white and plump. In about an hour after the finishing of the roof, the breathing-hole in the right side is opened, and a quantity

* Zool. Journ. i. 93.

of air is inspired; then, closing the orifice, it forms a very thin and transparent layer of slime, like a skin, between the surface of the mantle and the substances outside. Presently, from the whole surface of the collar, is poured out a copious fluid like thick cream, of a pure white; which, covering the whole of the exposed part of the animal, hardens immediately, and in the course of an hour be-

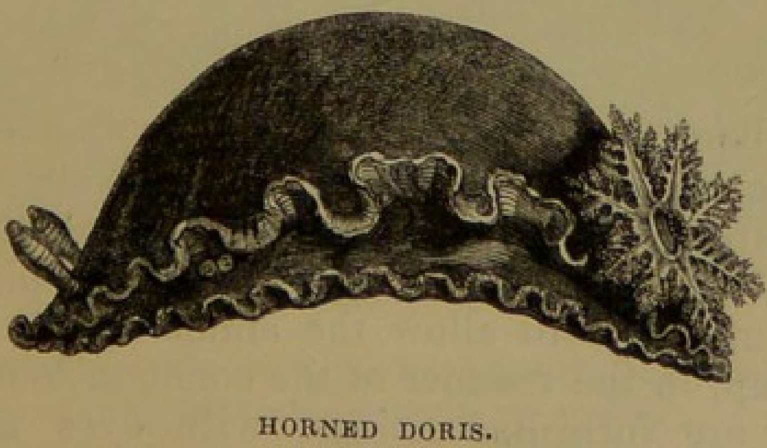


GARDEN SNAIL.

comes a perfectly solid *operculum*, a little thicker than a wafer. The Snail now expels a portion of the air it had taken in; and, thus contracting, retires farther into the shell, leaving a chamber of air between it and the *operculum*. Here it forms another layer of slime, which hardening into a skin stretched across the shell, it expels more air and retires farther, thus leaving another chamber, and so on until sometimes even six of these partitions are formed, inclosing cells filled with air. Two or three days are occupied by a single Snail in these operations; but the whole of October is spent before all have finished, and by the beginning of November none are found abroad except such as from disease have not sufficient strength to form their retreat, and which perish with the first severe frost.

The numerous genera of GASTEROPOD MOLLUSCA are arranged in Orders according to the peculiarities of their respiratory system. The first of these is named PULMONOBRANCHIATA, or *lung-gilled;* comprising those which breathe the air. This fluid is drawn into a cavity, lined with a very delicate network of blood-vessels; and in turn expelled: the orifice is on the right side, and may be readily seen to open and shut in the Slug and Snail. Most of the species, as those just named, are terrestrial in their habits, but others, as the *Limnea,* the *Planorbis,* &c., inhabit fresh waters, but come to the air to breathe; they may be often seen by scores, swimming with the foot upwards, on the surface of our ponds.

The Orders NUDIBRANCHIATA, (or naked-gilled,) and INFEROBRANCHIATA (or inferior-gilled), are marine Slugs, which are destitute of any shell. The gills are exposed; in the former they are situated on the hinder part of the back; in the latter, along each side, under the projecting edge of the mantle. Several species of the naked-gilled Mollusca are found in the British seas, such as those of the genus

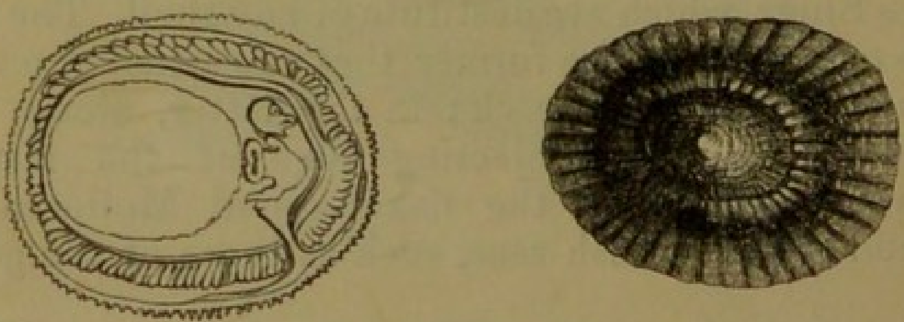


HORNED DORIS.

Doris, in which the breathing apparatus is arranged in the form of a spreading flower, the petals exquisitely branched, and radiating in a circle.

In the Order TECTIBRANCHIATA (or covered-gilled) we find the breathing organs taking the form of divided leaves, arranged along the right side, and covered by the mantle. They are, for the most part, naked sea-slugs, but some have a small shell concealed in the mantle, and others have a conspicuous one of considerable size. The species frequently found in fishermen's nets, called the Sea-hare (*Aplysia depilans*), is an example of this Order. When captured, and put into a vessel of water, it pours out from its sides a copious fluid, of a rich purple hue, which quickly diffuses its colour through the water. It was formerly much dreaded as a most potent poison, but the notion is now proved to be without foundation.

The Order CYCLOBRANCHIATA (or circle-gilled) have the gills arranged in a sort of fringe running round the body, beneath the edge of the mantle. Here are placed the Limpets (*Patella*) which adhere to

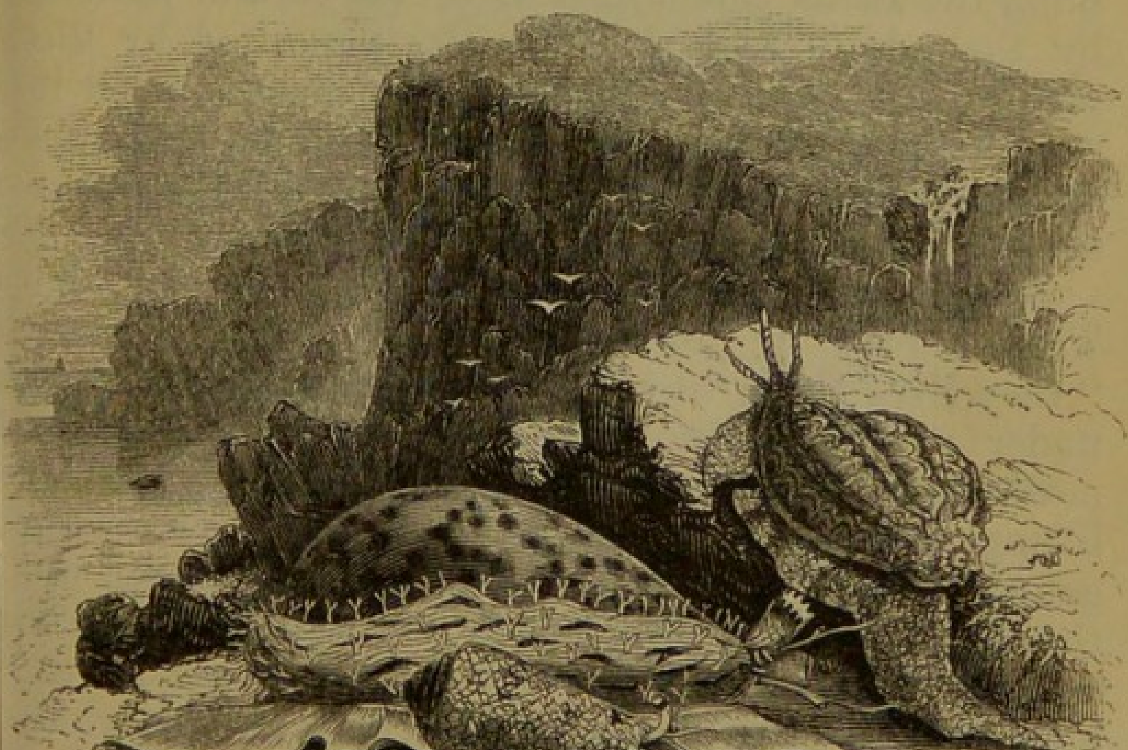


LIMPET.

rocks, beneath a shell, whose form is that of a low oval cone; and the Coat-of-mail shells (*Chiton*) which are covered by eight overlapping shelly plates, with a tough leathery border. These plates are sufficiently free to allow the animals to roll themselves up, in the manner of the common Woodlouse. These are furnished neither with eyes nor with tentacles.

By far the greatest number of species belongs to the Order PECTINIBRANCHIATA (or comb-gilled), so called because the respiratory organs assume the form of a comb, and are arranged in one or more rows, suspended from the interior of a chamber or cavity within the body. This cavity, which is situated within the last or most capacious whorl of the shell, communicates with the surrounding element by a wide orifice, or tube. The multitudinous species of marine Mollusca, with spiral or univalve shells, many of which are so curious and beautiful, are placed in this Order.

All the species have two tentacles, and two eyes, often raised on footstalks, a trumpet-like mouth, more or less lengthened, and a tongue armed with minute hooks, capable of rasping away the hardest substances. The sexes are separate. Many have a shelly or horny plate, called the *operculum*, which



TIGER COWRY (*Cypræa tigris*), HARP (*Harpa ventricosa*), and CLOTH-OF-GOLD CONE (*Conus textilis*).

accurately fits the orifice of the shell, and serves as a protection to the animal when it withdraws within its habitation. Its figure and appearance in the common Periwinkle (*Littorina vulgaris*) will be familiar to most of our readers. The appearance of the animals of this Order will be seen in the accompanying engraving, which represents three species, well known for the beauty of their polished shells. The figure of the Cowry illustrates the manner in which the ample sides of the mantle are turned up to envelope the shell, in order to deposit the glassy layer, for which these beautiful porcelain-like shells are remarkable in adult age. There is a singular change of form in this genus, as it passes from youth to maturity. Any one who might take into his hand one of the beautiful spotted Cowries from a mantle-piece, would scarcely recognise in it the spiral structure of an univalve shell. Yet, in early age, it is regular in its form, resembling the shells called Olives. At a certain period, by the addition of shelly matter deposited by the mantle, the outer lip is greatly thickened, until it nearly meets the opposite surface, or inner lip; this also is thickened, and both are plaited with the close-set transverse wrinkles that mark this genus.

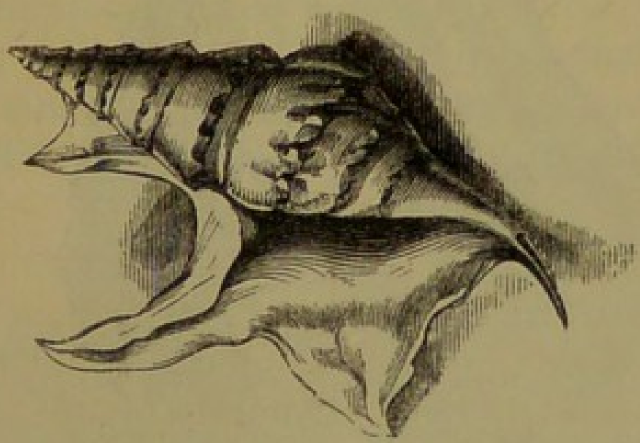
According to Mr. Stutchbury, who observed the Tiger Cowry in abundance at the Pearl Islands, "they lived there in very shallow water, and always under rotted masses of madrepores. They were never to be seen exposed to the sun's rays. On lifting one of these masses, a Tiger Cowry was generally observed with its shell entirely covered by the large mantle, which was mottled with dark colours, the intensity of which the animal seemed to have the power of changing; for the colours varied in the same light, and in the same medium, after the manner of the hues on a turkey's comb. On touching the mantle it was immediately withdrawn within the shell, which became exposed in all its brilliancy."*

Mr. Adams, however, who is equally familiar with the Tiger Cowry in a living state, could never see the changes of colour in the mantle here alluded to.†

The Family of the Conchs (*Strombidæ*) are also subject to a development of the shell in mature age,

* Zool. Journal. † Zoology of H.M.S. Samarang.

which renders the form very different from that of the young. In several of the species, the outer lip, which at first is small and regular, dilates greatly, and shoots out large fin-like expansions. This carnivorous genus is also remarkable for the enormous size of some of its members, as, for example, the Common Conch (*S. gigas*) of the West Indies, valued



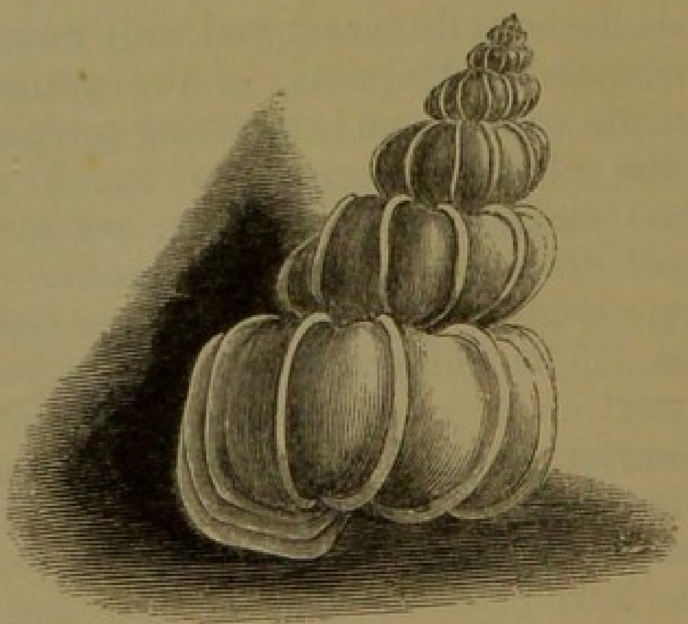
PELICAN'S-FOOT STROMBUS.

as a chimney ornament, on account of its size, and the beautiful rosy hue of its interior. Pearls of the same roseate colour are sometimes produced by this species.

Other shells equally large, and still more beautiful, are the massive Helmets, of the genus *Cassis*. They are made to serve an interesting purpose in the arts, for the elegant cameos, so much used for brooches and clasps of ladies' attire, are cut out of the thick substance of these fine shells. The accompanying engraving will show the nature of the process. The subject is worked in relievo in the white portion or outer crust of the shell, while the inner surface, of a pink or reddish-brown tint, is left for the ground.

The beauty, and more especially the rarity, of some shells have often caused them to bear a very high adventitious value. The elegant Chinese shell known as the Royal Staircase, or the Wentle-trap, derived its specific name (*Scalaria pretiosa*) from the high price at which large and fine specimens were sold. One in France was purchased for a hundred

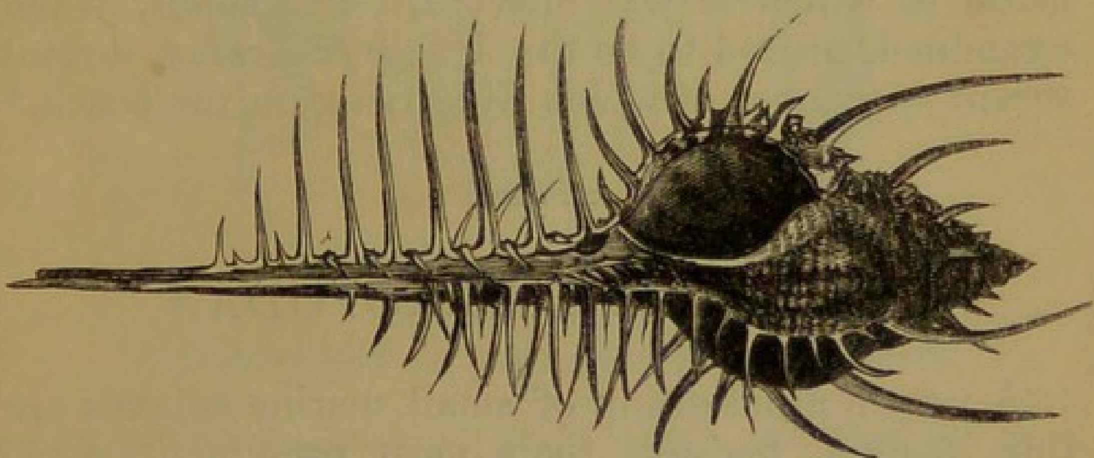
CASSIS TUBEROSA.



THE WENTLE-TRAP.

louis, and in England from twenty to thirty pounds have been given for a good specimen. The Empress Catherine of Russia possessed the largest then known. The Chinese, who are ingenious in every kind of deception, were accustomed to mend broken shells so cleverly that it was difficult to detect where the fracture had been. The shell is now far from rare, and shillings take the place of pounds in the purchase. Its beauty, however, will always command admiration: its ground colour is pale yellow, brilliantly polished, and the flat ribs, that at regular distances run round the whorls, are white.

The species of the numerous genus *Murex*, or the



THORNY WOODCOCK.

Rock-shells, have the front of the shell lengthened out into a canal of greater or less length, and are studded with spines, rough tubercles, or leafy frilled processes arranged in a regular but peculiar order. The animal, which is carnivorous, is furnished with a tubular proboscis, and two tentacles, each of which carries an eye on its outer side. The species which we have figured, common in cabinets, and known to collectors by the name of Thorny Woodcock (*Murex tenuispina*), exemplifies the peculiarities noticed above.

A purple liquor, capable of producing a rich and permanent dye, is known to be produced from many Gasteropoda, but the species of the genus before us are preeminent for this property. The renowned Tyrian purple of antiquity has long been attributed to some species of *Murex*, and from the researches of Mr. Wilde, we are now able with tolerable certainty to identify that species. This gentleman found on the shore, near the ruins of Tyre, a number of round holes cut in the solid rock, varying in size from that of an ordinary metal pot, to that of a large boiler. Within these, and on the beach, were great numbers of shells, broken apparently by design, but afterwards agglutinated together. It is hence supposed that the shells were pounded in great numbers in these mortars, for the purpose of extracting the purple fluid, especially as Pliny describes this as the mode in which it was effected. The shells, when examined, proved to be the *Murex trunculus*, several recent specimens of which were lying on the beach.*

CLASS V. PTEROPODA.†

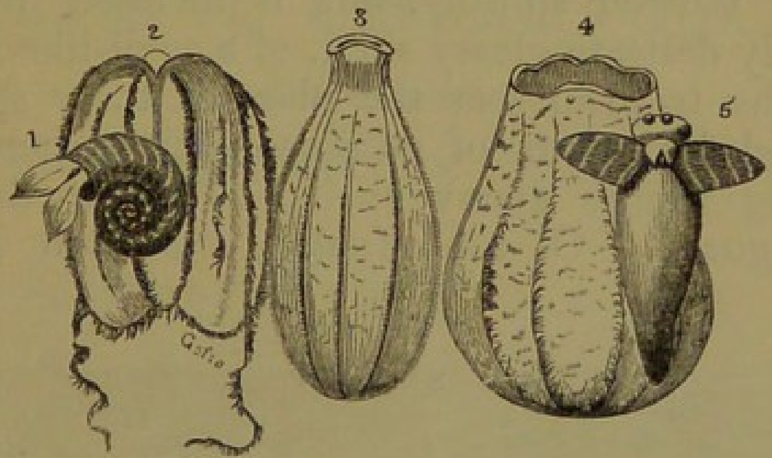
A very limited group of small marine animals are thus named, because their most prominent peculiarity is a broad wing-like expansion on each side of the head, by the use of which the little creatures swim in the sea. They somewhat resemble a butterfly with small expanded wings; yet it is found that the organs in question are but one, being connected by muscular cords concealed from view, and passing right through the neck, and expanded on each side; "forming an apparatus exactly comparable to the double-paddled oar with which the Greenlander steers his kajac, or canoe, through the very seas inhabited by the best known of these animals."

Some of these animals are destitute of a shell, but have a sort of contractile envelope instead of a mantle, as the *Clio borealis*, to which we have just alluded. In the polar seas these little creatures

* Narrative of a Voyage to Madeira, &c.

† "Wing-footed animals."

exist by countless millions, disporting themselves amidst the horrors of perpetual cold; coming to the surface, then instantly descending. They form, in common with small *Medusæ*, a considerable part of the food of the Whale, who has only to open his huge mouth, and myriads are engulfed. These little marine butterflies are described as making the



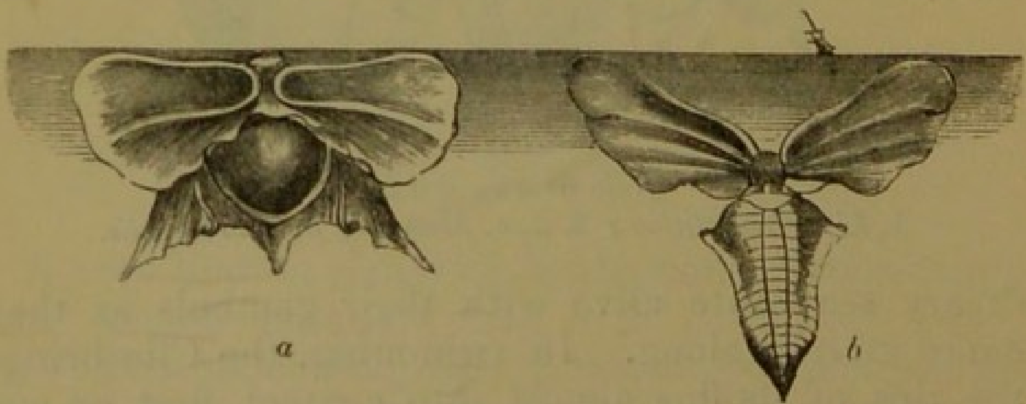
FOOD OF THE WHALE:
1, *Limacina helicina*; 2, 3, 4, *Medusæ*; 5, *Clio borealis.*

dreary sea quite alive with their gambols as they dance merrily along. In swimming, the Clio brings the tips of its fins almost into contact, first on one side, then on the other: in calm weather they rise to the surface in myriads, for the purpose of breathing, but scarcely have they reached it before they again descend into the deep. Mr. Scoresby, to whom the scientific world is so largely indebted for the knowledge of Arctic natural history, kept several of them alive in a glass of sea-water, for about a month, when they gradually wasted away and died. The head of one of these little creatures exhibits a most astonishing display of the wisdom of God in creation. Around the mouth are placed six tentacles, each of which is covered with about three thousand red specks, which are seen by the microscope to be transparent cylinders, each containing about twenty little suckers, capable of being thrust out, and adapted for seizing and holding their minute prey.

"Thus, therefore, there will be three hundred and sixty thousand of these microscopic suckers upon the head of one Clio; an apparatus for prehension perhaps unequalled in the creation."

Another species of this group, found in company with the above, in still more innumerable hosts, is the *Limacina helicina*, which does not materially differ from the Clio in structure, but its hinder part is twisted spirally, and is inclosed in an exquisitely delicate glassy shell, of a snail-like form.

In the tropical seas the place of these species is supplied by others of correspondent structure, inhabiting fragile glassy shells. Two of these are here figured. Of the *Hyalea*, the shell is small



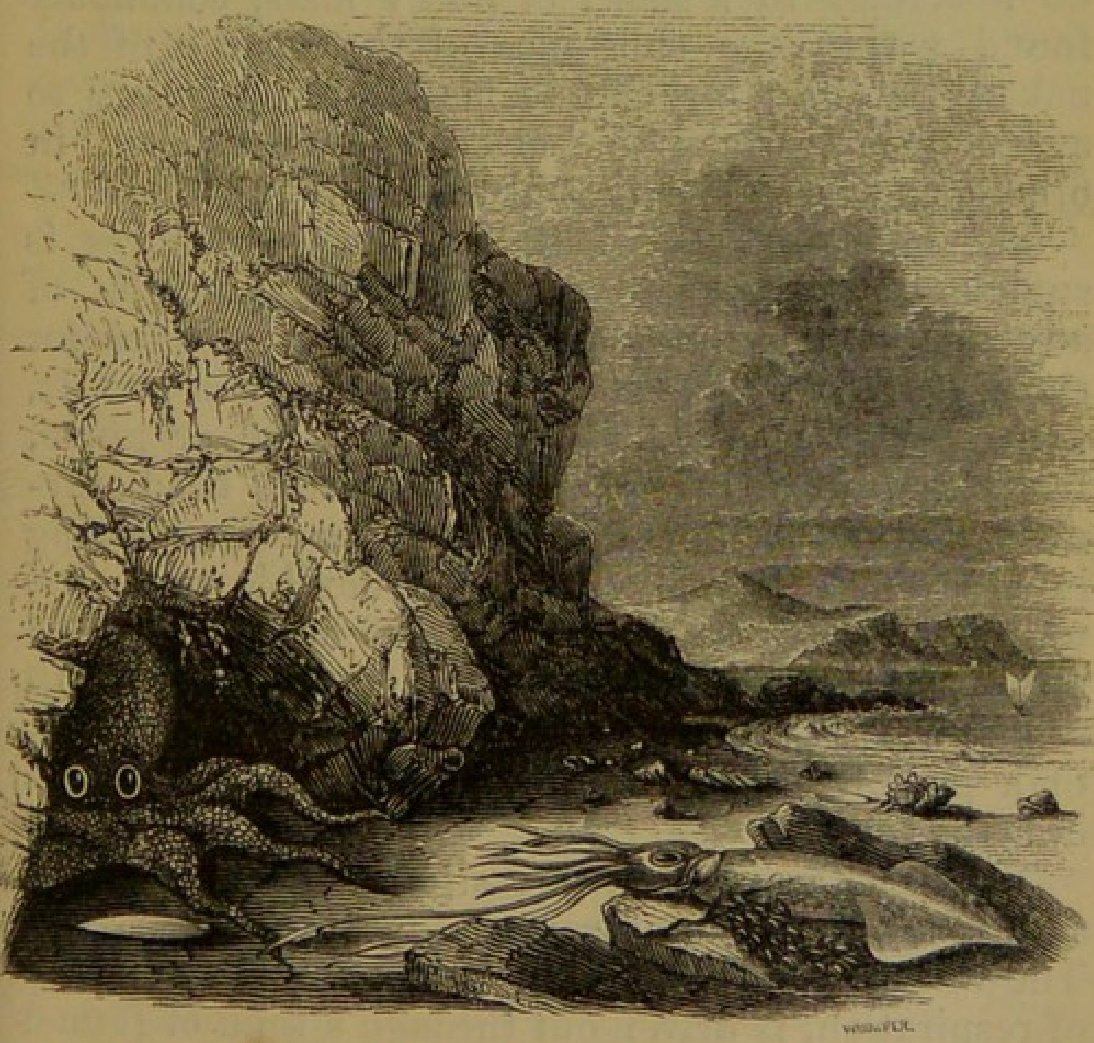
GLASS SHELLS (*a. Hyalea tridentata; b. Cleodora pyramidata*).

and somewhat globular, resembling a bivalve without a hinge; the hinder part being consolidated, and armed with three spines; the sides have a narrow fissure through which a semi-transparent membrane protrudes. The animal, like the Clio, is furnished with a wing or fin on each side, which it uses as oars. The *Cleodora* is a creature of extreme delicacy and beauty. The shell is glassy, and colourless, very fragile, nearly in the form of a triangular pyramid, with an aperture at its base, from which proceeds a long and slender glassy spine; and a similar spine projects from each side of the middle of the shell. The animal is like the preceding; but the hinder part is globular and pellucid, and in the dark vividly luminous, presenting a singularly striking appearance, as it shines through its perfectly transparent lantern. Both of these are found floating in great numbers on the surface of the sea.

CLASS VI. CEPHALOPODA.*

(Cuttle-fishes.)

It is worthy of remark that the Class of inverte-



POULPE AND SQUID.

brate animals which most closely approaches to the highest type of life, should strongly remind us of

* "Head-footed."

the lowest. The jelly-like body of a Cuttle-fish with its eight long flexible arms radiating from its summit, is so much like a Polype, that it has received the same name; for *Poulpe* is but a corruption of *Polypus*. Yet in these creatures, we find the first indications of a true internal skeleton; a large ganglion, which we may regard as the brain, is inclosed and protected by a cartilaginous box or skull, which contains organs of hearing and elaborately formed eyes, and gives attachment to the muscles which move the tentacles. Other cartilaginous pieces occur in other parts, which are considered as rudimentary traces of a spine. We do not refer to a shelly or horny mass, commonly found within the substance of the mantle of the naked Poulpes, for this seems rather analogous to a true shell, which is indeed fully developed in others, and resembles that of the GASTEROPODA.

The general form of these strange creatures is sufficiently remarkable to strike the attention of any one who beholds them in active motion for the first time. The body is enveloped in a mantle, which being closed beneath forms a sac or purse, from the front of which projects a large head, furnished with a pair of staring eyes, and terminating in eight or ten long, taper and flexible tentacles, united at their bases by a sort of fleshy web. In the centre of these tentacles or arms, is a mouth armed with two powerful jaws resembling the beak of a parrot, except that the upper mandible shuts into the lower.

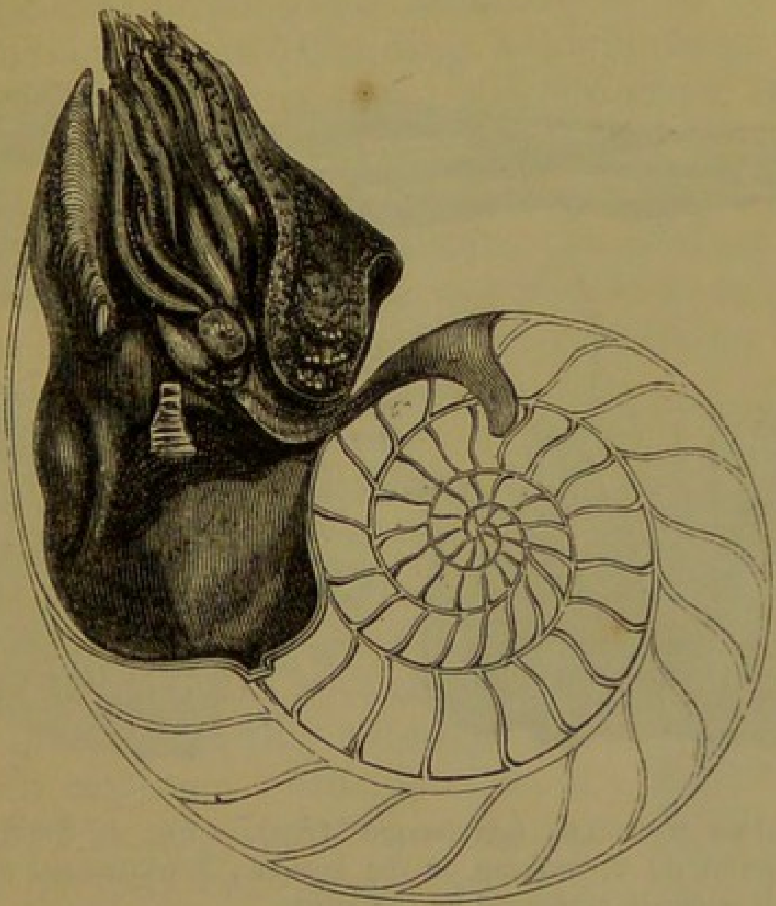
The breathing organs are situated within the sac, and resemble in appearance a pair of fern-leaves. The water, admitted into the sac for the purpose of respiration, is driven out through a kind of funnel situated at the back of the neck. The contents of the intestines are expelled through the same aperture, as is also a fluid secreted by many species, of an inky blackness, which serves these animals as a protection. When in danger, a quantity of ink is suddenly poured out from the funnel, which mingling with the surrounding water, produces an obscurity, under which the ingenious author of the stratagem darts away, like one of the heroes of antiquity protected in peril by the interposition of a favouring cloud. This ink dried and prepared, is the *sepia* of artists.

The long and muscular, though flexible arms, are most efficient instruments for capturing prey. Eminently carnivorous, voracious, and fierce, these animals feed largely upon fishes, whose activity, and slippery mail would elude a less effective apparatus than is presented by these organs. The inner surface of each arm is set with one or two rows of powerful suckers. Each sucker may be compared to a most perfect cupping-glass, consisting of a circular muscular cup, whose concave surface has in its centre an aperture leading into a cavity; a piston accurately fits the orifice, which may be withdrawn by muscular force. The animal, then, in throwing out its long flexible arms, brings one of them into contact with its prey; the instant the concave surface of but a single sucker is applied, the piston is withdrawn, and a vacuum is created, and by the atmospheric pressure without, the sucker adheres with astonishing force. But, as the suckers are numerous and close, many are made to adhere at one moment; the arm is swiftly twined round the object, and the other arms being likewise applied to it, it is easier to tear asunder the muscular fibres of the limb than to loosen the fearful and often fatal embrace. With all this adhesive power, which is very strong even after death, the animal can in an instant loose its grasp, and retire in case of danger, by simply pushing forward the piston and filling the vacuum. The power with which these arms are endowed, and the strength of the sharp and horny beak, render the CEPHALOPODA truly formidable opponents, especially as their courage and cunning are equal to their rapacity.

But there is a genus (*Onychoteuthis*) which is much more formidably endowed. The suckers which arm the expanded extremities of the long feet have a projecting sharp claw in the centre of each cup, which is curved backward. On the smooth and glossy scales of fishes, lubricated with slime, it might not be always easy at once to create a vacuum, but these hooks are plunged by the action of the sucker into the flesh of the struggling victim, whereby a firm hold is obtained, and the prey is dragged to the powerful beak. Besides this, however, there is an additional provision made for the requirements of these wonderful creatures: at the base of the fleshy expansions alluded to as being thus formidably armed, is a group of simple adhesive disks, which being placed in contact with each other, the two arms adhere at this point with much force, and being thus locked together, have more power in holding struggling prey, than they could have separately and singly: a structure that art has endeavoured to imitate, in the formation of a valuable and effective surgical implement.

A beautiful shell called the Pearly Nautilus had long been common in cabinets, but the nature and true character of its inhabitant were almost wholly unknown, until 1829, when Mr. G. Bennett brought one to England, which he had captured alive in the Pacific Ocean. This animal was the subject of an elaborate memoir by Professor Owen, who found it to be a Cephalopod, but differing in so many particulars from those members of the Class already known, as to form a new Order. This Order is named TETRABRANCHIATA, or four-gilled; all the rest of the Class having but one pair of respiratory organs.

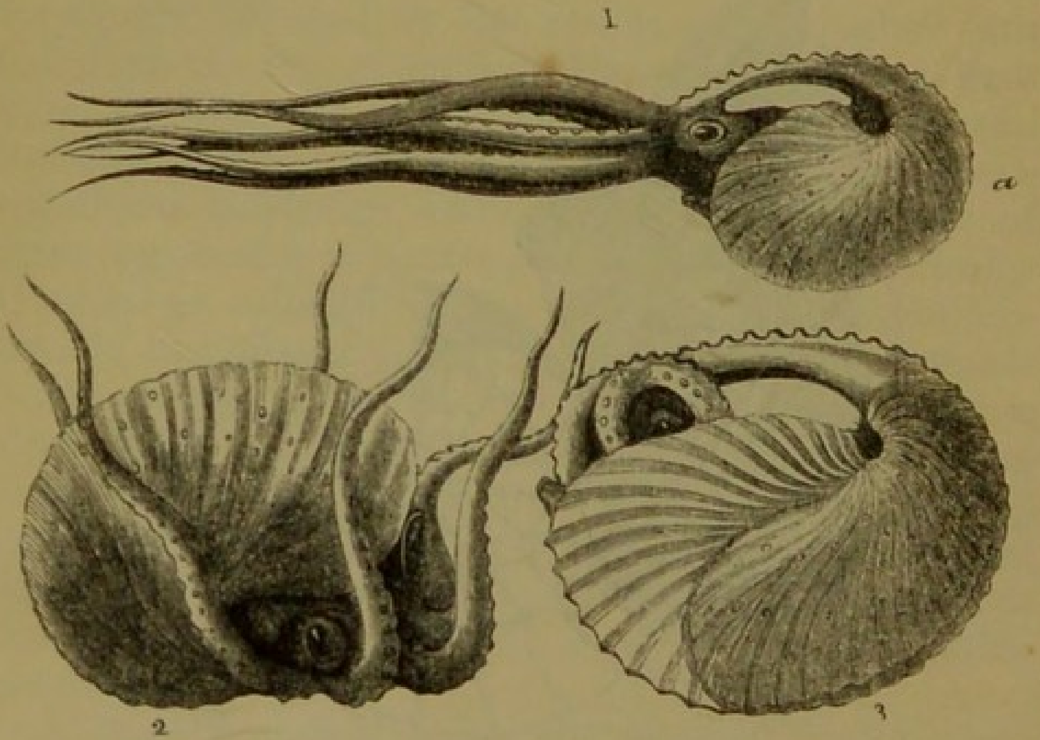
The shell of the Pearly Nautilus (*Nautilus Pompilius*) is a large spiral, flattened at the sides, the smaller whorls enclosed by the last, which is very capacious. The interior presents a curious structure; for it is divided into chambers by a great number of thin shelly partitions, each communicating with the rest by a small tubular hole in the centre of the partition. The animal occupies the outermost of these chambers, as seen in the engraving, having no connection with those behind it, except that a membranous tube runs from its body through the central holes, even to the first of the



PEARLY NAUTILUS (*with the shell in section*).

series. The Nautilus is destitute of a funnel, and of an ink-bag; its tentacles are numerous, but they are short, and are not furnished with suckers. It has a sort of fleshy foot, on which it crawls at the bottom of the sea, with the head downward, and the shell upward. It has no organs of hearing, and its eyes are more simple in their structure than those of the other CEPHALOPODA. In all these particulars, it is manifest that the four-gilled species of the Class approach nearly to the GASTEROPODA.

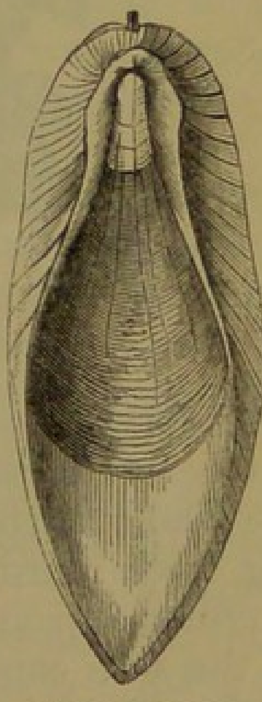
The animal and shell of which we have been speaking, must not be confounded with the Paper Nautilus (*Argonauta*). This also inhabits a shell of peculiar delicacy, shaped somewhat like the last, but very thin, and semi-transparent, and marked with elegant flutings. The animal is allied to the common Poulpe, having eight arms set with suckers, of which the hindmost pair have their tips dilated into broad fleshy disks. These the creature applies closely to



THE PAPER NAUTILUS (*Argonauta Argo*). *Fig.* 1, Swimming towards the point *a*; 2, walking on the bottom; 3, contracted within the shell, which is partly embraced by the arms.

its shell, one on each side, as seen in the accompanying figures; and it has been ascertained, that these disk-arms secrete the substance of the shell, as the mantle does in the Classes we have described. Whether these disks are ever expanded and used as sails, when the animal floats in its shelly boat upon the smooth surface of the summer sea, as has been always believed, is a question not yet settled; for it is denied and affirmed by excellent observers. But it is clearly established that the ordinary modes of progression are like those of the more common CEPHALOPODA; swimming backwards by the force of jets of water propelled through the funnel, or crawling on the bottom, with the head downward, by means of the base of the arms. With respect to the former action, M. Rang observes, "The disposition of the animal and shell is the most favourable for aiding the motion of the creature. The lightness of the shell; its narrow and keeled form; its width, smallest at the part which cleaves the water; the membrane smoothing all inequalities of the shell; the bundle of arms extending behind, so as to offer the least possible resistance; the two arms, stretched like a bridge over the cavity where the eggs are, as if to throw off the water from that cavity; all these adaptations concur to facilitate the gliding of the animal through the medium in which it is to move."*

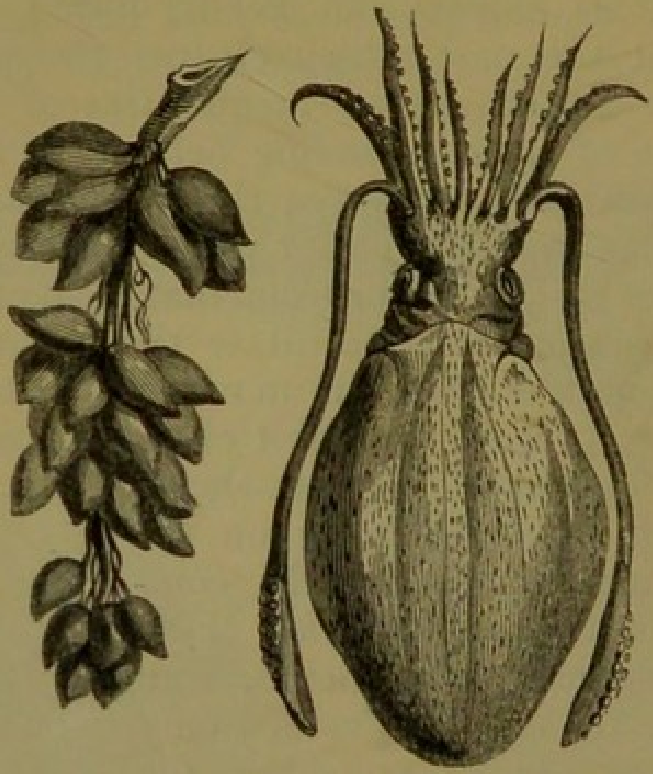
Those who are in the habit of wandering with an observant eye upon the sea-shore, must often have seen lying on the sand the internal shell of the common Cuttle (*Sepia officinalis*). Formerly it was used in medicine, as an absorbent, but now it is valued only for the purpose of polishing the softer metals, or for rubbing out errors in writing. During life it is inclosed in a cavity of the mantle, whence it falls out on an incision being made. It is an oval plate, concave on one side, where it is covered with a multitude of very thin parallel plates, connected together by thousands of little hollow columns, which are placed upright between every two plates. These plates and columns, though formed of shelly matter, are excessively fine, soft, and brittle, and are readily reduced to the softest powder. The possessor of this curious shell is abundant in our seas, and is much hated by fishermen for its voracity; as it is a common thing to find a haul of fish almost completely devoured by the Cuttle. It is about a foot in length, is robust in form, and is furnished with ten arms, two of which are much



CUTTLE-SHELL.

* Mag. Nat. Hist. N.S. iii. 521.

longer than the rest, and dilated near the ends, where alone the suckers are placed. The colour is a dirty white, but if viewed during life there will



CUTTLE-FISH AND EGGS.

be observed a sort of network of lines and irregular patches of a reddish or purplish hue, playing over the whole surface; the markings continually changing their form and position. The cause of this singular appearance is as follows: the interior layer of the skin consists of a great number of cells, filled with a fluid in which the colouring matter is held suspended; the cells possess the power of rapid contraction and expansion, and thus the colouring substance can be driven from one into another, brought nearer to the surface, or carried farther from it at the pleasure of the animal. The changes of colour thus produced have been compared with those of the Chameleon, which are by some attributed to a similar structure.

The eggs of the Cuttle are also frequently seen on the sea-beach. They bear no small resemblance to a bunch of black grapes, being accumulated in clusters, adhering to each other by slender foot-stalks; they are, moreover, very nearly of the size, form, and colour of that fruit.

The eggs of a species almost equally common, the Pen-fish or Squid (*Loligo vulgaris*), "are deposited in the form of numerous lengthened groups, radiating from a common centre, and spreading every way into a circular form; each egg is of a glassy transparency, and the young animal may be very distinctly observed in each, many days before the period of exclusion. These groups of the eggs of the Calamary are often seen swimming on the surface, and are occasionally thrown on shore; the whole group sometimes measures more than a foot in diameter, and from its general appearance, unless closely inspected, is often mistaken for a species of Medusa, or Sea Blubber."*

The name of Sea-pen, as well as that of Calamary (*calamus*, Lat. a pen), both of which are applied to this species, allude to the form of the interior shell. The proportion of calcareous to animal matter in this production is very small, hence its consistence is that of horn or cartilage, rather than shell. It is a long transparent plate dilated at one end, and at the other somewhat cylindrical; so as to resemble the feather and barrel of a quill. The term Squid is perhaps a corruption of "squirt," and derived from the animal's habit of projecting its ink as a defence.

The general figure of the Squid is very different from that of the Cuttle. It is long and cylindrical, and the mantle is dilated on each side into a broad triangular fleshy fin, by the flapping of which the animal is enabled to take flying leaps, not only through the water, but also, at least in the case of some species, through the air. The eyes are large and lustrous, of a brilliant emerald-green; and when the creature is excited, are phosphoric and glittering in a high degree.

* Shaw's Zool. Lect. i. 133.

SUB-KINGDOM V. VERTEBRATA.

We have traced the progressive stages of animal life from the dubious conditions of being in which its first dawning is dimly discerned, through a long line of forms, in which its functions and powers increase in energy, in proportion as the nervous matter is more and more concentrated. We have seen that in the lower Classes the flesh is soft and gelatinous, and that the motions of the muscles are obedient to the will in but feeble measure, from the lack of a firm support and attachment for them. Then we have traced the development of a *skeleton*, at least that important form of it which is external; first in the skin of the Intestinal Worms, then in the glassy shells of many of the Rotifera, then in the cartilaginous crust of the Starfishes, hardening to a sort of stone in the Urchins, and finally we have seen it attaining its highest point of development in the Insects and Crustacea. The vigour and energy of muscular action, the perfection of the senses, the powers of motion enjoyed by the limbs, the distinction of sex, the wonderful instincts, the mental affections, and the varied intelligence, which we cannot fail to mark in these tribes, show that animal life has here reached a high point of perfection. It is in fact the highest phase of life associated with an external skeleton.

We then had to retrace our steps, and, following a series of animals far inferior in energy and intelligence to those which we have just named, observe the gradual degradation of the exterior skeleton, to cartilage in the *Tunicata*, to shelly plates united by cartilage in the *Cirripedia*, to stony shells destitute of life, but affording muscular attachment in the

Bivalves, to a shell having no vital connexion with the flesh in the *Univalves*, until in the *Cephalopoda*, it becomes smaller and smaller, and at length disappears.

But it is observable that as the last traces of the *external* skeleton are vanishing, the rudiments of another form are beginning to appear, which, as it advances to progressive perfection, we shall find associated with conditions of animal life far higher in rank than any we have yet seen in the most highly endowed Beetle, Spider or Crustacean.

Henceforth we have to consider animals whose skeleton is *internal:* whose bodies (if we except the lowest dubious species that link with the feebler forms behind) are built up, as it were, upon a framework of many pieces, composed of a living substance capable of growth and renovation, jointed to each other, and affording bases, and levers, and points of resistance to muscles, fitted to perform all the energetic, yet precise and delicate movements, required by the wants and wills of the most gifted forms of animated existence.

Another office of this bony framework is that of affording protection to the nervous matter; which is now concentrated into a large mass situated in the head of the animal, and a chord of similar substance running through the length of the body. The former is known as the brain, and the latter as the spinal marrow. The brain is inclosed in a chamber or box of bony plates soldered, as it were, together at their edges, with openings for the admission of impressions received from the organs of sense, and for the sending forth of the spinal chord. The latter is contained in a jointed tube composed of many pieces called *vertebræ* (from *vertere*, to turn, because they form the centre or axis on which the whole body turns), united by the interposition of a sort of cushion of cartilage, which allows a certain degree of flexibility to the whole. Perforations in these bones allow of the passage of nervous threads, which branch to every region of the body, and are the medium by which sensation is conveyed from every part. The nervous system may thus be compared to an electric telegraph, of which the brain is the central office, and the nerves the wires, along which travel with inconceivable rapidity the various commands and reports to and from all quarters of the complex system.

Such are the essential parts of the skeleton, which are found in every Vertebrate animal; but in the great majority there are other series of bones attached to these, performing various parts in the economy of the creature. Thus there is in general a series of arched bones, called ribs, jointed to the *vertebræ*, and approaching or meeting each other in the front of the trunk. They thus surround the most important of the internal organs, such as the heart, the lungs, the liver, the stomach, &c., inclosing them as if with strong hoops, and affording at the same time extensive attachment to muscles that move various parts of the body. In Fishes and (less conspicuously) in Reptiles, there is another series of arches nearer the skull connected with respiration, and called the *hyoid** apparatus. In general there is on the front or lower aspect of the body a breast-bone, composed of several pieces, sometimes united into one; it is particularly large in Birds. Two pairs of limbs, of which the fore-pair are suspended in the flesh, and the hind pair jointed to the spine, are found in most of the Class, forming the arms and legs in Man, the fore and hind legs in Beasts, the wings and feet in Birds, and the pectoral and ventral fins in Fishes.

The organs of sense are found in the VERTEBRATA in the highest perfection of structure. The eyes, two in number, are lodged in cavities formed for their protection by the bones of the face, and are, while more simple, more complete instruments

* Hyoïd; that is "V-shaped:"—because in the higher animals the rudiment which represents this apparatus is forked.

of vision than in the preceding Classes. The ears are more and more distinct, and more highly organized, and at length become furnished with an external conch for the collection of sounds. These are double, as are also the organs of smell, which, however variously constructed, are always found. The faculty of appreciating tastes, appropriated in many to the tongue and interior surface of the mouth, is probably less definitely enjoyed by some Birds, Reptiles, and Fishes, which swallow their food whole. Finally, that of touch is not only diffused over the whole surface of the body, but especially allotted to particular parts capable of more delicate perceptions, such principally as the extremities of the limbs, and the organs of the mouth.

The blood is composed of red particles, of an oval or circular form, floating in a watery fluid. It circulates through a double system of vessels, those which carry it from the heart termed arteries, those which bring it back to be renewed called veins.

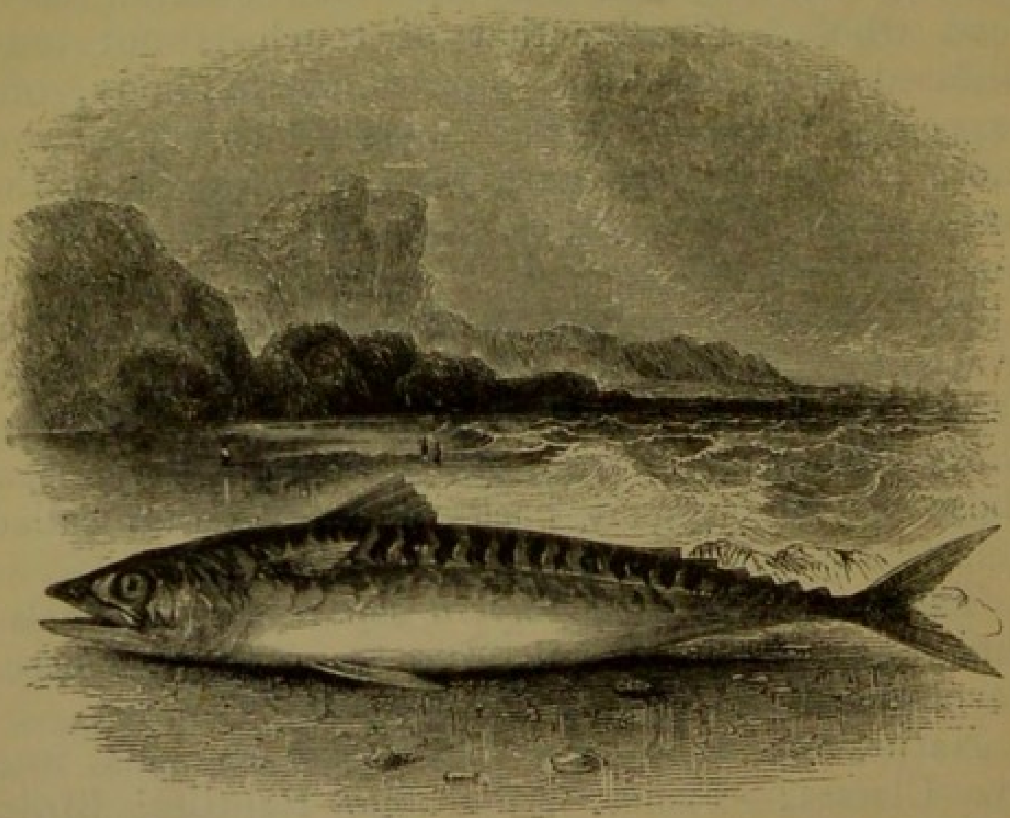
The sexes are invariably in separate individuals; the young are produced from eggs, in some cases developed in the body of the mother.

Naturalists divide the Vertebrate animals into five Classes:—Fishes, Amphibia, Reptiles, Birds, and Mammalia.

CLASS I. PISCES.

(*Fishes*).

Every child who has ever drawn a stick through water is aware how difficult it is to do it swiftly, as compared with the motion of the same object through the air. The water is a far denser fluid than the air, and hence its resistance is much greater. Yet when we stand on the brink of a river, and watch the bright-sided fishes darting hither and thither, we are struck with the rapidity, the elegance, and the apparent ease with which they shoot along, cleaving the dense fluid with scarcely less fleetness than a bird divides the impalpable air. Now let us take a fish in our hands and examine it, and we shall see how beautifully it is constructed for rapid progression through a dense medium. Look at a Mackerel. Its form is that of a spindle,



MACKEREL.

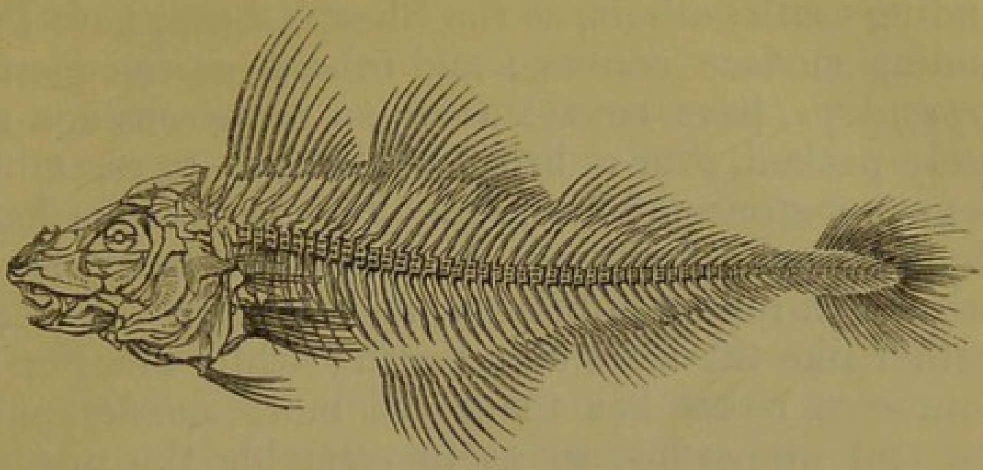
thick in the middle, and gradually tapering to each extremity, with gently sweeping outlines. This is the shape best adapted for a body of a given bulk to pass through water, and is that given to the hull of a ship. There is nothing to break the uniformity of the outline, but a few filmy fins, which, though of considerable breadth, are so thin as to offer scarcely any resistance to water, when moving in the line of their edge; and we perceive that this is the manner in which they are placed upon the fish. The whole body is encased in an armour composed of scales, overlapping each other; these are hard, smooth, and delicately polished, and are so accurately fitted to one another, and lie so close, as to leave not the smallest space between the surfaces; the free edges are all directed backwards, so that the progression of the fish only presses them the closer in proportion to the rapidity of its course, and the whole united surface is moreover lubricated with a slippery kind of slime, which aids the flow of the watery particles past the body, while being insoluble in the fluid, it protects the scales and the parts beneath from maceration and decay.

The internal anatomy, as well as the external characters, show that these animals are formed for living in the water. In order to swim with less effort, many species are provided with a capacious bladder filled with air, situated beneath the backbone: by the increase or decrease of muscular pressure on this bladder, at the will of the animal, the inclosed air is either condensed or dilated, and thus the specific gravity or comparative weight of the whole body is increased or diminished, and the fish sinks to a lower or rises to a higher level. Those fishes which grovel at the bottom, such as the Rays, and the Flat-fishes, are destitute of the swim-bladder. It is, however, wanting even in a few of the species that swim at the surface.

The air-bladder is probably the first rudiment of an apparatus suited to breathe air; but it is not the proper organ of respiration in this Class of animals, which, as we have said, are aquatic. Their respiration is, therefore, effected not by lungs but by gills; which are arranged in two series, placed on each side of the neck. They consist of numerous thin plates consisting of a fine net-work of branching blood-vessels, arranged upon several arches of bone. The blood after having circulated through the system is brought to the gills, and thus spread out to the water, in order that it may imbibe oxygen and be renewed. For this purpose it is needful that a constant current of the surrounding fluid should be poured over them, and this is for the most part effected by the water passing in at the mouth and out on each side through the gill-opening, bathing the delicate net-work of blood-vessels as it goes. The gills are generally protected by large bony covers, which are more or less free and open behind; in the Mackerel and Herring, the opening is very large, in the Eel it is small. Those fishes that have the gill-opening large, die quickly when taken out of the water, and *vice versá.* The cause of death is believed to be the adhesion and drying up of the fine net-work of vessels by exposure to the air, so that the blood can no longer pass through them. If sufficient water could be retained to keep the gill-plates floating, the fish would continue to live, for the needful oxygen would be supplied from the air.* There are some species of Frog-fishes (*Lophiadæ*) which are furnished with a contrivance for retaining water, and these are able to crawl on shore, and live in the air for many hours, and even (as it is reported) days. The blood after having passed through the gills is distributed by means of the arteries to every part of the body, whence a system of veins conveys it back to the heart, and thence again to the gills.

The skeleton of a fish consists of four parts, the spinal column, the skull, the gill-arches, and the limbs. The *vertebræ* or joints of which the spine is composed are cylindrical bones, with a funnel-shaped hollow before and behind: the hollows are connected by a hole pierced through the centre of each bone. When in contact, the hollow between every two joints is filled with a soft gristle or jelly which passes through the central hole, allowing great flexibility in the spine. In the great division which includes the Sharks and Rays, this hole is so much enlarged as to leave only a mere ring of bone.

* Owen, Comp. Anat. ii. 260.



SKELETON OF HADDOCK.

Spinous processes (see the above fig.) project from the *vertebræ* both above and below, for the support of the muscles; but the lower ones are not found within the cavity of the belly, where their place is supplied by lateral processes, to which are attached the ribs. The number of *vertebræ* varies greatly in different species; the Sun-fish has but sixteen, the Conger a hundred and sixty-two, and the Electric Eel two hundred and thirty-six. The ribs are slender, flexible bones, embedded among the muscles of the sides; each rib gives origin to long slender branches, inclined backwards, and in the Herring as well as some other species, similar bones are sent off from the *vertebræ;* which will account for the great multitude of fine thread-like bones, which prove so annoying to the lovers of this wholesome fish.

The skull varies much in form in different tribes, but in general consists of pieces answering to those which compose the head of the other VERTEBRATA. Teeth are generally very numerous; and are found in almost every one of the bones that enter into the composition of the mouth, though not in all the species. They are generally simple spines, curved backwards; but innumerable modifications of this form occur. Thus the jaws of the deadly Shark are flat and lancet-like, the cutting edges being notched like a saw; the front teeth of the Flounder are compressed plates; some, as the Wrasse, have flat grinding teeth; others, as the Sheep's-head, have the grinding surface convex; and others, as the genus *Chrysophrys*, have convex teeth so numerous and so closely packed over a broad surface, as to resemble the paving-stones of a street. The beautiful Chætodons of warm climates, on the other hand, have teeth which resemble bristles, and these are set close together like the hairs of a brush; while the Perch of our own rivers has them still more slender, minute and numerous, so as to resemble the pile of velvet. Another of our well-known fishes, the bold and fierce Pike, is armed with teeth scarcely less formidable, in size, form, and sharpness, than the canines of a carnivorous quadruped. In number also there is great variety. The Pike, the Perch, the Catfish, and many others, have their mouth crowded with innumerable teeth; while the Carp and the Roach have only a few strong teeth in the throat, and a single flat one above, and the Sturgeon, the Pipe-fish, and the Sandlance, are entirely toothless.

The limbs of the VERTEBRATA are never more than four; in Fishes these are very different in appearance from those of the other Classes. The external portion consists of a series, (often numerous) of slender rays, across which a fine membrane is stretched. These rays are sometimes entire, stiff, and spinous, at others jointed, flexible, gristly, and branching, and often both sorts of rays are found in the same fin. Two pairs of fins, called the *pectorals* and the *ventrals*, answer to the fore and hind limbs of quadrupeds; but a fish is furnished with other fins besides these. Thus one, two, or sometimes more, called *dorsals*, run along the line of the back, above which they can be made to stand perpendicularly; one or more, called *anals*, of similar structure, are placed beneath the hinder part of the body, and the extremity of the tail is furnished with another, which usually expands both above and below, called the *caudal*. All these fins may be observed in the common Cod (see engraving on p. 261).

The principal agent in locomotion is the tail, which strikes the water alternately to the left and right; the other fins seem to be used chiefly in maintaining the balance of the body, and (at least the *pectorals*) in slight and gentle movement. There is considerable diversity in the depth of water which different species of fishes habitually inhabit; and this depends, in a great measure, on the position of the ventral fins. Such as mainly reside at or near the surface have them so placed that the centre of the body shall fall nearly midway between them and the pectorals. Those whose habits lead them to range to great distances without any material change in their depth of water, have the ventral fins placed far back on the belly, as the Herring and the Salmon; while those which feed at the bottom in deep water, but yet have considerable power of swimming, such as the Cod, require the ventrals to be situated near the head, sometimes even in advance of the pectorals, in order to act with rapidity and effect upon the fore part of the body, which is usually heavy in such fishes. The Flat-fishes and Skates, in which the ventrals are little developed, and the Eels, in which they are wanting, rarely quit the ground, but grovel on the mud in shallow water. Many fishes have certain spines of the fins developed into stiff and formidable weapons, and others have equally effective armour placed upon the gill-covers, the sides of the body, or the tail. With these, which are usually jointed, and which the fish has the power of erecting stiffly, and of directing with considerable precision, it sometimes inflicts severe wounds on the incautious fisherman, as well as on its opponent in the battles with its own kind which often occur. The little Stickleback (*Gasterosteus*), which abounds all round the coast, as well as in our fresh waters, is armed with sharp spines on the back and sides, which it wields like a perfect tyrant.

The food of fishes consists principally of animal matter. Those which inhabit fresh-waters live upon worms, mollusks, the larvæ of water-insects, or such flies as play or alight upon the surface; others feed upon reptiles and small quadrupeds. The marine kinds often devour crustaceans, star-fishes, and mollusks; and some, both of fresh and salt-waters, feed on vegetables. But the great majority prey upon each other; the larger devouring the less, these devouring others inferior to them, and so on. Those who are in the habit of cleaning fish for the table, often have curious evidence of their indiscriminate voracity in the contents of their stomachs. This subject will be illustrated in the following extract from a lecture delivered before the Zoological Society of Dublin, by Dr. Houston.

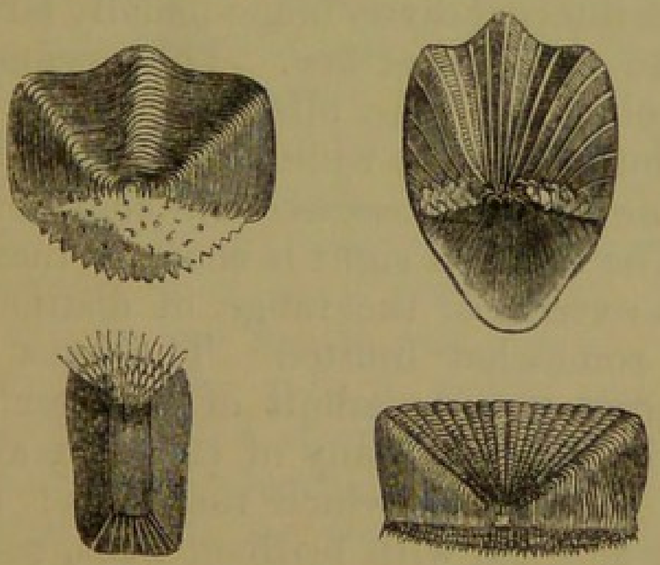
"This preparation (for the fidelity of which I can vouch, as it belongs to the Museum of the Royal College of Surgeons, and which may be taken as a fair average specimen of a fish's breakfast party, captured at an early hour of the morning) will serve as an illustration of the voraciousness of their habits. Here is the skeleton of a Frog-fish two and a half feet in length, in the stomach of which is the skeleton of a Cod-fish two feet long, in whose stomach again are contained the skeletons of two Whitings of the ordinary size; in the stomach of each Whiting there lay numerous half-digested little fishes, which were too small and broken up to admit of preservation. The Frog-fish, with all these contents, was taken last summer by the fishermen, and offered for sale in the market, as an article of food, without any reference at all to the size of its stomach, which to them is an every-day appearance."*

The armour in which most Fishes are encased is well worthy of our admiration. In some species, as the Pipe-fishes and Sea-horses (*Syngnathidæ*) the body is covered with strong bony plates; which, in the Trunk-fishes (*Ostracion*), are so firmly soldered together as to form a solid box, through openings in

* Quoted in Patterson's Zoology, ii. 226.

which the tail and fins project. The skin of the Shark is covered with minute spines, which are felt to be rough and rasp-like if the hand be passed over them from the tail towards the head, but are imperceptible if rubbed in the contrary direction.

But the most common form of a fish's covering is that of separate scales, each imbedded in a fold of the skin on the side next the head, and overlapping its successor with the opposite edge. When examined by a low magnifying power, the scales of fishes afford interesting and instructive subjects of observation. They vary in form: those from different



SCALES OF FISHES.

parts of the body not being quite alike, even in the same fish. They are not perfectly flat, but take the form of a very flattened cone, of which the apex is usually a little behind the middle. Between this point and the edge there is a great number of concentric flutings, too fine, as well as too near each other, to be readily counted; and it is presumed that each of these lines indicates a stage in the growth of the scale; that the scale is increased, perhaps annually, or perhaps oftener, by a deposit of horny matter on the surface next the skin, each of which deposits exceeds in diameter that which preceded it, by a very minute amount on every side. The concentric lines are often traversed by other lines, diverging with great regularity from the apex. The edges are sometimes cut into points, scallops, or waves, of exquisite symmetry; the surface is often variously sculptured; and the whole presents a specimen of the most elaborate workmanship, worthy of the Divine Architect that formed it for his praise.

The senses are probably all possessed by Fishes, but some are much more developed than others. Taste and touch are considered to be feebly and imperfectly exercised; hearing is probably more perfect, the internal cavity being usually large, though there is no external orifice. The organs of smell are very obvious: the olfactory nerves are large and distributed over a wide surface, and hence this sense is doubtless possessed in considerable perfection. The sense of sight is acute in these animals, though its extent, or the range of distinct vision, is doubtless somewhat limited. The eyes are generally of great size, to admit of a larger number of rays of light, since so many of these are absorbed in the dense medium in which they live: the iris is frequently adorned with brilliant hues, such as scarlet, orange, yellow, blue, and often gleams with a metallic or gem-like radiance.

Fishes, like Reptiles and Birds, are *oviparous;* that is, they increase by depositing eggs, or *spawn*. There are a few inconsiderable exceptions, in which the eggs are hatched within the body of the parent, and the young produced alive. The female is known by the presence of the *hard roe*, that is, the ovary, or egg-organ, the eggs in which, at least in many species, are accumulated in countless thousands, resembling minute globular seeds, every one of which is capable of producing a fish. Six millions of eggs have been estimated to lie in the roe of a single Cod-fish.

At the proper season for depositing the eggs, which is different in different species, the fishes resort to shallow waters. River fishes usually lay the spawn upon the gravelly bottom, sometimes in shallow furrows ploughed up by the muzzle; and marine species for the most part seek the shoal waters in the neighbourhood of the coasts. Hence large numbers of fishes are brought near the shores at certain seasons, a beneficent provision of the All-wise and Good Creator, to afford to man an opportunity of securing an immense amount of nutritive food, which would not repay the expense and trouble of seeking it, as long as each individual fish roamed independently through the deep sea. And it is worthy of observation, as an admirable ordination of Divine Providence, that these tribes are thus periodically brought within the reach of man precisely at the season when they are in the highest condition, and therefore most wholesome, as well as most agreeable. For they come from the deep water fat, and in full health and vigour; but after having spawned they return, sickly and poor to recruit their exhausted strength.

The procuring, preserving, and selling of these valuable products of the seas, are to this country a most important branch of national industry, and afford a revenue of immense value. They yield a cheap, wholesome, and abundant food to the poor, as well as luxuries and delicacies to the opulent; many a town and village on our coasts, many tons of shipping, and many tens of thousands of men, women, and children are exclusively engaged in the fisheries of Britain.

The scientific arrangement of the numerous tribes of Fishes is a difficult matter. Cuvier's is generally adopted, though it is not perfectly satisfactory, and to it we shall adhere. They are divided into two great groups, or Sub-classes, the Cartilaginous Fishes, whose skeleton is composed of cartilage, and the Proper Fishes, in which it is composed of bone. These groups must be considered as parallel to each other, yet as the former manifest most affinity to the animals which we have already described, we shall speak of them first.

SUB-CLASS I. CHONDROPTERYGII.*

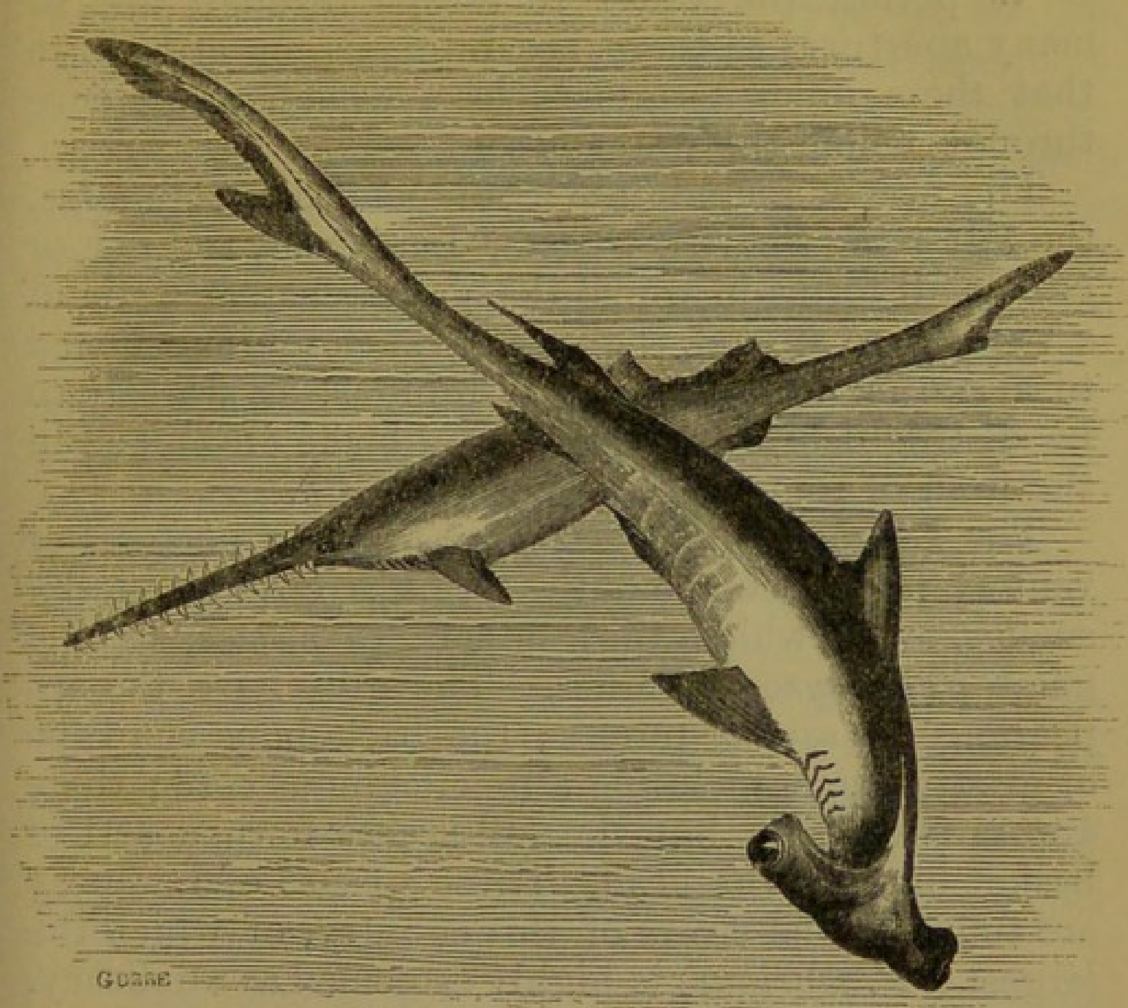
(*Cartilaginous Fishes.*)

The largest and most formidable of all Fishes are found in this division. "The peculiar structure of their skeleton, which gives rise to their name, admits of these animals continuing to grow as long as they live; the consequence of which is, that as they inhabit the wide ocean, and have few enemies, they are sometimes met with of such an enormous size that their weight and dimensions are almost incredible."† The Great Sturgeon of the East of Europe is sometimes found fifteen feet in length, and weighing two or three thousand pounds: the Hammer-headed Shark is as large or larger; the Saw-fish, another species of Shark, has been taken twenty-two feet long, and of the weight of eleven thousand pounds. The dreaded White Shark, that terrific monster of the tropic seas, is said to attain the length of twenty-five feet, and the Basking Shark, occasionally taken on the British shores, has been seen thirty-six feet long. To mention no others, the Horned Ray, a powerful and ferocious monster, is said to reach a length of twenty-five feet, combined with a width of thirty.

The distinguishing character of this Sub-class is the cartilaginous structure of their bones; the particles of earthy matter which give firmness and hardness to the bone, being deposited in these animals in the form of small grains, and not in fibres. Their skull is formed of a single piece without *sutures* or

* This term is a compound of two Greek words, signifying that the fins are composed of gristle or cartilage.

† Swainson.



HAMMER-SHARK AND SAW-FISH.

joining lines; and some of the bones of the face and of the spine, which in other fishes are separate and jointed, are in these soldered, as it were, into a single piece. The jelly-like substance, which we have already spoken of, as filling the funnel-shaped cavities of the *vertebræ*, and passing through a narrow hole in the centre of each, is in most of these animals a cord nearly uniform in thickness, running through the whole spine.

Some of the gristly Fishes manifest an agreement with the bony Fishes in having the gills free, with a single wide opening, and protected by a gill-cover, but destitute of rays. Others differ from these as well as from all other Fishes, in not having the gills free on their outer edge, and opening all their intervals into a single large orifice, but adhering by that edge, so as to permit the water to escape through just so many apertures as there are intervals, or at least so that these holes terminate in a common aperture through which the water is sent.

The former include the Sturgeons and Chimæras, the latter the Sharks, Skates, Lampreys, and one or two small forms in which the grand characteristic of a Vertebrate animal, the internal skeleton, is reduced to a rudiment so slight and dubious, as scarcely to be distinguished from the horny blade enveloped in the flesh of some of the CEPHALOPODA.

The Lampreys (*Petromyzidæ*) have no pectoral or ventral fins; their mouth forms a circular fleshy sucker, with which they adhere to stones, as the name *Petromyzon* signifies. The gills have the appearance of sacs or purses; the back bone is a tube of gristly rings, inclosing a mucilaginous cord; there are no true ribs; but the gill-arches form a sort of basket beneath the head. Three species of Lamprey are found in the rivers of this country, of which the largest (*P. marinus*) is highly esteemed as a delicacy. It is rich and somewhat unwholesome; one of our early monarchs, Henry I., is said to have owed his death to a surfeit on this, his favourite fish. It is taken in the Thames, is about two feet in length, of a yellowish hue, mottled with brown. Sir W. Jardine states, that when they wish to deposit their spawn, as they cannot plough a furrow in the gravel, like most other river fishes, owing to the form of their muzzle, they set about excavating one by removing the pebbles one by one, lifting them out by means of their sucker-mouth.

The Family of the Skates (*Raiadæ*) have the body flat, and exceedingly wide, owing to the great breadth of the pectoral fins, which project on each side in a triangular shape, and are united in front of the muzzle. The ventrals are also wide. The shape of the body is thus rhomboidal, or "diamond form;" and it is abruptly produced into a long, slender, but muscular tail, which commonly carries two dorsals.

There is no distinct head, but the eyes are on the upper surface; the mouth, nostrils, and gill-openings on the lower. Eight or nine species are found on the British coasts; the flesh of which is wholesome and well-tasted, though rather hard. The skin is commonly roughened with points, which in some rise into bony tubercles bearing sharp spines, and the tail is always thorny. The Skate's "mode of defending itself, as described by Mr. Couch, is very effectual: the point of the nose and the base of the tail are bent upwards towards each other; the upper surface of the body being then concave, the tail is lashed about in all directions over it, and the rows of sharp spines frequently inflict severe wounds."*

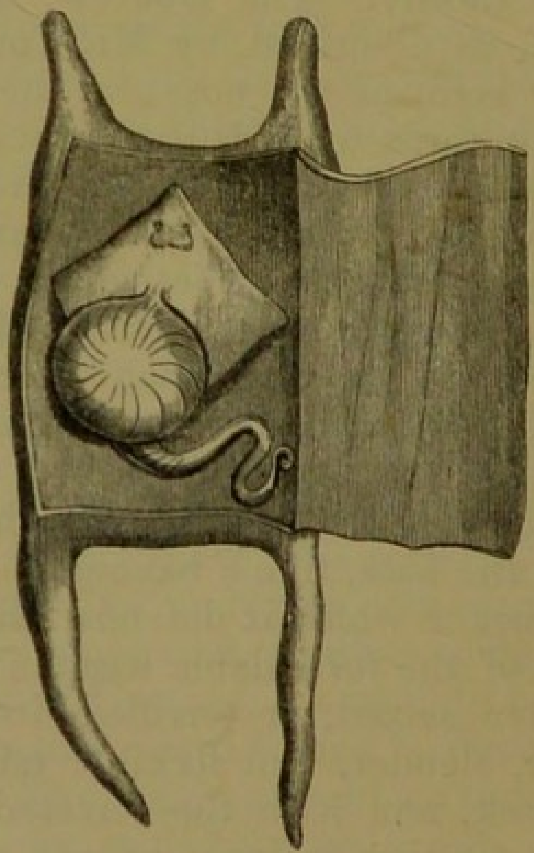
A species sometimes taken in the English Channel, and known to the fishermen by the name of Fire-flaire (*Trygon pastinaca*), is still more formidably armed; for the tail is furnished with a stiff, bony spine, cut into notches along each side, which projects from the base, like a bayonet.

"The manner in which it defends itself shows its consciousness of the formidable weapon it carries on its tail. When seized, or terrified, its habit is to twist its long, slender, and flexible tail round the object of attack, and with the serrated spine, tear the surface, lacerating it in a manner calculated to produce violent inflammation."†

The eggs of the cartilaginous Fishes are far less numerous than those of the bony tribes. Those of the Skates and the Sharks are singular in their appearance and structure. They are of large size, and resemble in shape a butcher's tray, or rather two trays placed face to face, and united. They have also been compared to a pillow-case with the corners lengthened; and on the coast of Cumberland they are called Skate-barrows, from the resemblance in shape to the common four-handed machine by which two men carry goods. The texture of the shell is rough, like horn, and the colour is generally a clear

* Yarrell's Brit. Fishes, ii. 415. † Ibid. ii. 443.

yellowish-brown. On cutting them open, we discover the glaire and yolk, or the embryo in various stages of forwardness. The accompanying figure represents the young nearly ready for birth, but in some cases, the enclosed fœtus more nearly fills the cavity, and is packed with the broad pectorals bent over the back, and the tail coiled round the body.



EGG OF SKATE.

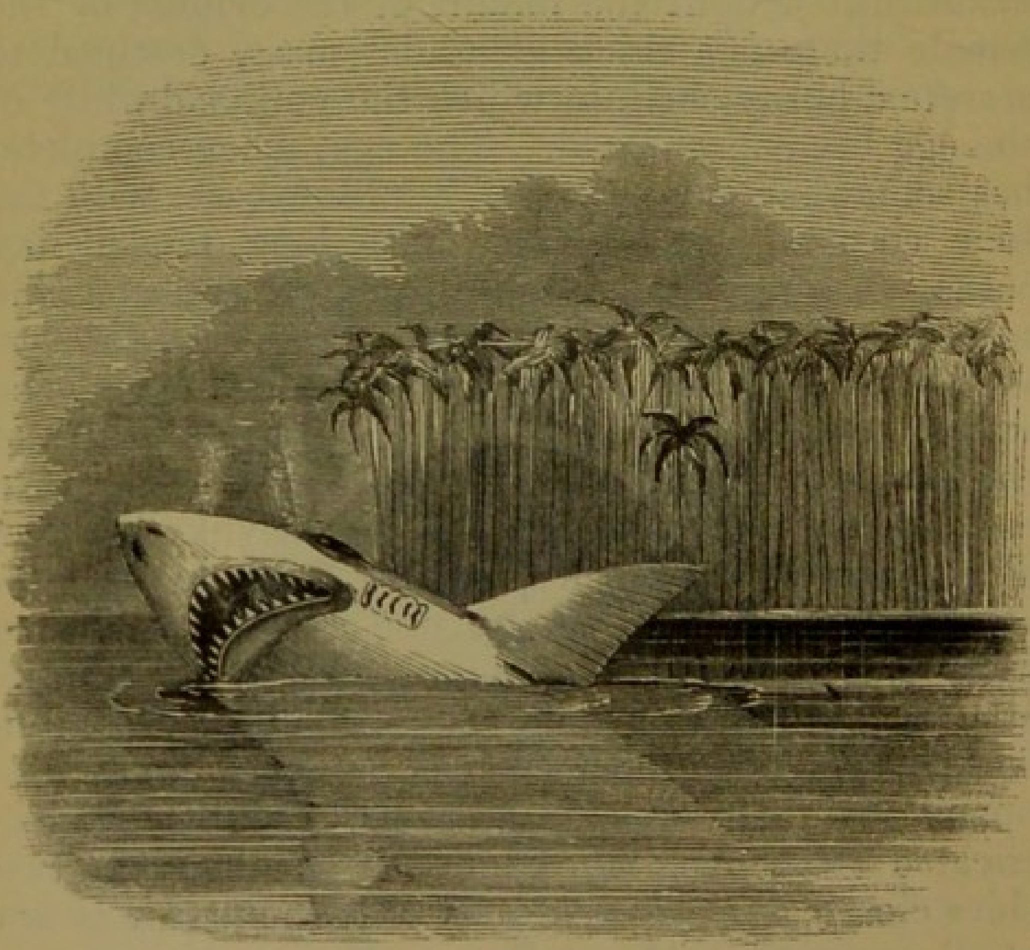
The egg of the Sharks (*Squalidæ*) closely resembles that of the Skates, but displays additional contrivances for the well-being of the young animal. All God's creatures, however repulsive or formidable they may be to us, are the objects of his care: "He hateth nothing that He hath made;" and, therefore, we are not surprised to find special provisions for the safety of even the destructive and dreaded Shark. It is a general law in nature, that the most carnivorous and powerful animals should increase slowly, or they would desolate the creation; the eggs of the Shark are but few; but, then there is a danger, lest, being few, they should be easily destroyed, and the species become extinct. Their safety, therefore, is jealously guarded.

"The means employed for this end are simple and beautiful. About the middle of the oviduct of the female there is a thick glandular mass, destined to secrete a horny shell, in which the yolk and white of the egg become encased. The egg, when complete, has somewhat the shape of a pillow case, with the four corners lenthened out into long tendril-like cords, whereby the egg is entangled amongst the seaweed at the bottom of the ocean. A brittle egg-shell would soon be destroyed by the beating of the waves, hence the necessity for the corneous nature of the envelope; and yet how is the feeble embryo to escape from such a tough and leather-like cradle? This likewise has been provided for: the egg remains permanently open at one extremity, or, to carry out our humble simile, one end of the pillow-case is left unsewn; the slightest pressure from within, therefore, separates the valvular lips of the opening, and no sooner has the little Shark thus extricated itself from its confinement, than the two sides close again so accurately that the fissure is not at all perceptible."*

The great White Shark (*Carcharias vulgaris*) is the scourge of the tropical seas, and the object of terror and hatred to seamen. Many wild tales of its voracity are on record, some of which are sufficiently full of horrors: its size and strength are enormous, and the many rows of lancet-like teeth, with which its jaws are armed, are sufficient to sever the limbs or even the body of a man at a snap. One peculiarity has sometimes saved the life of an intended victim, and disappointed the monster of his prey. Owing to the projection of the muzzle, the mouth is placed considerably beneath the head, and hence in seizing any object at or near the surface, the Shark is obliged to turn over on its

* Jones's Gen. Outl. 535.

side, an awkward action, and requiring some little time to effect. It is probable that the food of this terrific creature is commonly found at the bottom,



WHITE SHARK.

and consists of dead fishes, whales, &c., for the devouring of which, a mouth so situated would be admirably adapted.

Happily this animal is unknown in our seas; but many species of the tribe, with similar structure and instincts, though smaller and less formidable, are common, and are mostly known as Dog-fishes, Spotted Hounds, &c. They are hated by fishermen, for the depredations they commit on the shoals of more valuable fishes, to get at which they often cut to pieces the nets, with their serried rows of teeth.

Among the most curious forms of this Family are the Saw-fish (*Pristis*) and the Hammer-head (*Zygæna*), both of which we have figured in a preceding page. In the former the muzzle is prolonged into an immense flat bony blade, which projects horizontally in front, into the sides of which are set sharp and strong teeth, the whole constituting a most terrific implement for the laceration of an enemy. The latter has the sides of the head widened out like a double-headed hammer, with the eyes placed at the lateral extremities.

THE STURGEON (*Acipenser Sturio.*)

The general form of the Sturgeons (*Sturionidæ*) resembles that of the Sharks, but the head is more pointed, and armed with bony shields: the body is angled, and studded with several rows of conical knobs of bone, bearing some resemblance to the spines of the Thornback. The mouth is destitute of teeth. One species is frequently taken in the Thames, and finds its way to our fish-markets, as the flesh is much esteemed; it is thought to resemble veal. But the rivers of Russia, particularly those that fall into the Black and Caspian Seas, are most noted for Sturgeons, some kinds of which there attain a great size. Other species inhabit the rivers of North America. The roe of the Sturgeon forms the delicacy called *caviare*, and the air-bladder is made into *isinglass*.

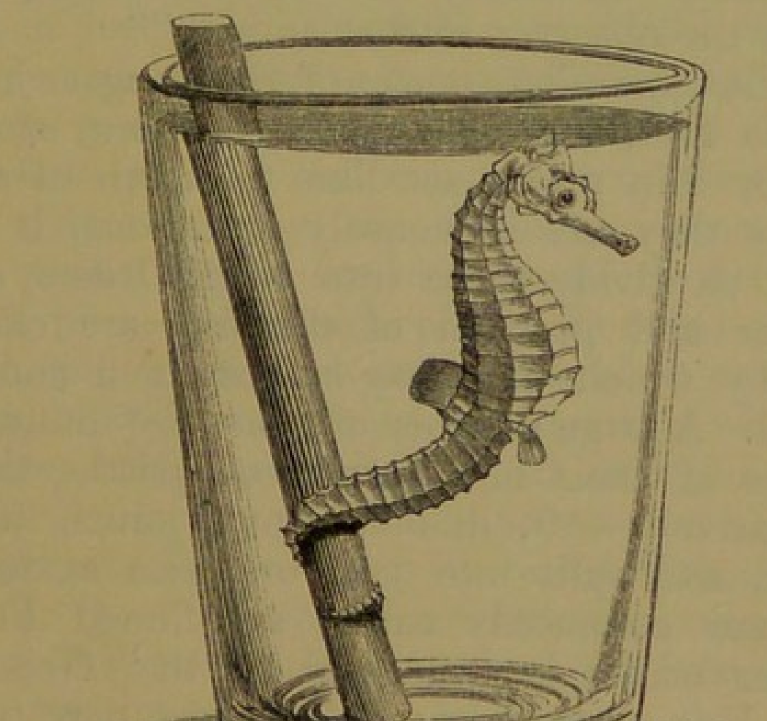
SUB-CLASS II. OSSEI.

(*Bony Fishes*).

The true or Osseous Fishes constitute a far more numerous host than the Cartilaginous tribes. They are arranged by the great French zoologist in six Orders, of which the first is represented by species very few of which are ever seen in our seas. They are the Trunk fishes (*Ostracion*), which are enclosed in a sort of bony box, the surface of which is cut into regular mathematical figures; the File-fishes (*Balistes*), which are covered with large hard scales, as rough as the teeth of a file, and have a curious spine on the back, which, on being erected, springs into an immoveable position, like the trigger of a gun; the Porcupine-fishes (*Diodon*), whose bodies are covered with sharp spines, and are capable of being inflated like a blown bladder, when the spines stand stiffly out on every side; and the Sun-fishes (*Orthagoriscus*), sometimes taken on the British coast, with a short, high body, a long and pointed dorsal and anal, and the tail so short as to present the appearance of the front-half of a fish cut off. All these species agree in having the bones of the jaws soldered together, as it were, having no power of independent motion; hence the Order is named PLECTOGNATHI, from Greek words expressing this peculiarity.

The next Order is termed LOPHOBRANCHIATI, signifying *Tuft-gilled.* They have the bones of the jaws free, and are distinguished by having the gills arranged in small round tufts, disposed along the arches in pairs, a structure which has no parallel in other Fishes. They are generally of small size and singular form, but their economy is still more singular. The female of the Opossum and Kangaroo, as is well known, is furnished with a pouch under her abdomen, into which the young is transferred at a very early period of its existence, and in which it remains until ready to behold the world. These little fishes have a similar pouch, which receives the eggs, and contains them till they are hatched. But strange to say, it is here the male, not the female, that is so provided; and who thus acts as *wet-nurse* to the infant progeny.

The members of the Order are known as Pipe-



SEA-HORSE.

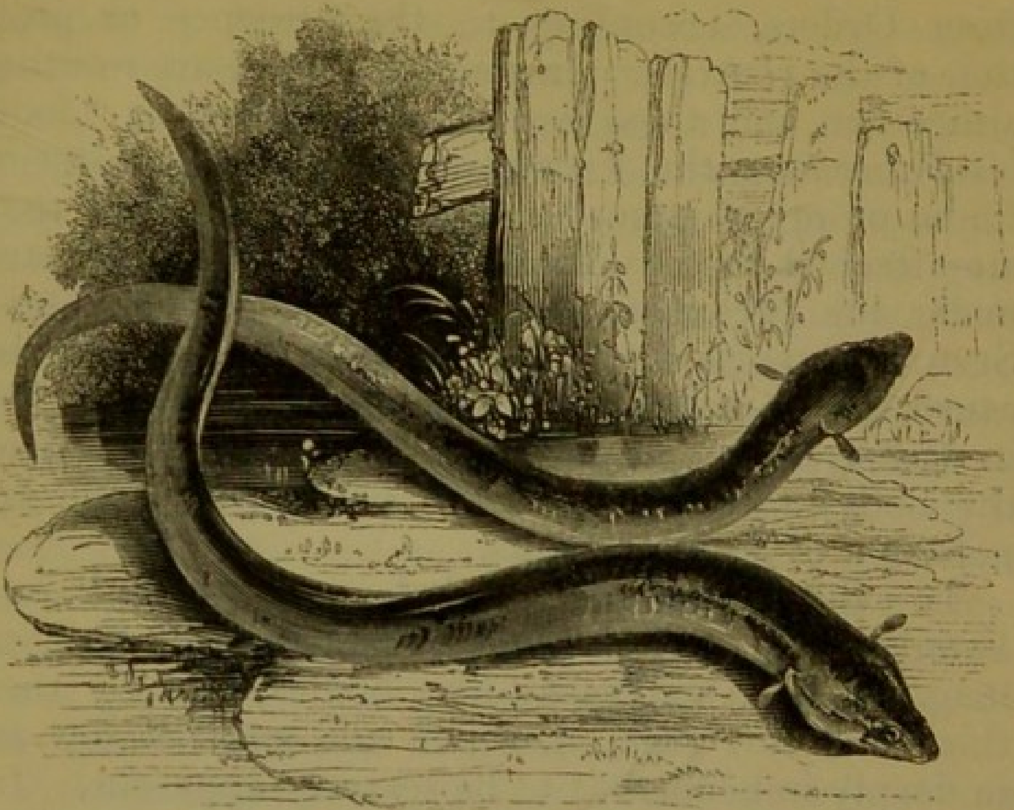
fishes (*Syngnathus*) and Sea-horses (*Hippocampus*); most of the species are found in the British seas, and are often dried, and preserved as curiosities, for their singular shape. The accompanying figure represents one of the latter genus, the habits of which have been observed and described in an interesting manner by Mr. Lukis. "When swimming about, they maintain a vertical position; but the tail is ready to grasp whatever meets it in the water, quickly entwines in any direction round the weeds, and, when fixed, the animal intently watches the surrounding objects, and darts at its prey with great dexterity. When two approach each other, they often twist their tails together, and struggle to separate, or attach themselves to the weeds; this is done by the under part of their cheeks or chin, which is also used for raising the body when a new spot is wanted for the tail to entwine afresh. The eyes move independently of each other, as in the Chameleon; this, with the brilliant changeable iridescence about the head, and its blue bands, forcibly reminds the observer of that animal."

All the remaining species of Fishes agree in having the gills free, and arranged in the form of parallel fibres, or thin plates, set like the teeth of a comb. Still, as they are immensely numerous, it is convenient to divide these into other Orders, and the character and position of the fins are chosen as marks by which they may be arranged and discriminated. A large number of fishes are found to have the rays of their fins formed of gristle, therefore comparatively soft, divided into joints, therefore flexible, and split into two branches at the end. These are commonly called soft-finned Fishes, a character which is expressed by the Greek compound, MALACOPTERYGII. The rest have the front rays of the dorsal, or the whole of the first dorsal, if there be more than one, stiff and spiny; there are also some spines always in the anal, and at least one at the front of each ventral. They are thence termed ACANTHOPTERYGII, or Spiny-finned. Among fresh-water fishes, the Trout will serve as a familiar example of the former, and the Perch of the latter; while the Herring and the Mullet bear the same relation to each other among sea-fishes.

The Soft-finned fishes are again subdivided into three Orders, according to the presence or position of the ventrals. In some these fins are wanting altogether, and these are termed APODA, or "footless," because the ventrals represent the posterior limbs of other animals. In a large number they are attached to the shoulder-bones, and are situated under the pectorals, and these are thence named SUB-BRACHIATI, signifying "under the arms," because the pectorals represent the fore-limbs. But in the great majority the ventrals are situated on the belly, whence this Order has received the appellation of ABDOMINALES.

To the Order APODA belong the well-known Family of Eels, *Anguilladæ*, distinguished by their long, slender, and snake-like bodies, and by their thick and soft skin, in which the small scales are so deeply imbedded as to be scarcely apparent. Indeed most persons are scarcely aware of the existence of scales in these familar fishes, but they will be readily discovered by the following process, and form a pretty object for microscopical observation. "Take a piece of the skin of the Eel that grows on the side, and while it is moist spread it on a piece of glass, that it may dry very smooth; when thus dried, the surface will appear all over dimpled or pitted by the scales, which lie under a sort of cuticle, or thin skin: this skin may be raised with the sharp point of a penknife, together with the scales, which will then easily slip out, and thus you may procure as many as you please."

Three or four species of Eels are found in our fresh waters, known as the Sharp-nosed, the Broad-nosed, the Snig, and the Grig, but whether the last is a distinct species has not been yet ascertained. The first of these, represented in the accompanying engraving, is the most common. Another species, called the Conger, inhabits the seas that wash our coasts. All these are valuable as food, for though the flesh of the great Conger is somewhat coarse, it is eaten in considerable quantities by the poorer



SHARP-NOSED EEL.

classes of persons resident in seaport-towns. This species attains ten feet in length, and sometimes weighs a hundred and twenty pounds.

The other species are not confined to the fresh waters, but spend a part of every year in the sea, travelling backwards and forwards. Sir Humphrey Davy observes:—"There are two migrations of Eels, one *from*, the other *to*, the sea; the first in spring and summer, and the second in autumn, or early in winter;—the first of very small Eels, which are sometimes not more than two, or two and a half inches long; the second, of large Eels, which sometimes are three or four feet long, and weigh from ten to fifteen or even twenty pounds. There is great reason to believe that all Eels found in fresh water are the results of the first migration: they appear in millions in April and May, and sometimes continue to rise as late even as July and the beginning of August."*

That Eels will quit the water and roam over low-

* Salmonia.

lying meadows, especially during the night, and when the atmosphere is damp and sultry, is now a well established fact.

The consumption of Eels in London is very great. The supply is chiefly drawn from Holland, whence they are brought in capacious boxes beneath the surface of the water, and kept alive till wanted. Each Dutch vessel brings a cargo of fifteen or twenty thousand pounds weight of live Eels, and one or more is constantly lying in the Thames, near Billingsgate, to meet the demand of that great metropolitan market.

The power of communicating electric shocks is possessed by several fishes, but by none so powerfully as by a member of this Family. The *Gymnotus*, or Electric Eel, is a native of Guiana, but the large specimen which was so long preserved alive at the Adelaide Gallery, in London, has made us familiar with its formidable powers. The shock is given as a means of disabling other fishes on which it preys, and the intensity seems to depend on the will of the animal. "I was so fortunate," observes Professor Owen, "as to witness the experiments performed by Dr. Faraday on the large Gymnotus. That the most powerful shocks were received when one hand grasped the head and the other hand the tail of the Gymnotus, I had painful experience; especially at the wrists, the elbows, and across the back. But our distinguished experimenter showed us that the nearer the hands were together, within certain limits, the less powerful was the shock. He demonstrated by the galvanometer that the direction of the electric current was always from the anterior parts of the animal to the posterior parts, and that the person touching the fish with both hands received only the discharge of the parts of the organs included between the points of contact. Needles were converted into magnets; iodine was obtained by polar decomposition of iodide of potassium; and, availing himself of this test, Professor Faraday showed that any given part of the organ is negative to other parts before it, and positive to such as are behind it. Finally heat was evolved, and the electric spark obtained."*

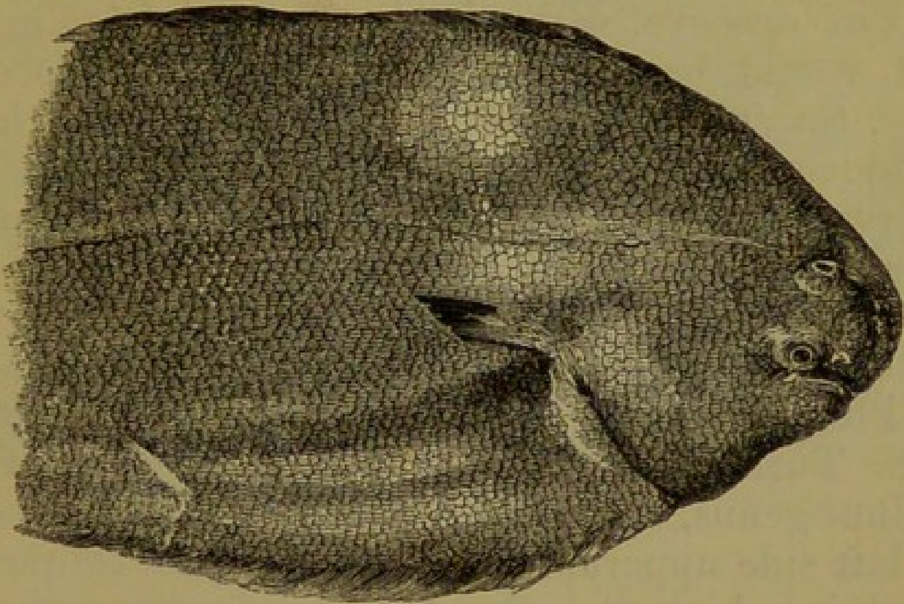
The organs which thus produce electricity are very large, occupying the greatest portion of the body of the animal; so great indeed that, to use the words of the eminent physiologist just cited, "the proper body is, as it were, a mere appendage tacked on to the fore part of the enormous batteries." These organs, as in the Cramp-fish or *Torpedo* of our own seas, consist of a great number of cells, formed of extremely delicate membranous plates; these cells are differently placed in the two fishes, so that, to compare them with a voltaic pile, the batteries are horizontal and the plates vertical in the Gymnotus, and the reverse in the Torpedo.

The next Order, SUB-BRACHIATI, which has the ventrals placed beneath the pectorals, is almost entirely occupied with two great Families of Fishes, as valuable as they are extensive. The one is that of the Flat-fishes (*Pleuronectidæ*),† containing the noble Turbot and Brill (*Rhombus*), the valuable Sole (*Solea*), the gigantic Halibut (*Hippoglossus*), the Plaice, the Flounder, and the various species of Dabs and Flukes (*Platessa*), all of which in a greater or less degree are in estimation as human food. These fishes are remarkable for the absence of that symmetry of exterior form which is found in all except the very lowest Classes of animals. "Their form is very deep, but at the same time very thin, and they are not constituted to swim as other fishes do, with the back uppermost, but lying upon one side. They reside wholly upon the bottom, shuffling along by waving their flattened bodies, fringed with the dorsal and anal fins; and as they are somewhat sluggish in their movements, they need concealment from enemies. This is afforded to them

* Lect. on Comp. Anat. ii. 216.

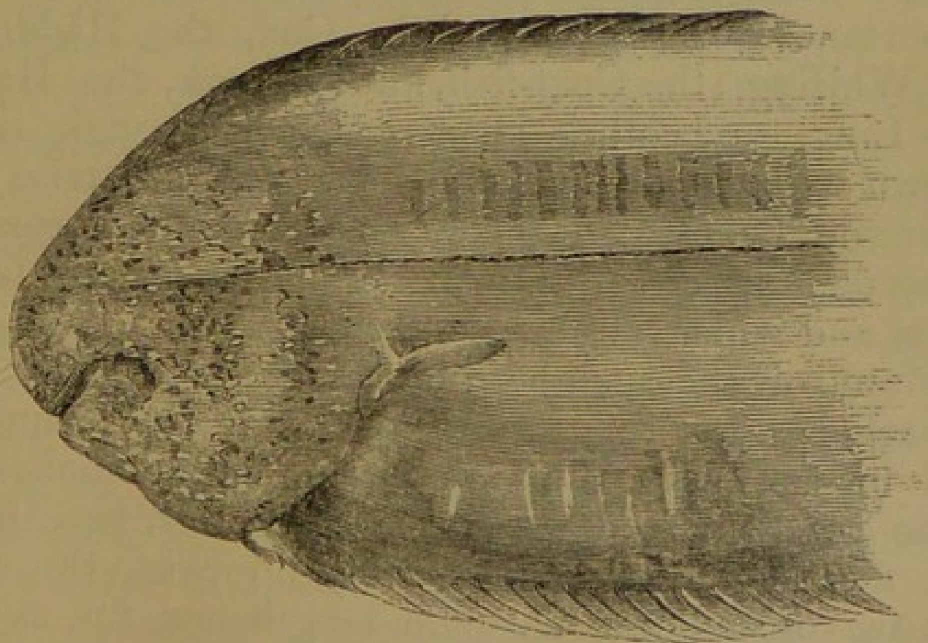
† A term signifying "swimmers on the side."

by the side which is uppermost being of a dusky brown hue, undistinguishable from the mud on which they rest; and so conscious are they where



UPPER SIDE OF THE SOLE.

their safety lies, that when alarmed, they do not seek to escape by flight, like other fishes, but sink



UNDER SIDE OF THE SOLE.

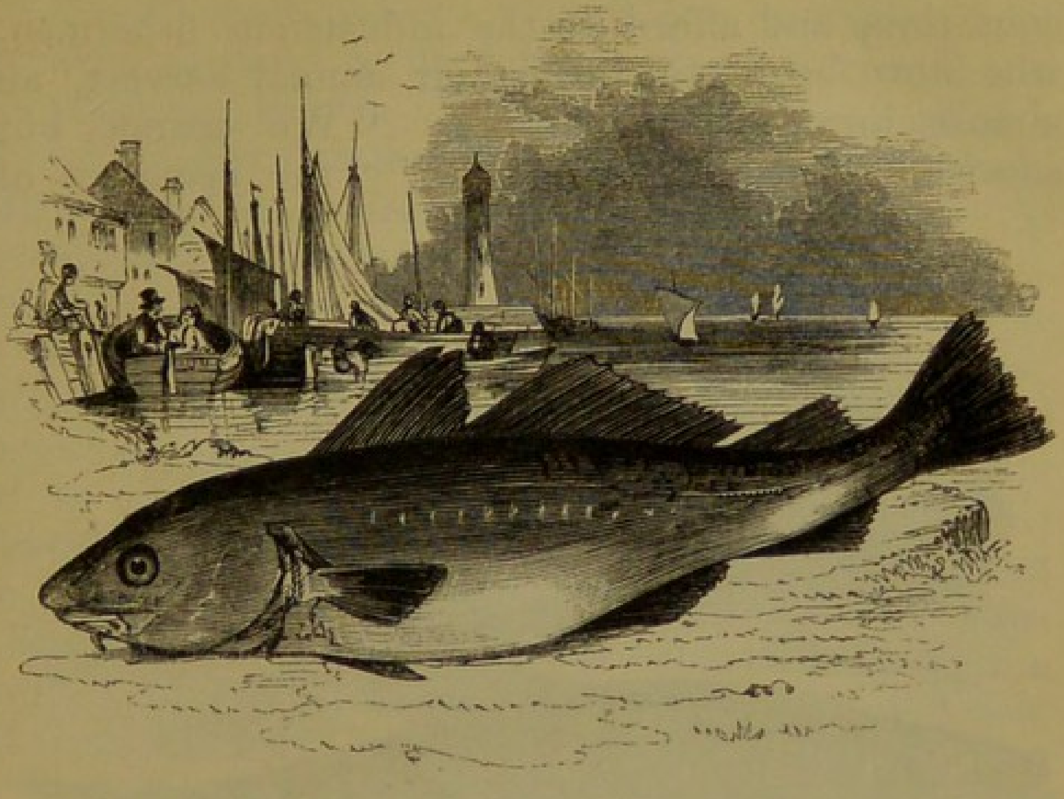
down close to the bottom, and lie perfectly motionless. In the structure of the head, again, there is a peculiar and very remarkable provision for the wants of the creature. If the eyes were placed as in all other animals, one on each side of the head, it is plain that the Flat-fishes, habitually grovelling in the manner described, would be deprived of the sight of one eye, which being always buried in the mud, would be quite useless. To meet this difficulty, the spine is distorted, taking, near the head, a sudden twist to one side; and thus the two eyes are placed on the side which is kept uppermost, where both are available."

The side which is furnished with eyes and with the dark colour varies in the different genera; in the Plaice, Flounder, and Sole, it is the right side; in the Turbot, and Brill, it is the left, while of the Halibut genus, some species have the right and some the left side uppermost. Individuals are frequently found in which the proper order is reversed, and occasionally both sides are coloured; but these are casual exceptions. The value of these Fishes may be estimated from the fact, that London pays to the Dutch 80,000*l*. every year for Turbot alone.*

The other Family (*Gadidæ*) is even still more important; for it contains the Cod, the Haddock, the Whiting, the Coal-fish, the Pollack, the Hake, the Ling, and other species which, though little known with us, are valuable in other countries for their wholesome and savoury flesh, which forms an important article of human food, both in the fresh state, and when salted and dried.

Many of the members of this great Family are remarkable for the number of their fins: thus it will be seen that the Cod has no fewer than ten, three dorsals, two pectorals, two ventrals, two anals, and a caudal. In some species, however, the dorsals are united into a single lengthened fin, as are also the anals. Most of them also have fleshy beards or tentacles depending from the lower jaw. The fishery for the Cod is the most valuable in the world, the pursuit, the curing, and the transport affording

* Encyc. Brit. Art. FISHERIES.

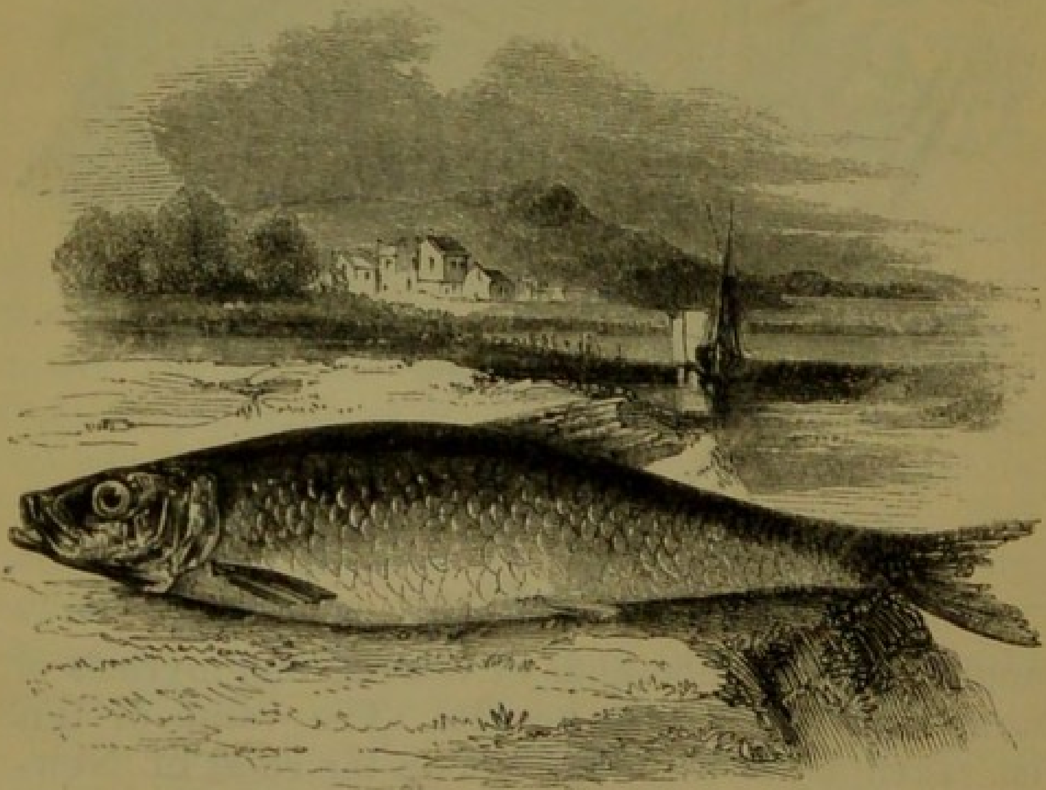


THE COD.

employment to thousands of vessels, and myriads of hardy and industrious people. The value of this fish taken by British subjects on the coast of Newfoundland is not less than 500,000*l.* annually.

We now arrive at that extensive Order named ABDOMINALES, from the position of the ventral fins under the belly. Most of our fresh-water Fishes are found in this group, and therefore it is the one most interesting to the angler: it includes also some valuable marine species. The Family of the Herrings (*Clupeadæ*) is of the latter sort; and as it includes, besides the true Herrings, two species of which are British, the Pilchard, the Sprat, the Whitebait, the Shad, and the Anchovy, its value to man will not be readily over-estimated.

The Common Herring (*Clupea harengus*) is very abundant all round the British coasts, but is little seen except at spawning-time. In August and September immense hosts of this excellent fish approach the shore, for the purpose of depositing their eggs; they are at this time in the very best condition, and afford to the industrious fishermen, who now begin to reap their annual harvest, an almost inexhaustible supply. "We cannot but admire," observes Mr. Couch, "the economy of



HERRING.

Divine Providence, by which this and several other species of fish are brought to the shores, within the reach of man, at the time when they are in the highest perfection, and best fitted to be his food." After they have spawned, they become emaciated and unfit to be eaten, a "shotten Herring" being proverbially worthless: they retire into deep water, where they remain until the autumn again brings them into view.

The Herring fishery of these islands employs twelve thousand boats, and about ninety thousand men, of whom fifty-five thousand may be fishermen, and the remainder curers, coopers, &c., and produces five hundred thousand barrels of cured fish, besides the immense quantities that are distributed through the country and eaten fresh.

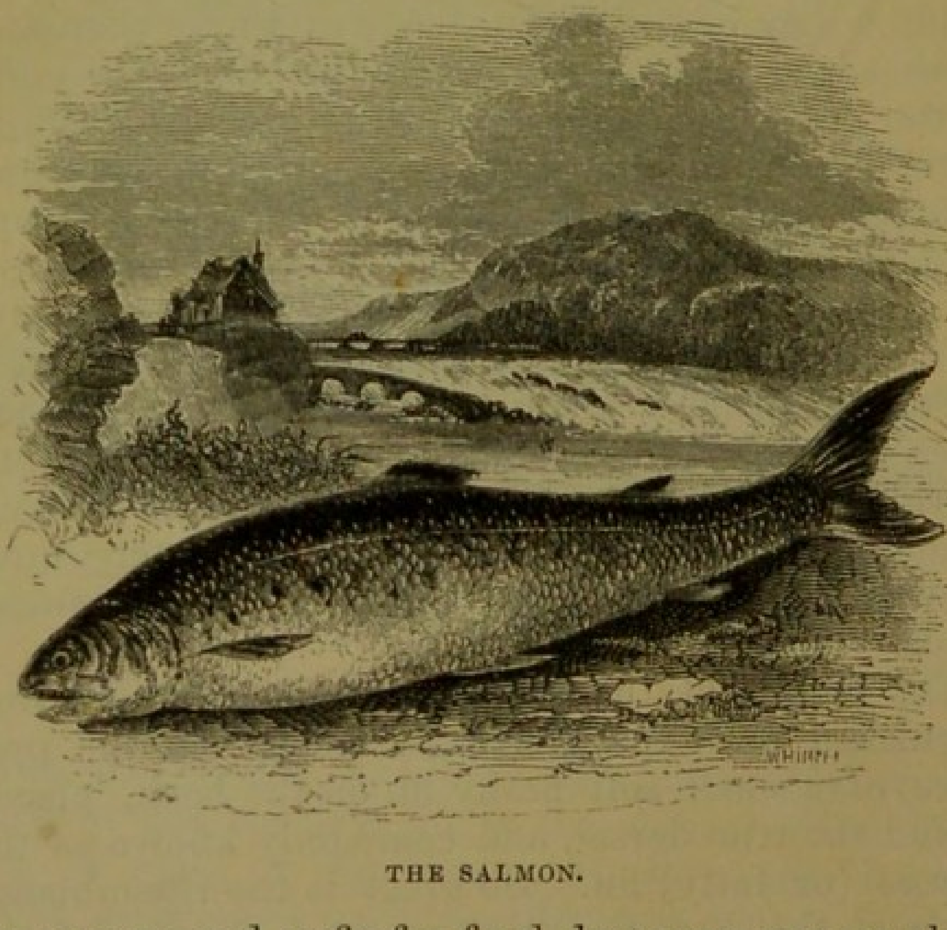
The Pilchard fishery, though less extensive, is of great importance to the inhabitants of Cornwall and Devonshire, to the coasts of which it is confined. It is a smaller fish than the Herring, which it otherwise much resembles: eight or nine inches may be considered as its average length. It gives employment to about a thousand boats, and to eight or nine thousand persons, of whom three thousand five hundred may be fishermen. About thirty thousand hogsheads are exported annually, chiefly to the ports of the Mediterranean; but a very great quantity is retained to be consumed in this country, either cured or fresh. In the season of 1835, the quantity supplied to the home market was estimated at twelve millions of Pilchards: they are often sold at the rate of from 1*s.* to 1*s.* 3*d.* per hundred.

Ten thousand hogsheads of Pilchards have been taken on shore in one port in a single day, "thus providing," says Mr. Yarrell, "the enormous multitude of twenty-five millions of living creatures drawn at once from the ocean for human sustenance."

The Family of the Salmons (*Salmonidæ*) are distinguished from the Herrings, chiefly by the presence of a small soft fleshy fin on the back, placed behind the true dorsal, and commonly known as the *adipose* (or fatty) fin. So great is the resemblance between the Families, that an Irish species of the *Salmonidæ* is commonly known by the appellation of fresh-water Herring.

The Salmon (*Salmo salar*), the largest and most valuable of the Family, is a well known inhabitant of our coasts and rivers. It is found in all the temperate and Arctic seas, whence in spring it enters the large rivers, making its way towards their sources with an energy and determination that are not easily surmounted. They shoot up rapids with great velocity, and leap cascades to the height of several yards, and though they often fail in their attempts, and fall backwards, they continue to renew their efforts with wonderful perseverance. The object of this migration is to reach the gravelly beds which are found in the shallow pools at the upper part of the stream, where the spawn is to be deposited.

The fish when relieved of their burden again seek the sea, descending the rivers from pool to pool in the early part of the spring. At this time they



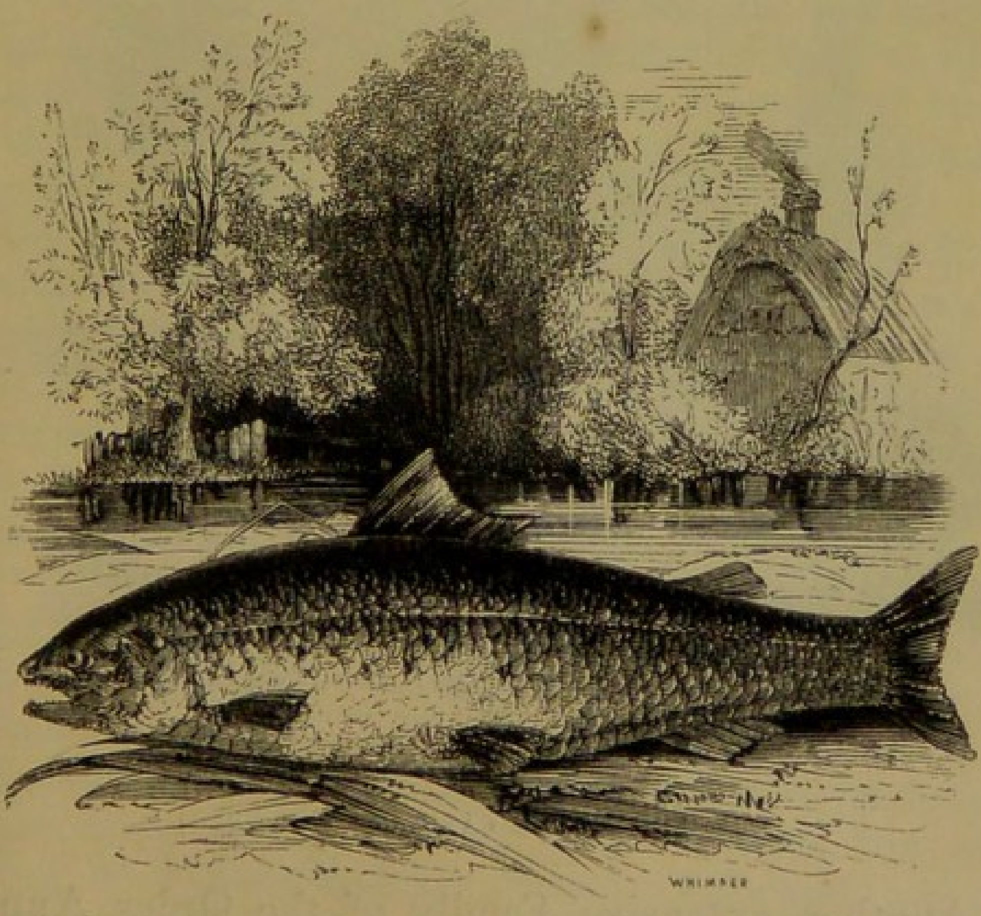
THE SALMON.

are meagre and unfit for food, but soon recover their condition in the salt water.

The principal Salmon fisheries are in the friths and rivers of Scotland, whence the London market is mostly supplied. As this branch of industry has never been the subject of either tax or bounty, no accurate estimate can be made of its extent. The rivers on the coast of Sutherland are stated to have yielded in 1835 two hundred and fifty-eight thousand two hundred and ninety-one pounds of Salmon, while the total quantity brought by sea to London from Scotland and Ireland in the same year was supposed to be twenty thousand cwts. The fish is packed with ice in boxes, to preserve it from decomposition.

Many years ago, great quantities of Salmon were taken in the Thames, but that species of sport has been annihilated, in all probability by the influx of poisonous ingredients which flow in from gas works, and other numerous modern innovations, introduced during the last fifteen years.

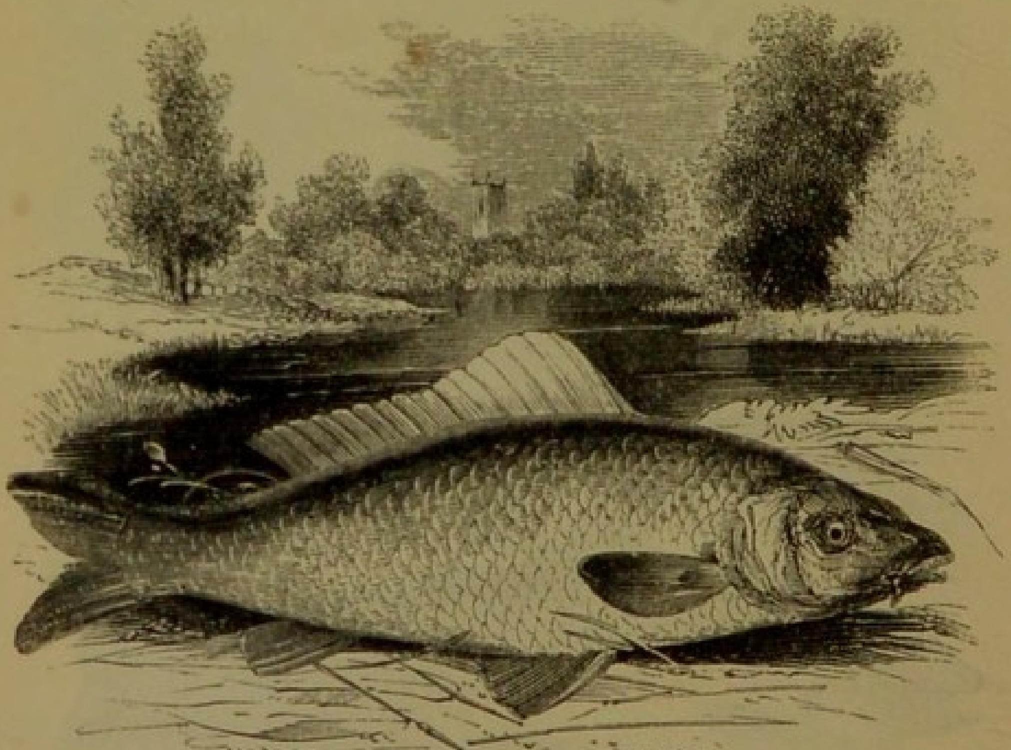
Mr. Lloyd describes a simple but effective mode of taking Salmon at Deje, in Sweden, where this fish is very abundant. By rocks or artificial embankments, a portion of the river is divided into several small



THE COMMON TROUT.

channels. On each of these, two sluices are constructed, one at each end, capable of being opened or closed at pleasure. The fish having once entered these traps, are prevented from returning, and the water being allowed to run off, they are taken out, even by hand, without the least difficulty. Five hundred, and even eight hundred Salmon are thus taken in a single day; though at the same locality, notwithstanding their abundance, they invariably refuse a bait.*

The speckled Trouts, of which besides the favourite of anglers (*Salmo fario*) there are four species marked as British; the Golden Charr of the mountain lakes (*S. salvelinus*), and the Grayling (*Thymallus vulgaris*) with its thymy odour, and high dorsal banded like a butterfly's wing, with several other of our native fishes, belong to the Family *Salmonidæ*.



THE CARP.

Another extensive Family of the Order Abdominales is that of the Carps (*Cyprinidæ*). It includes many of our most familiar river-fishes, as the Common Carp (*Cyprinus carpio*), of which we have two other species besides that brilliant little gem of the waters, the Gold-fish (*C. auratus*), the Barbel, the Gudgeon, the Tench, the different sorts of

* Field Sports, &c., i. 302.

Bream, the Roaches, the Dace, the Chub, the Bleak, the little Minnow, and the still smaller Loach.

The mouth in these fishes is of small size, and the jaws feeble ; there are commonly strong teeth in the throat, but none in the jaws ; the scales are large and thick. They have only one dorsal fin. Many of the species are vegetable feeders, and they are remarkably tenacious of life ; it is said that a Carp or a Tench will live for weeks in a bag of wet moss hung up in the air in a cool place, provided it be occasionally moistened with cold water. The Dutch frequently keep them in this manner, feeding them with bread soaked in milk.

The Family of the Pikes (*Esocidæ*) are distinguished by the width of the mouth and the flatness of the head ; the teeth are numerous, sharp, and strong, but there are none in the upper jaw ; the dorsal is placed far behind on the lengthened body. The Common Pike (*Esox lucius*) is the tyrant of our waters, and as its voracity and boldness are remarkable, and as it sometimes grows to a great size, it is a formidable adversary. People's feet are sometimes seized by this ferocious fish when washing ; and Mr. Jesse has recorded some instances of its fearless attacks. "I have seen one," he observes, "follow a bait within a foot of the spot where I have been standing ; and the head-keeper of Richmond Park assured me that he was once washing his hand at the side of a boat, in the great pond in that park, when a Pike made a dart at it, and he had but just time to withdraw it. A gentleman now residing at Weybridge, in Surrey, informed me that, walking one day by the side of the river Wey, near that town, he saw a large Pike in a shallow creek. He immediately pulled off his coat, tucked up his shirt-sleeves, and went into the water to intercept the return of the fish to the river, and to endeavour to throw it upon the bank by getting his hands under it. During this attempt, the Pike, finding he could not make his escape, seized one of the arms of the gentleman, and lacerated it so much that the wound is still very visible."*

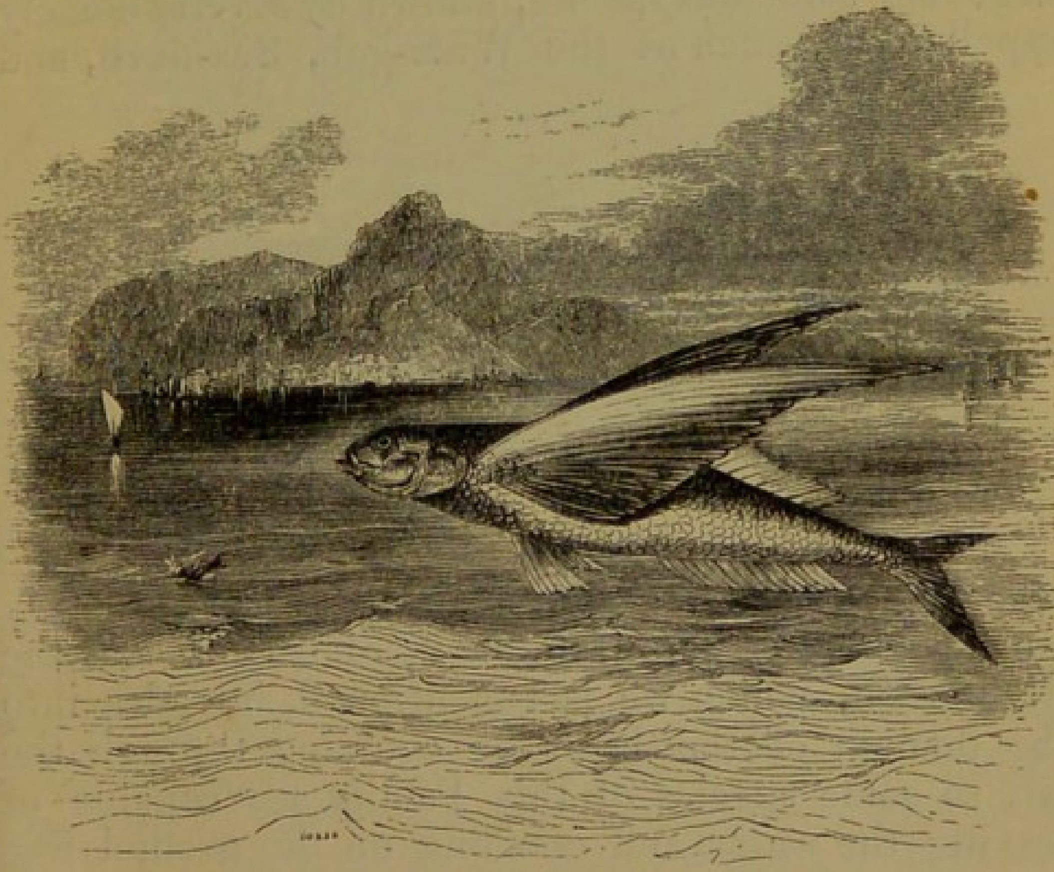
The Pike is commonly supposed to have been not originally a native of the British islands, but to have been introduced from the Continent; but it was well known in the time of Edward I., who regulated the market price of various kinds of fish, and also in that of Chaucer, who speaks of it as preserved for fattening in stews.

THE PIKE.

The Pike attains a great age:—Pennant mentions one ninety years old; and Gesner speaks of one taken out of a lake in Suabia, in 1497, to which was attached a ring, bearing date 1230, two hundred and sixty seven years before: it weighed three hundred and fifty pounds.† The skeleton of this gigantic fish measured nineteen feet in length, and was long preserved at Mannheim, as a natural curiosity. In 1765, one was captured at Newport Pagnell, in Buckinghamshire, which weighed one hundred and seventy pounds.

* Gleanings, p. 39. † De Piscibus, Introd.

That singular creature of two elements, the Flying-fish (*Exocœtus volitans*) belongs to the Pike Family. The fins are all very much developed, but the pectorals in particular are so long and large as to be capable of sustaining the fish in long flights through the air. From repeated and careful observations made expressly to ascertain this point, we can positively state that the Flying-fish has the

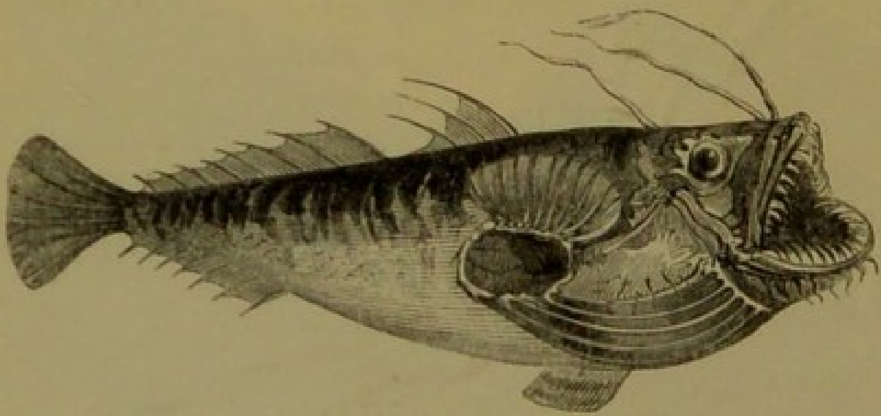


THE FLYING-FISH.

power of altering its direction while in the air; very frequently turning to one side, more rarely rising to avoid the summit of a wave; and we have seen a decided flapping of the pectorals, so that the action is truly a flight. They usually associate in flocks, all rising into the air at once, not exclusively, as we think, to escape pursuit, but in play. In the tropics several species are very common; it is rare in our latitudes, but four or five instances have occurred in which it has been seen on the British coasts.

We come now to the last Order of Fishes, those which have the front rays of their dorsal, ventral, and anal fins spinous, and which are on this account termed Acanthopterygii. It is divided into fifteen Families, some of which we are compelled to pass over, having room only for a short notice of the more important and interesting.

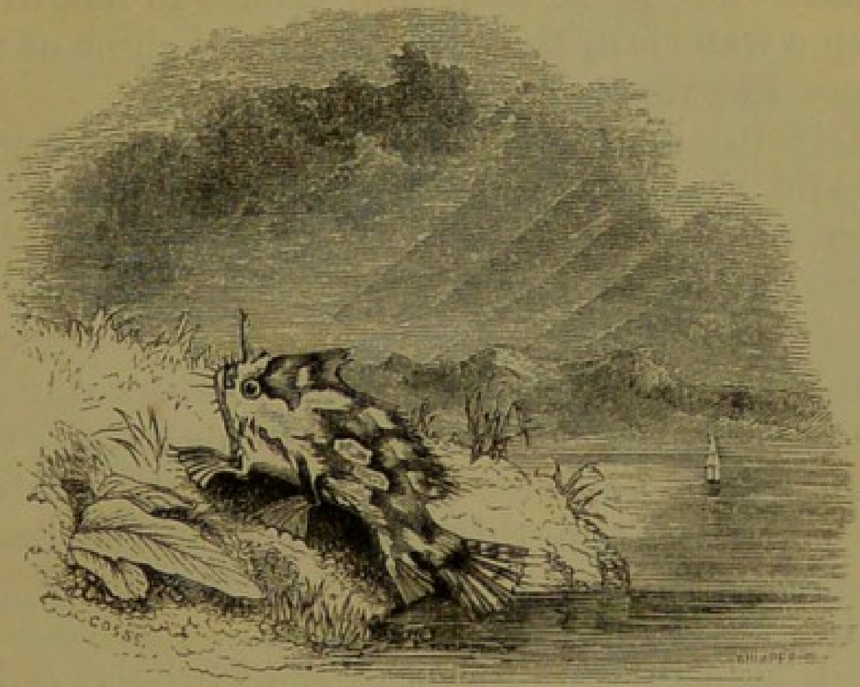
A small but very curious Family is that of the Anglers (*Lophiadæ*), represented in our seas by a large and voracious species, known by several homely appellations, such as the Wide-gab, Sea-devil, and



FISHING-FROG.

more commonly Frog-fish, or Fishing-frog. As the Flying-fish, which we last-mentioned, intrudes into the domain of the birds by coursing through the air, so some species of this Family are capable of leaving the water and crawling on the ground like a quadruped. The pectoral and ventral fins are shaped like hands, and projecting so far from the surface of the body as to expose the joints, are capable of being bent forward and used as feet, as represented in the accompanying figure of a little species which we once took in the Atlantic Ocean crawling and pushing its way among the tangled gulf-weed that formed large floating fields upon the surface. Our British species, however, is a large fish, sometimes attaining five feet in length.

The head, as will be observed, is furnished with one or two slender horns, divided at the tip into several processes resembling little worms. The use of these organs is very remarkable. The fish is not one of swift motion, and therefore cannot take its prey by pursuit: instead of this, it usually conceals itself among the mud at the bottom, or perhaps among the stalks of floating weed, while it agitates its curious



MARBLED ANGLER.

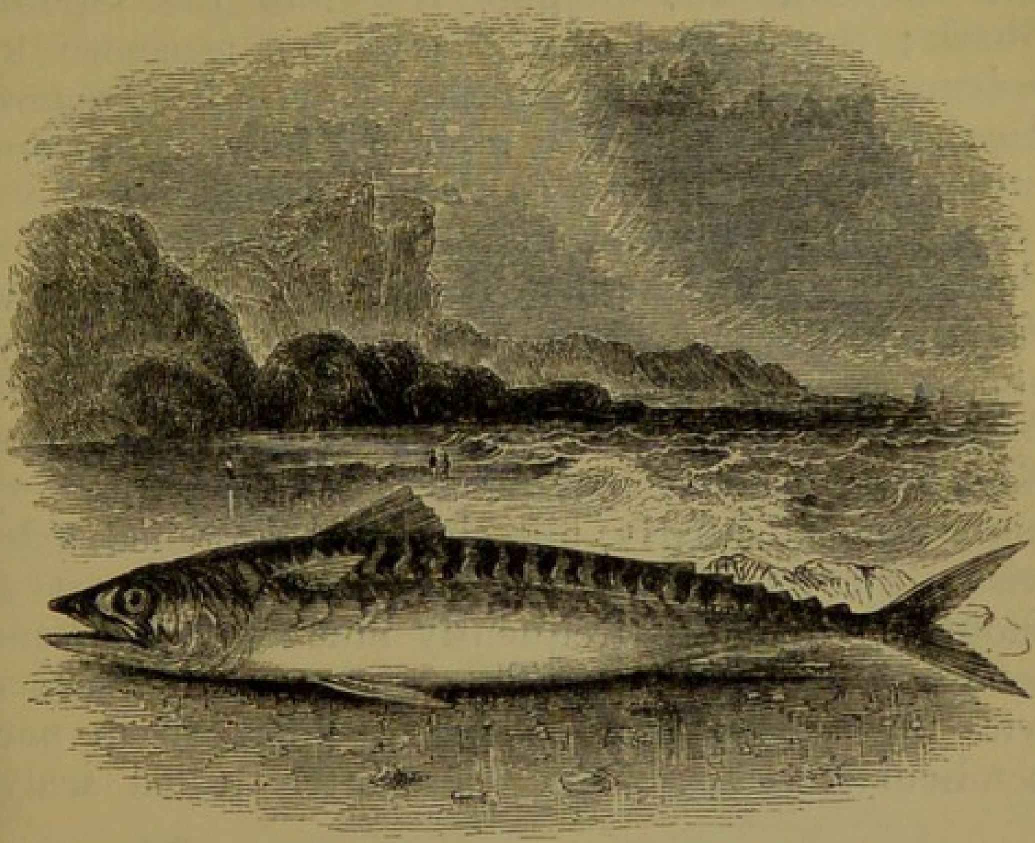
fleshy horns; their resemblance to worms and their motion attract other fishes, which, coming within reach, are seized by the capacious mouth of the latent Frog-fish. The lower jaw extending beyond the upper, causes the mouth to open perpendicularly, and the eyes are so situated as to look in the same direction, both of which arrangements facilitate the capture of prey by this singular mode. It is not improbable that the worm-like tentacles attached to the mouth and chin of other fishes, as the Cod and Barbel, for example, answer an end somewhat similar to this.

The Mullets (*Mugilidæ*) are valued for the excellency of their flesh, which is increased by confining them to fresh-water. They habitually live in the shallow waters near the shore, when the weather is warm, but often explore those rivers into which the tide enters. The thick rounded body nearly cylindrical, clothed with large, strongly-defined scales, the angular form of the mouth when closed, the two far-separated dorsals, and the situation of the ventrals behind the pectorals, distinguish these fishes. They are active and cunning; we have seen specimens not more than four inches in length leaping up a waterfall, the perpendicular height of which was not less than six feet.

Their intelligence may also be inferred from the skill and vigilance these fishes display in avoiding danger, more especially in effecting their escape in circumstances of great peril. The Grey Mullet, when enclosed within a ground-seine or sweep-net, as soon as the danger is seen, and before the limits of its range are straitened, and when even the end of the net might be passed, will frequently prefer the shorter course, and throw itself over the headline and so escape; and if one of the company passes all immediately follow.

With respect to the food of the Mullets, opinions differ, two of our most accurate observers arriving at very different conclusions. Mr. Couch, of Polperro, says, "It is indeed the only fish of which I am able to express my belief that it usually selects for food nothing that has life; although it sometimes swallows the common sand-worm." On the other hand, Mr. Thompson of Belfast remarks, that the stomachs of many individuals that he had examined presented "many hundred-fold greater destruction of animal life than he had ever witnessed on a similar inspection of the food of any bird or fish. From a single stomach he had taken as many univalve and bivalve mollusca as would fill a large-sized breakfast cup; so that one of these stomachs may justly be regarded as quite a storehouse to a conchologist."

The elegant and well-flavoured Mackerel (*Scomber scomber*) is the representation of another Family of this Order, to which it gives name (*Scombridæ*). Its gracefully tapering form, the rich hues of its back, gleaming in green and blue, with dark zebra-like bands, and the pearly opalescence of its sides, are known and admired by every one; and the solidity and delicate savour of its flesh are as universally esteemed. It has two dorsals, the hinder of which,

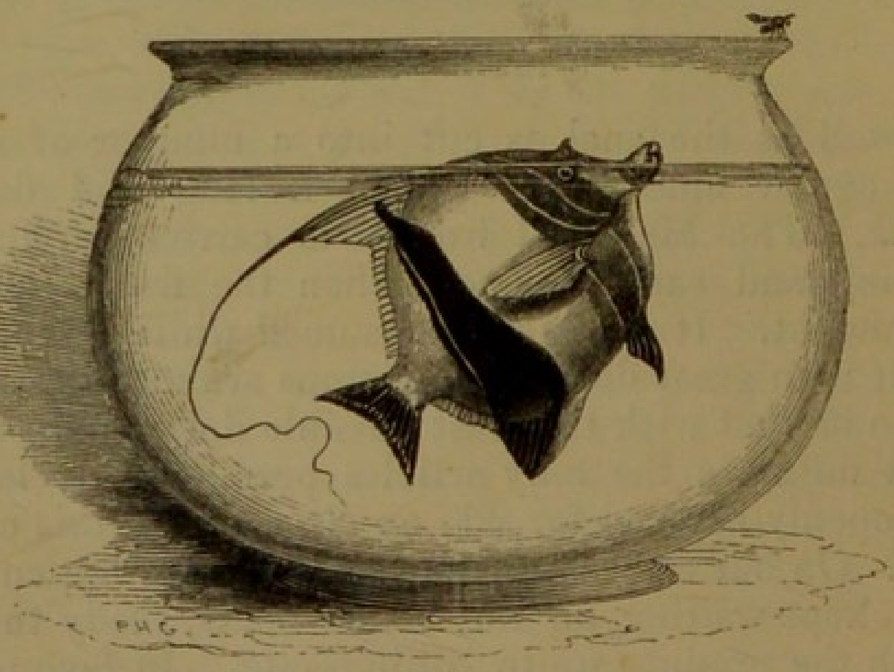


THE MACKEREL.

as well as the anal, is cut into a number of small triangular finlets: the caudal is long and deeply cleft. The Mackerel fishery is carried on in the spring and early summer, when the fish is always abundant. It is chiefly consumed while fresh, and as it is in great demand, exertions are made to bring it to market with the least possible delay. Mackerel and milk are the only articles permitted by law to be openly hawked for sale on Sundays in this country. On our South-eastern coasts fast-sailing cutters are kept waiting on the fishing-boats, ready to run with the produce up to Billingsgate. In favourable seasons, one hundred thousand Mackerel are brought to this great metropolitan market every week.

The Mackerel family includes several other Fishes worthy of mention; such as the Tunny and the Bonito (*Thynnus vulgaris* and *pelamys*), remarkable for having warm blood, and flesh as red as beef; the great Sword-fish (*Xiphias gladius*), the enemy of the Whale; the Pilot-fish (*Naucrates ductor*), the faithful attendant and humble friend of the terrible Shark; the John Dory (*Zeus faber*), esteemed by epicures; and the magnificent King-fish (*Lampris luna*), as beautiful as it is rare. All these and several others are found in the British waters.

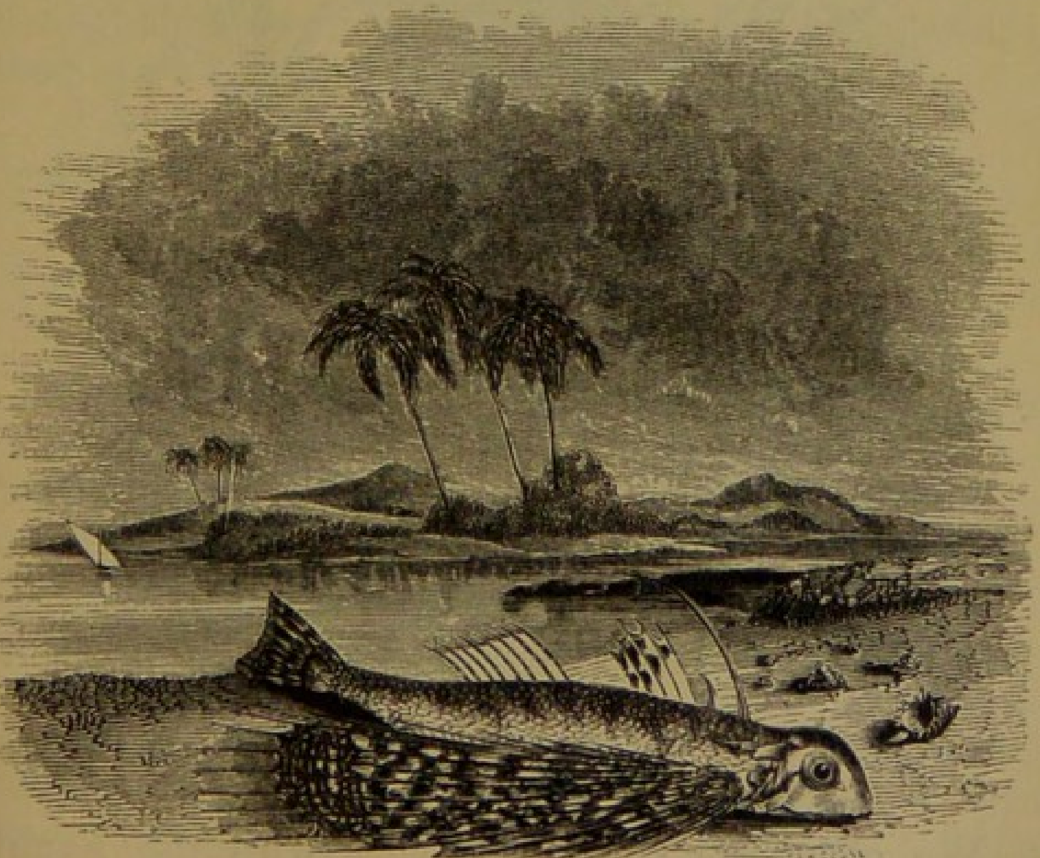
Our shores have produced a few specimens of a richly-coloured Fish called Ray's Sea-Bream, (*Brama Rayi*), interesting because it represents a Family, almost confined to the tropical seas, of very singular forms and habits. The Family is named *Chætodontidæ*, from the principal genus in it. They are very high perpendicularly, but thin and flattened sidewise; the mouth in some projects into a sort of snout, the fins are frequently much elevated, and send off long filaments. They are generally adorned with highly contrasted colours, which run in perpendicular bands. They are often called scaly-



HORNED CHÆTODON.

finned fishes, because the dorsal and anal are clothed, at least in part, with scales, so as not to be distinguished from the body.

The tubular snout of some, as of a little species, which we here represent, is applied to an extraordinary use, that of shooting flies! The fish approaches under a fly which it has discovered, resting on a leaf or twig, a few feet above the water, taking care not to alarm it by too sudden a motion; then, projecting the tip of its beak from the surface, it shoots a single drop at the insect with so clever an aim, as very rarely to miss it, when it falls into the water and is devoured. Being common in the Indian seas, it is often kept by the Chinese in vases, as we keep Gold-fishes, for the amusement of witnessing this feat. A fly is *fastened* at some distance, at which the fish shoots, but, disappointed of course, and wondering that its prey does not fall, it goes on to repeat the discharge for many times in succession, without seeming to take in a fresh stock of ammunition, and scarcely ever missing the mark, though at a distance of three or four feet.



ORIENTAL FLYING-GURNARD.

The Family of the Gurnards (*Trigladæ*), of which we have many native species, contains Fishes of singular appearance. The head and cheeks are armed with hard plates, sometimes running out into angular projections and fantastic points. In some the whole body is defended by sharp bony plates. The fins, especially the pectorals, are for the most part greatly developed, and often marked with brilliant colours. Such is the Sapphirine Gurnard (*Trigla hirundo*), which has these large butterfly-like fins of a brilliant sapphirine blue. But in the tropical seas, there are species in which the pectorals acquire the size and power of wings, so that they rise into the air like the proper Flying-fish. Their form will be seen from the accompanying figure of the Oriental Flying-gurnard (*Dactylopterus orientalis.*)

THE PERCH.

We close the Class of Fishes with the Family *Percadæ*, including not only the fresh-water and marine Perches, after which it is named, but also the Weevers and the Surmullets. The gill-cover is generally notched at its edge, or armed with projecting points; the scales generally hard and rough, with notched edges; the *vomer*, or middle ridge of the palate is set with teeth, as are the jaws and the palate.

The beauty of our Common Perch (*Perca fluviatilis*) is generally admired: the olive-green back, crossed by regular dark bands, the silvery-white sides, and the rich scarlet of the fins and tail, well set off its plump but graceful form; and as it prefers the vicinity of the bank to the middle of the river, as it is very common in our streams, and as it will readily take a bait, even from a schoolboy's hook; few of our fishes are better known. The flesh is delicate, firm, and well-flavoured.

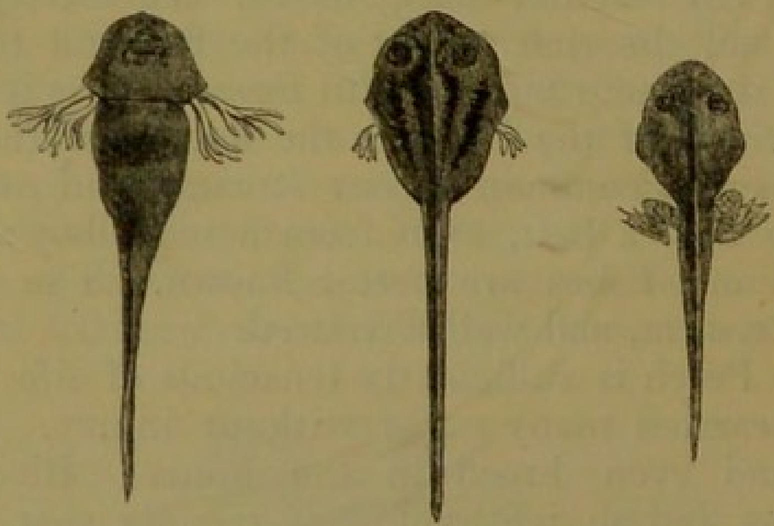
The Perch is sufficiently tenacious of life to bear to be carried many miles without injury. It will live and even breed in the house: Bloch, the eminent Jewish ichthyologist, records that he had the satisfaction of watching some Perch depositing their spawn in a vessel in his room.

CLASS II. AMPHIBIA.

(*Naked Reptiles.*)

In perusing the preceding pages, our young readers will have become familiar with the strange phenomena of *metamorphosis*, characterizing, as it does, the whole of the vast Class of Insects, and partially that of Crustacea. Those phenomena again present themselves to us in the economy of the animals before us, in which the change of form is so great as to require a change of the element in which they reside. Hence they are named AMPHIBIA, a term compounded of two Greek words signifying "living in both."

Examples of this peculiarity may be found in the most common of our native animals. Every one is aware that the Frog is, in its first condition of existence, a Tadpole, or little creature resembling a fish, inhabiting the water, which it breathes by means of gills, destitute of limbs, and furnished with a long muscular finny tail, so as to present scarcely a vestige of resemblance to its future form. But in process of time the tail is gradually absorbed till no trace of



TADPOLES.

it remains, four limbs bud forth, and grow into well-formed legs, with feet and toes, while at the same time the branched and tuft-like gills become smaller, until at length they are no longer visible. The eyes and mouth are now fully developed, and the colour, which in the Tadpole was black, has changed to a greenish olive, spotted with yellow; and the animal has assumed the appearance of a little Frog.

But while the gills, organs by which the vital oxygen has been hitherto separated from the water, have been gradually absorbed, another breathing apparatus has been developed in the cavity of the chest, consisting of two large membranous sacs, divided into numerous cells, over which the blood-vessels are spread in minute branches, as in the gills of Fishes. These organs, which constitute the breathing apparatus of all the remaining VERTEBRATA, are called *lungs*, and are fitted for separating oxygen from the air of the atmosphere, instead of from water; this fluid being periodically inhaled and rejected through the mouth and throat.

Another important character of these animals is found in the surface of their bodies; which is expressed by the designation which we have placed at the head of the Class, *Naked Reptiles.* They are not defended by plates or scales, nor clothed with hair or feathers. In general the skin is moist and clammy, and performs an important part in the process of respiration, accessory to the lungs. The skin of a Frog or Toad, while it remains moist, is capable of absorbing water, either from the element in which it swims, or from the damp earth, or from the moist atmosphere, and of separating from the fluid thus absorbed, the oxygen necessary to life. By a beautiful provision, the skin is endowed with the power of absorbing more water than can be respired at the time, and of storing up the superfluous stock in an internal reservoir for the purpose, where it remains uninjured, till it is wanted; from thence the moisture necessary to keep the skin in a respiring condition is supplied, when the animal happens to be placed in a dry situation. The skin is shed at irregular periods, becoming detached in shreds or patches.

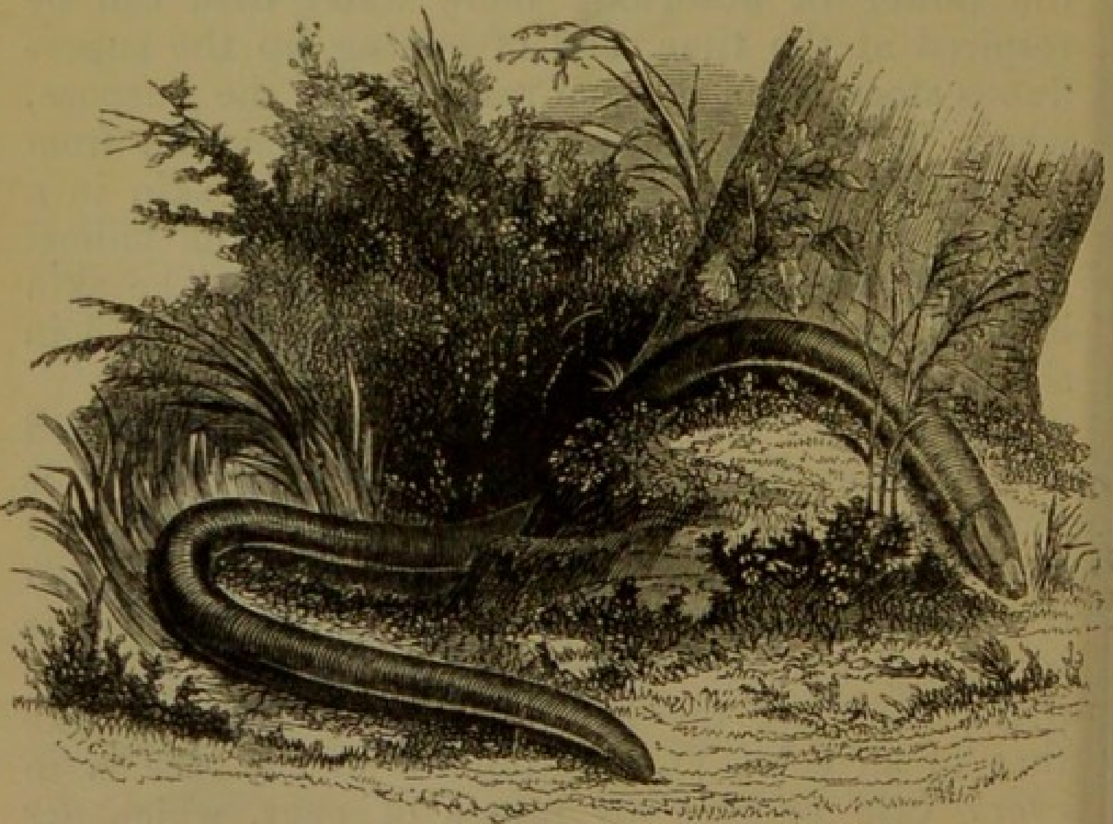
The form of these animals is generally lengthened and slender, though an exception to this rule is found in the Frogs and Toads, which in their adult condition, have a short, thick-set figure. They commonly possess two pairs of limbs; but some foreign genera are deprived of one or even of both pairs, and have the body greatly lengthened, like that of an eel. The continuance of the race is in every case effected by means of eggs, which are numerous, usually globular, pellucid, and destitute of a shelly covering, but frequently incased in a transparent jelly. The skeleton is destitute of a breast-bone (*sternum*), and also of ribs, except that slight rudiments of the latter are sometimes present: the skull is jointed to the first *vertebra* of the spine by *two* processes, resembling in this respect that of the Sharks and Rays, whereas in true Reptiles, there is but one process.

The species of this Class, which, as compared with those of others, are not numerous, are arranged in five Orders.

ORDER I. APODA.

(*Footless Amphibia.*)

The first three Orders of the Class before us are composed of a few singular forms, which deviate in some important points from the common characters of their fellows, and form interesting links of connexion with animals of other Classes. Thus the



TWO-LINED CÆCILIA.

Amphibia termed *Apoda* so much resemble certain Snakes, not only in form but in some particulars of internal structure, that the illustrious Cuvier actually arranged them with the Serpents.

They are small animals resembling a Worm or Snake in shape, the body being lengthened, cylindrical and quite destitute of limbs; the skin is apparently naked, and covered only with a slimy secretion, but marked with a great number of transverse wrinkles, like those of the common Earthworm. If these folds are raised with the point of a needle, they are found to conceal a great number of very minute overlapping scales, set like those of fishes. Gills are said to have been discovered in a young specimen, but no trace of them is to be seen in the adult.

These animals are natives of the hottest parts of America and India, where they are said to burrow in soft earth or mud; they swim freely, with an undulating motion. From the observations of Mr. Leperieur, they would seem to be viviparous. This gentleman, during his stay at Cayenne having procured a living specimen, which he placed in a vessel filled with water, saw it bring forth, in the space of some days, from five to seven young, perfectly similar to their mother.

ORDER II. ABRANCHIA.

(*Amphibia without gills.*)

A few creatures found in the Southern United States constitute this limited group. They are exceedingly like Eels; the body being greatly lengthened, smooth and flexible; and though they have four limbs, these are so minute, so rudimentary, and placed so far apart, as scarcely to affect this eel-like contour. The toes on these feet are scarcely more than little pimples.

These animals appear to form an exception to the universality of *metamorphosis* in the Class. They habitually reside in the water, but are exclusively air-breathers; no gills having been observed at any stage of their life, though there is an orifice on each side of the neck. The eyes are small, and the bones of the spine present both in front and rear that concavity which marks the *vertebræ* of Fishes.

The species figured below grows to the length of eighteen inches, but there is another kind which attains the size of three feet. They are some-

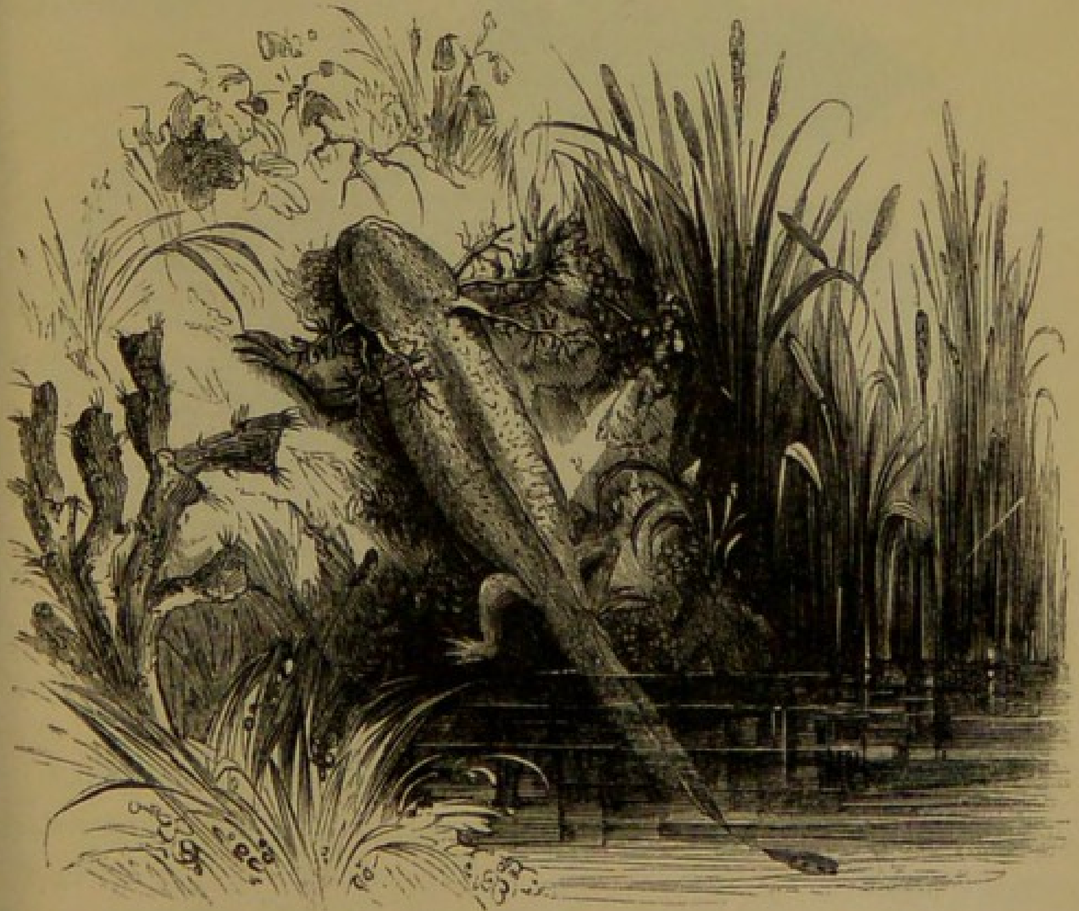
TWO-TOED AMPHIUMA.

times found, by persons engaged in digging foundations, burrowing in great numbers through the soil three or four feet below the surface. They inhabit also stagnant ponds, ditches, and lakes; or lurk under the trunks of decaying trees in moist woods. As the jaws and palate are furnished with small teeth, it is probable that worms and aquatic insects form their chief food:—but we do not know much about their habits.

ORDER III. AMPHIPNEUSTA.

(*Doubly breathing Amphibia.*)

As we have just spoken of some species of the present Class which appear to be destitute of gills at any period, we now, on the other hand, meet with some which possess these organs throughout their whole existence, as well as lungs. These better deserve the name of *Amphibia* than any others, inasmuch as they are capable of performing the important vital function of respiration in a two-fold manner, and in either of two elements, *at the same time*. They do not undergo a proper metamorphosis.

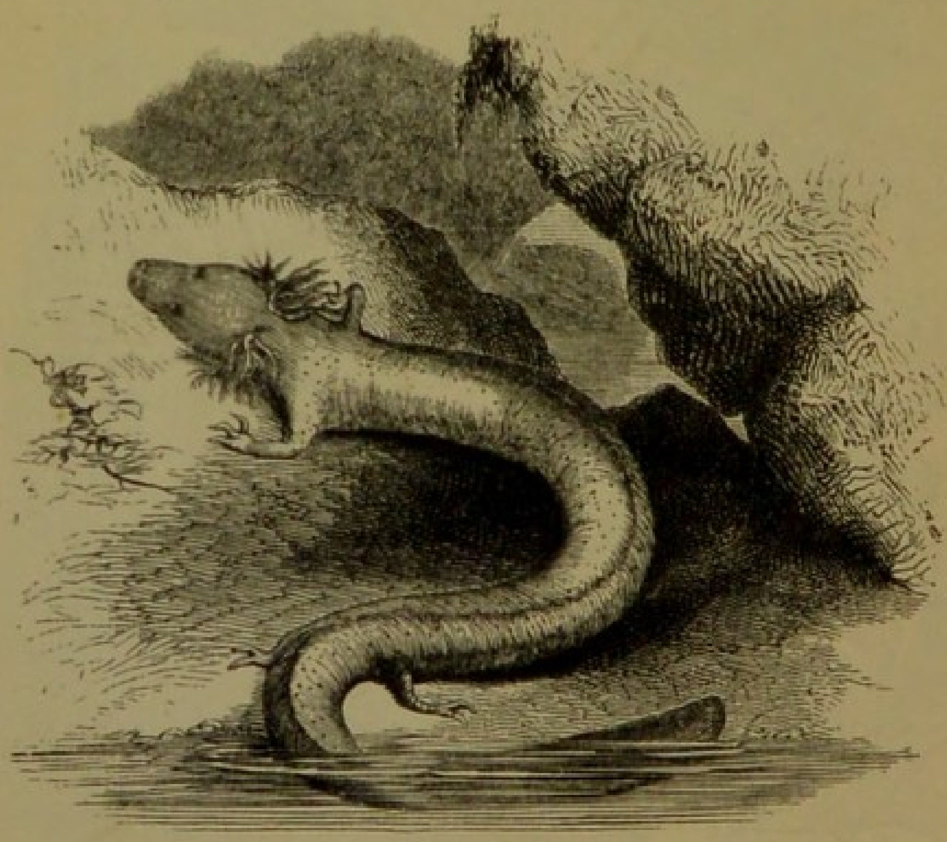


THE AXOLOTL.

The gills project from orifices on each side of the neck, and take the form of branched tufts, as may be seen in the accompanying figure of the

Axolotl (*Axolotus pisciformis*), an animal inhabiting the lakes of Mexico.

It is about ten inches in length, and much resembles the tadpole of a Newt, which it was long supposed to be. Repeated observations, however, have proved that this is the permanent form of the creature. It is said to be commonly sold in the market of Mexico, and to be esteemed as a luxury by the inhabitants; it is dressed in the manner of stewed eels, and served up with rich sauce. Humboldt declares that he found it savoury and wholesome. Lake Champlain in Canada produces a species much resembling this, but three or four times as large.



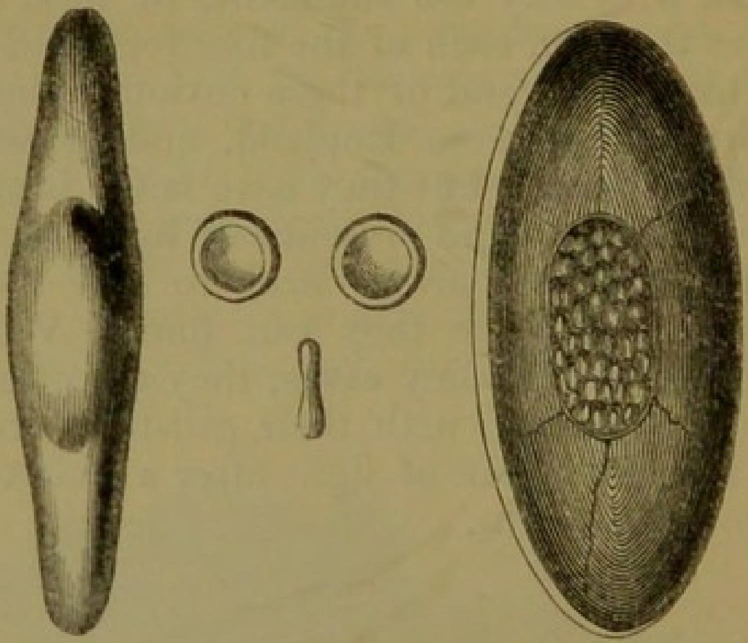
PROTEUS.

A still more celebrated species is the Proteus of Austria (*Proteus anguinus*), which swims in the dark waters of the great caverns of that country, where the light of day never penetrates. Sight in such situations would be an useless endowment, and hence we find these singular creatures, like other animals which live only in the recesses of caverns, totally blind. The feet, in the Axolotl of which we last spoke, are well formed, and sufficiently large; but in the Proteus, they are very small, and are furnished with only the rudiments of toes, of which there are three on each of the fore feet, and but two on the hind. Several of these curious animals have been brought alive to England, and preserved for a considerable time, but they have never been known to eat anything. The presence of light seems painful to them, as they always seek to hide themselves in the darkest place they can find. When first taken from their gloomy caves, they are of a whitish or pale flesh-colour, with their gill-tufts crimson or pink; but the action of light after a time turns the body to an olive tint.

SKELETON OF SIREN.

Another North American genus, closely allied to the above, differs from it in the total want of the hinder limbs. It is called the Siren. A few years ago a healthy specimen of *Siren lacertina* was living in the Zoological Gardens in Regent's Park: it was kept in a tub of water with mud at the bottom, into which it was fond of retiring: it was fed upon earthworms, of which it would devour eighteen or twenty every second day.

In the Penny Cyclopædia, (vol. xxii. p. 61) are recorded some interesting observations by Professor Owen, on the size of the blood-disks (commonly called globules) in the AMPHIBIA as compared with



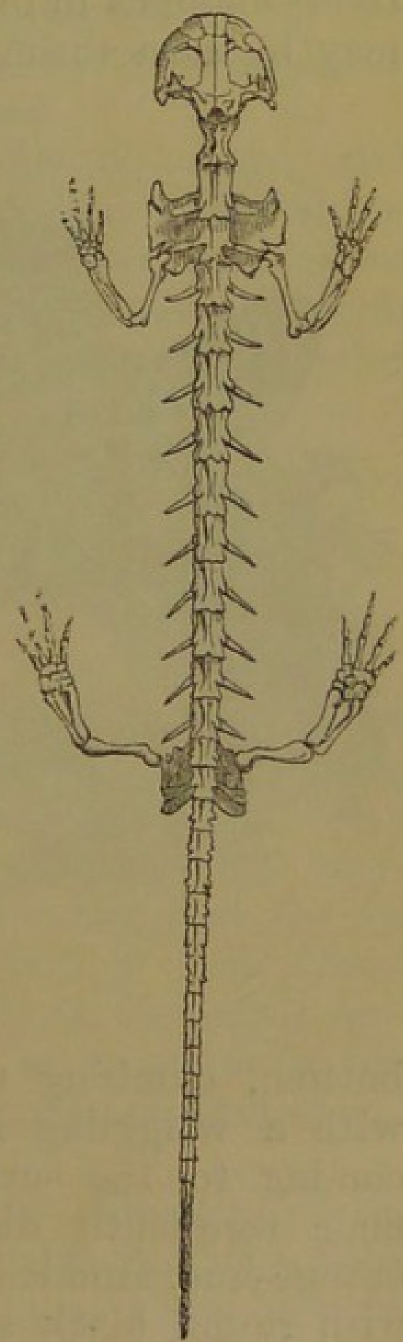
BLOOD-DISKS OF SIREN AND OF MAN.

other animals. Their size in these Reptiles is very great, and their magnitude seems to bear a proportion to the permanency of the external gills, or *branchiæ*. In the doubly breathing animals before us, the *Sirens* and *Protei*, these disks are so large as to be distinguishable even with the unassisted eye, while their appearance under a microscope is exhibited in the accompanying figures. The large oval figures exhibit their form as seen directly and sideways; the smaller ones represent the human blood-disk for the purpose of comparison; both are magnified seven hundred times in linear dimensions. The blood from which the former figures were taken was obtained from one of the external gills of a *Siren lacertina* twenty inches in length, which was then (1841) living at the Zoological Gardens, Regent's Park. Though subjected to examination immediately, the large figure shows in the crossing lines, traces of folds produced by the partial drying of the external capsule.

ORDER IV. URODELA.*

(Salamanders and Newts.)

We are now come to those AMPHIBIA which undergo the metamorphosis already described. The Newts and Salamanders that constitute the present Order, as well as the Frogs and Toads which we shall presently describe, agree in this character, that they pass through a tadpole or larva condition, in which respiration is aquatic and performed by means of gills only, and that afterwards these organs are exchanged for lungs capable of breathing air alone. The principal distinction between the two Orders is that the Newts do not lose the tail when they pass out of the tadpole state, but retain it large, long, and well developed through life; but on the other hand, the Frogs, as we have already observed, have no traces of this member in their mature condition.



SKELETON OF SALAMANDER.

The accompanying figure of the skeleton of one of these animals will display its general form and structure: the body is slender, lengthened, and lizard-like; the limbs are four, well formed, and furnished with the full number of toes; the *vertebræ* are numerous and flexible, the ribs numerous but very short.

* "Having a conspicuous tail."

Some foreign species are aquatic only in the tadpole state, and these are properly called Salamanders; but those with which we are familiar are aquatic throughout life, and are commonly known as Newts, or Water-Efts.

The beautiful little Smooth-newt (*Lissotriton punctatus*) abounds in our ditches and ponds, in which it may be seen through the summer crawling on the

SMOOTH-NEWT.

bottom, climbing up the water-plants, swimming with a wriggling motion through the stream, or coming to the surface to breathe the air. The male frequently displays his belly of the richest orange-hue, studded over, as is also the olive back, with round black spots; his tail also, in spring, is bordered with a finny expansion, and is often tipped with bright red or violet. The female deposits her eggs on the leaves of aquatic plants, which she folds up in a curious manner and glues together, as a protection to the soft and shell-less egg.

A very remarkable circumstance in the history of these animals, is their power of renewing portions, or even the whole of limbs, which have been destroyed by violence. If a Newt have the misfortune to be deprived of a member, suppose the whole leg, a new limb will soon be seen budding out from the side, which gradually takes the shape of the former, and puts forth perfect toes, supported by all the usual bones, as before. Even the eye is reproduced after it has been totally obliterated.

The Newts feed on water-insects, slugs, and other small animals that they can find in the situations which they frequent. They cast their skins about once in three weeks, or oftener in warm weather, and appear brighter and healthier after this operation.

ORDER V. ANOURA.*

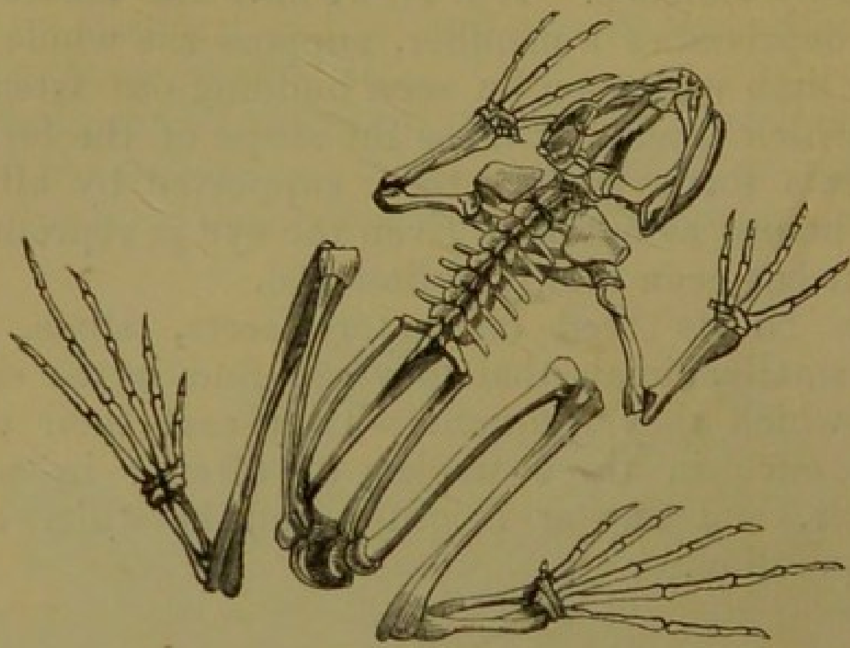
(*Frogs and Toads.*)

The total absence of the least vestige of a tail in these familiar animals, and their short, squat, dilated forms, their great heads, huge mouths, and long muscular limbs, are sufficient to identify them anywhere, especially as in these particulars they deviate so widely from the other members of their Class. But these distinctions apply only to the adult animals; in the tadpole condition an unscientific observer would scarcely detect any difference between a Frog and a Newt.

The accompanying figure of the skeleton of the common Frog may be compared with that of a Salamander, on a preceding page. This, it will be seen, with many points in common, presents important differences, particularly the small number of joints in the spine, which are in a manner soldered together as in Birds, the great size of the pelvis or bony frame-work at the hinder-part, and the great deve-

* "Without a tail."

lopment of the hinder limbs, besides some other points which have been mentioned above. We may



SKELETON OF FROG.

add also, what the engravings do not show, that the Frog has no trace of ribs,* which in the Newts do exist, though very small: and that in the former, the ear is visible externally, like a round scale on each side of the head.

We have already briefly alluded to the changes of form and of manner of life, which are more conspicuous in this Order than in any of the others. We shall therefore merely observe that the spawn of the Frog is to be distinguished from that of the Toad by its being deposited in large masses, that of the latter in long strings. In the former, the eggs are seen as black dots distributed at equal distances throughout the whole mass of jelly; in the latter, they are arranged in a double row.

The agile and powerful motions of the common Frog (*Rana temporaria*) command general admiration. The length of its leaps and its vigorous action in swimming depend on the great develop-

* The pieces which form a row on each side in the figure, are not ribs, but transverse processes of the *vertebræ*.

ment of the hinder limbs; the joints are all much lengthened to increase their power as levers, and they are moved by thick and strong muscles. The latter are shown in the rounded and thickened thigh, and the plump well-shaped calf of the leg.

FROG.

These animals feed on Slugs and Insects, and take them by suddenly applying the tip of the tongue to them, which is covered with a glutinous secretion. The tongue is commonly bent back upon itself, the tip towards the throat, but on the appearance of a fly, or a beetle, it is launched forth like lightning, and again withdrawn, carrying the captive prey adhering to its extremity. They are useful inhabitants of gardens.

"Mr. Knight, the intelligent nurseryman in the King's Road, Chelsea, who has done so much in introducing new and beautiful plants into this country, keeps a large number of Toads in his stoves, as he finds them beneficial in destroying the wood-lice, which injure his plants. The heat in some of the stoves is occasionally as high as one hundred and thirty degrees, and yet the toads did not appear at all affected by it. If an insect was put five or six inches from one of them, it seized it with so much rapidity, that it was difficult to perceive how it disappeared. On one occasion a large Toad ate four good sized beetles, one after the other; he took

TOAD.

them up in his fore feet, and when he got them endwise to his mouth they were immediately swallowed. Toads are harmless animals, and of infinite use in a garden, consuming great numbers of slugs and destructive insects. They are certainly capable of attachment,—indeed what animal is not?—and when they are without fear, their eyes are peculiarly soft and mild in their expression. They are, however, a loathed and persecuted species. Shakspeare characterizes them as 'ugly and venomous,' while Milton, as if to increase the odium against them, assimilates one of the species to the arch enemy of mankind.

"I should be very glad," adds Mr. Jesse, who records the above, "to rescue these poor unoffending animals from the cruelty which is so commonly practised upon them. It is impossible to walk through a village without seeing several mummies of toads, sprawling with extended feet, having been beaten flat by stones thrown at them by mischievous boys. Gardeners either cut them in two with their spades, or else destroy them in some other way; while every one seems to enjoy the misery which is inflicted on this unfortunate reptile. In short, they are surrounded by enemies, and the whole race would probably become extinct if they left their

TREE-FROG.

retreats in the day-time. Were people only to bear in mind that animals were created, not out of caprice, but to be useful to man, they would refrain from wantonly destroying them." *

In the warm parts of the globe there are many species of this Order which habitually inhabit trees, hopping and leaping among the foliage with great activity, and without any fear of falling. This they are enabled to do by means of their toes, which are furnished with little sucking disks at their tips. They are called Tree-frogs (*Hyladæ*). They are often adorned with bright and beautiful colours. We have no native species in England, but there is one common on the Continent, (*Hyla viridis*), which we here figure. It is of a delicate green above, and white beneath, with a stripe of yellow and one of purple running down each side.

CLASS III. REPTILIA.

(*Reptiles.*)

We now ascend a step higher in the scale of animated beings, and arrive at some which, notwithstanding popular prejudice, deserve far more attention and admiration than they receive. Most of them indeed are either despised or hated, and their forms and qualities have often been used as images to heighten whatever is repulsive or horrible. Let us, however, lay aside prejudice, and we shall find that the great majority of these animals are perfectly inoffensive; that many are clad in mail of the most brilliant polish, unsullied with spot or stain; that others are arrayed in rich and tastefully arranged colours; and that all afford, in the perfection of their structure, the skill and power displayed in the different contrivances of their organization, the varied instincts and habits with which they are endowed, their means of offence and defence, and the great

* Jesse's Gleanings, 344.

diversity of form and structure which they exhibit, as rich a feast of intellectual gratification to the philosophic student of Nature, as any of the other wonderful works of Him for the display of whose glory they were created.

The name given to this Class is derived from a word which signifies "to creep," and may be considered as equivalent to the expression so often used in the Holy Scriptures, "creeping things." It seems to express the circumstance that the body is either in contact with, or is brought very near to, the ground, in motion; and this depends upon the shortness of the legs, or in one extensive Order, that of the Serpents, the entire absence of these organs. The term must not be understood, however, as necessarily implying *slowness* of motion, for though the tardiness of a Tortoise is proverbial, this applies only to those which move on land, for the aquatic species are very swift, and the motions of many of the Lizards are scarcely less rapid than those of a bird.

Reptiles have an incomplete circulation: the whole of the blood which passes through the heart does not pass through the lungs, but only a portion of it, varying in amount in the different genera, so that much less of heat is communicated to it, and the animal is proportionally deficient in sensation and vital energy. Hence they are cold-blooded, their blood being not perceptibly warmer than the air or water in which they dwell. They therefore do not need to be covered with such materials as hair, wool, or feathers, which retain the animal heat; but their bodies are commonly clothed with bony shields or scaly plates, for the purpose of protection. If the temperature of the air descend below a certain average, as, for instance, during winter in the temperate zones, these animals become torpid, passing the inclement season in a sort of death-like sleep, in which the ordinary functions of life are suspended.

The continuation of the species is effected by means of eggs, which have a calcareous covering; sometimes tough and parchment-like, at others shelly, much like those of birds. In a few cases they are hatched in the body of the parent, as is the case with our common Slow-worm, our smaller Lizard, and the Viper.

There is great diversity of form in this Class; the clumsy, inflexible Tortoise, incased in its plated box, marching heavily on its four pillar-like limbs, affords a strong contrast to the long, slender, flexible, footless Serpent, gliding swiftly over the ground in its sinuous and graceful undulations. Yet between these remote forms there is a chain of intermediate links, which in a most beautiful and interesting manner conduct us from one to the other.

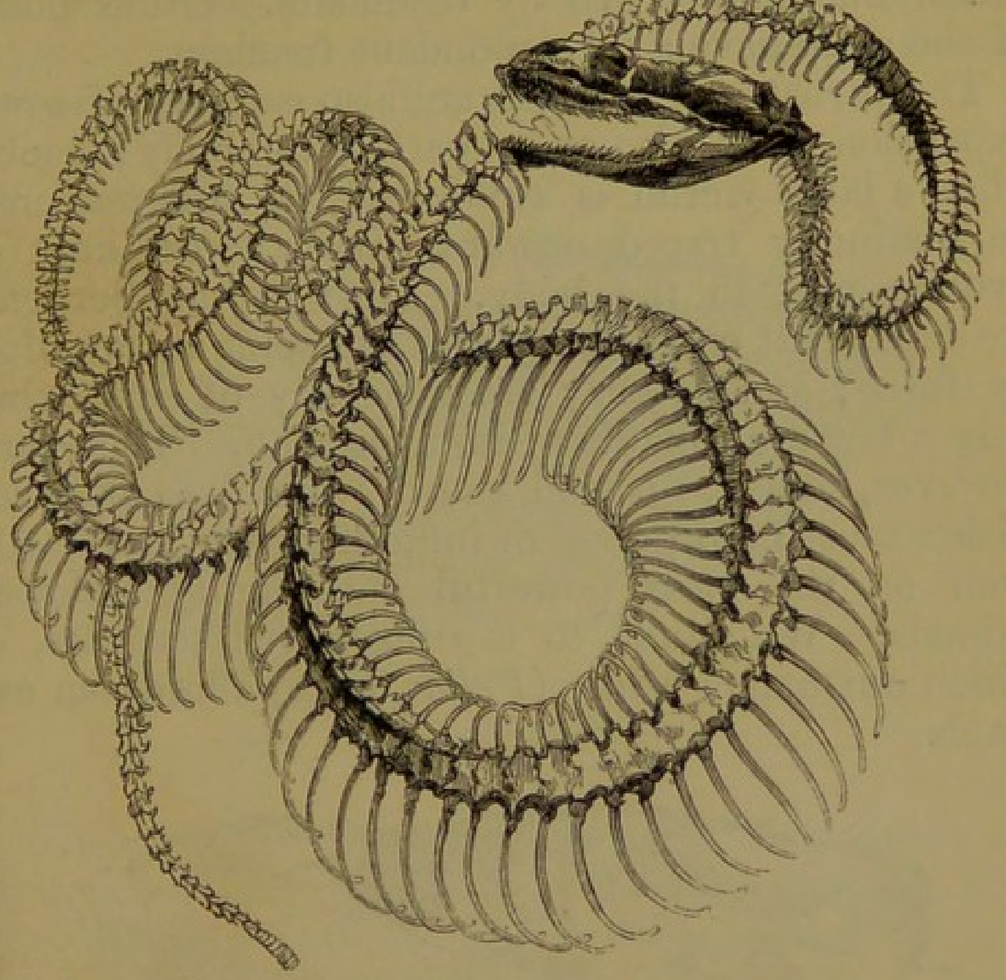
The Reptiles are arranged in four Orders, named Serpents (Ophidia), Lizards (Sauria), Crocodiles (Loricata), and Tortoises (Testudinata).

ORDER I. OPHIDIA.

(*Serpents.*)

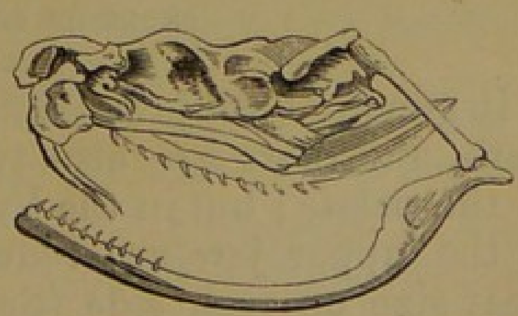
Of those who have often observed a Snake gliding swiftly and smoothly across the road, or through the grass, few, probably, are aware how the progression is effected, or would conjecture that any similarity exists between the motion of this footless animal, and that of the many-footed Centipede. Yet so it is. A glance at the accompanying figure will show the immense number of ribs with which a Serpent is endowed. These have considerable independent motion, and are used like so many feet, each being brought forward in succession, and its tip applied to the ground, with only the thin skin of the belly between. The edges of the belly-plates directed backwards help the action.

Another peculiarity in the skeleton is the looseness with which the bones of the skull are put together. The prey of a Serpent is invariably swallowed whole, for as there are only grasping teeth, no power of dividing it exists. But the prey often



SKELETON OF SERPENT.

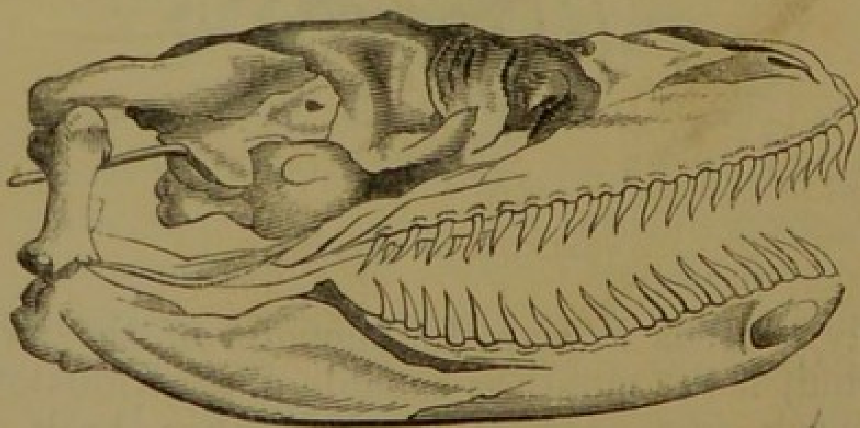
greatly exceeds in size the diameter of the mouth. To admit it the mouth is capable of great dilatation, the lower jaw extends much farther back than the skull, is not hinged to the upper jaw, but is suspended at the end of a long slender bone, which is attached to the hinder part of the skull by muscles and ligaments, so as to be very moveable. It will be readily seen how this contrivance permits a very wide expansion of the posterior part



SKULL OF SNAKE.

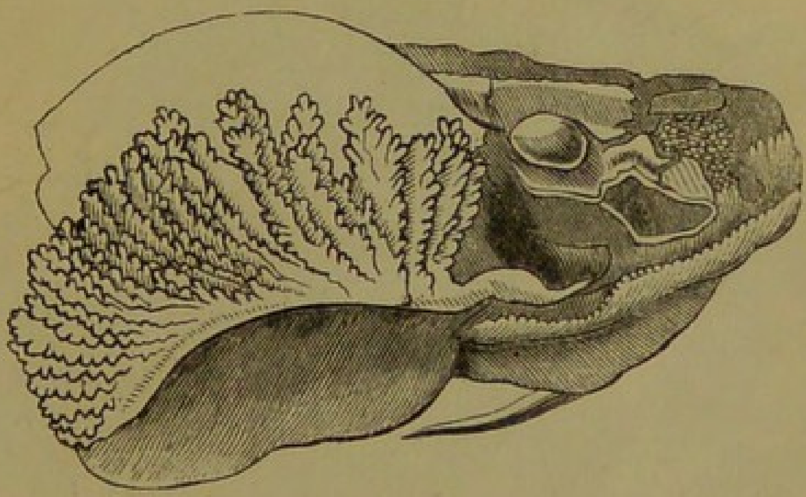
of the lower jaw, which is attained in a less degree in front by the nature of the union of the two branches, they not being soldered together there as usual, but simply tied by ligaments. Other bones of the skull have a correspondent freedom.

The throat and stomach are also capable of great expansion, as is also every part of the body; hence, when a large victim is swallowed, its progress may be distinctly traced onward, like a great knot or swollen part in the body. Most of the Serpents are dependent on the prey they can seize and swallow by force; and as they are generally of small size, only a few are capable of injuring man. There are, however, some, as is well known, which are endowed with a most fatal power of inflicting pain and death, even on the most powerful and highly endowed animals. We allude to the poisonous serpents, of which our native Viper (*Pelias berus*) affords an example.



SKULL OF PYTHON.

In general both jaws are set with numerous pointed teeth, and there are also two rows of similar teeth on the palate; but in the Venomous Snakes the teeth of the upper jaw are reduced to a single fang of great size on each side (See fig. on p. 297). This tooth, which is very sharp, is pierced through its length, and communicates with a reservoir of poisonous fluid secreted by glands which lie beneath the eyes. The Snake strikes his enemy with his long erected fangs, which as they enter the flesh press with their base upon the poison-bag, the contents of which are thus forced through the tooth into the wound. The results of a bite from a poisonous Serpent are much more likely to be fatal in a warm country than in a colder one.



POISON GLAND.

The great Serpents which are not venomous kill their prey also before they swallow it; but in a very different manner. They are said to watch in the forests, and especially near the drinking places of the rivers, hanging from a tree, until some animal passes. They dart upon their victim, and, more swiftly than the eye can follow, encircle it in many coils; then, by a strong muscular contraction, the bones of the miserable animal are crushed, and life is destroyed. The dreadful embrace is then loosened, and the prey is swallowed whole.

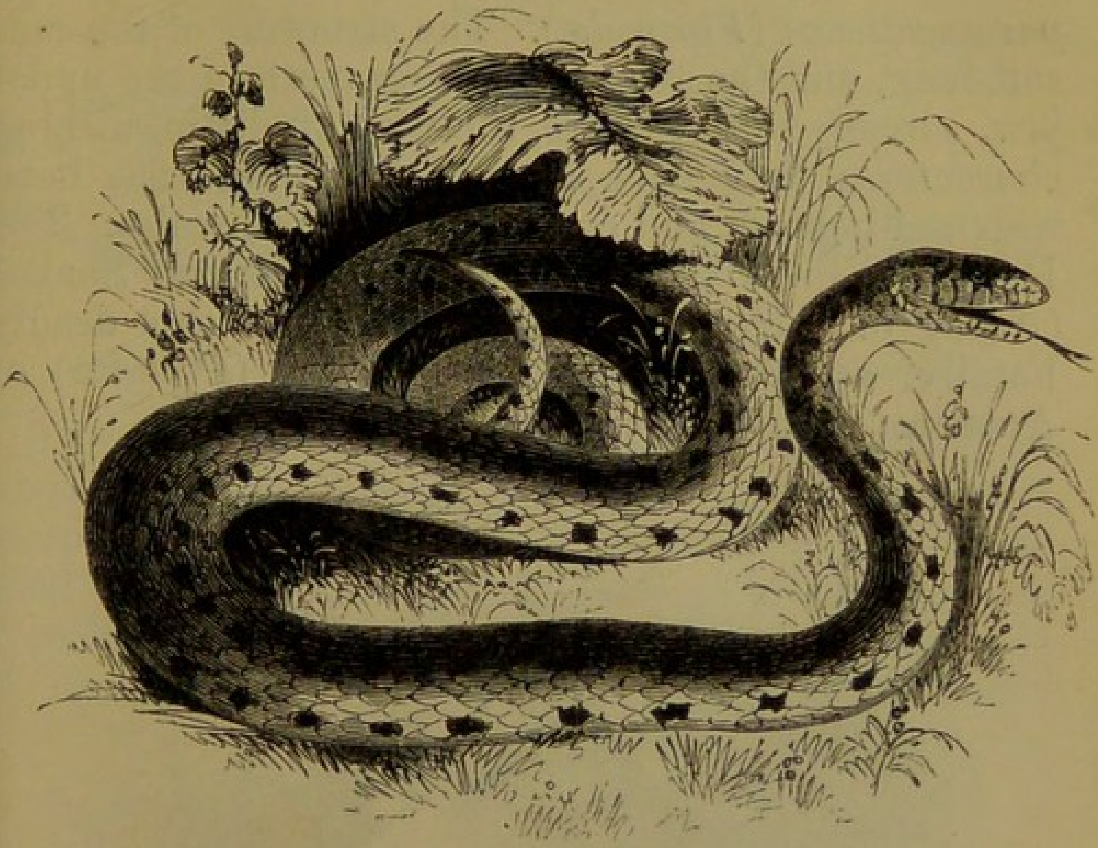
The beautiful Ringed Snake of our own country (*Natrix torquata*) is perfectly harmless. It is a bold and voracious animal, however, devouring birds, as well as their eggs and young, and lizards, but more especially frogs. Professor Bell, in his History of British Reptiles, has described, from personal observation, the manner in which it takes its food.

This species lays its eggs, which are from fifteen to twenty in number, in the earth in sunny situations, in crevices of limekilns, and in dung-hills. They are about an inch in length, covered with a

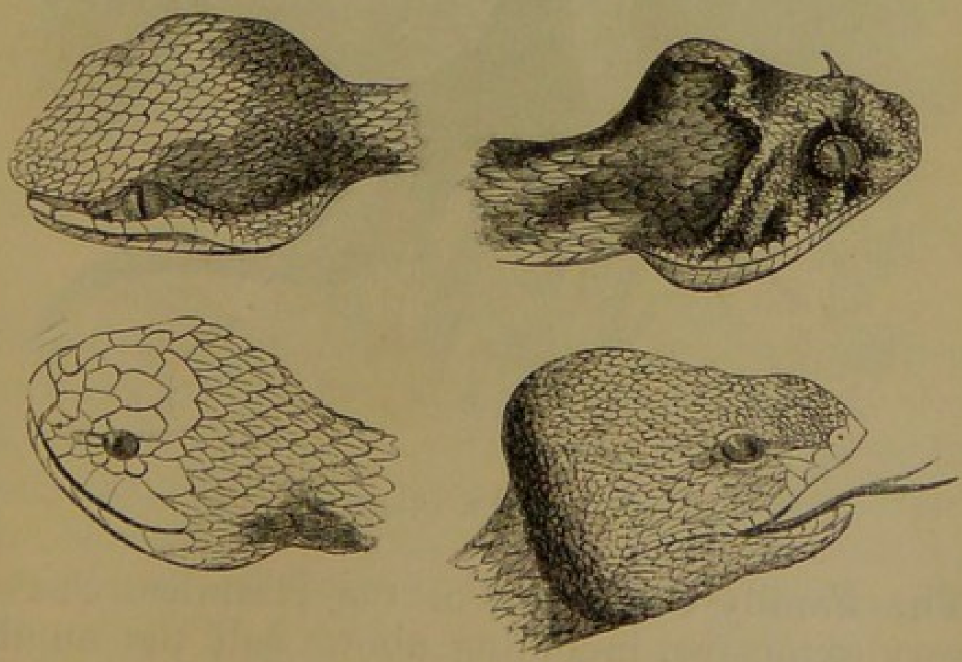
PYTHON WATCHING FOR PREY.

tough leathery skin, and are connected together in strings.

The Serpents are comprised in five Families. The first is composed of the Sea-snakes (*Hydrophidæ*), which inhabit the Indian Ocean; they have the tail flattened, like that of an Eel. They are highly



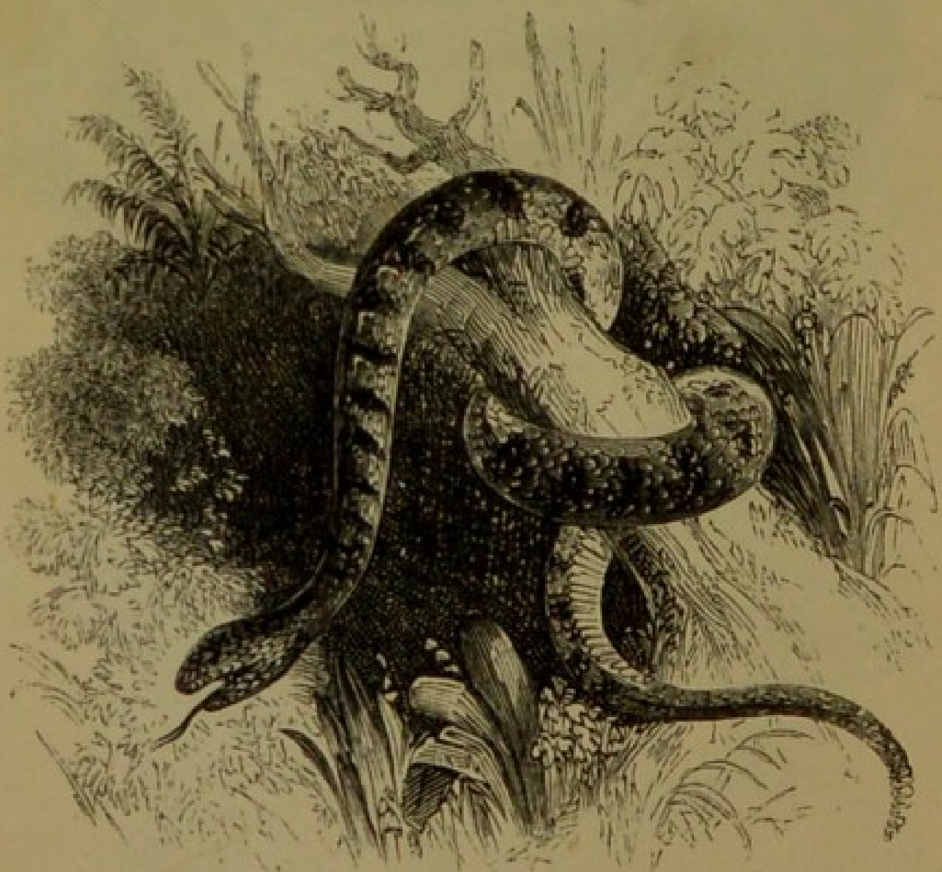
COMMON SNAKE.



HEADS OF POISONOUS SNAKES OF DIFFERENT GENERA.

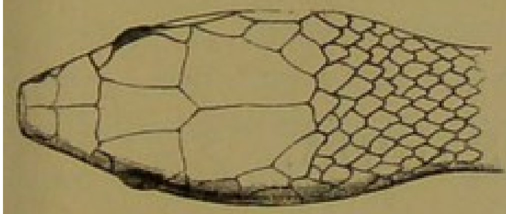
venomous, but, unlike the next Family, the poison-fang is only the first of a row of smaller teeth in the upper jaw. The species are not numerous, about fifty being known.

The next Family is that of the Venomous Snakes *par excellence* (*Viperadæ*). The structure of the poison-fang, and the absence of other teeth in the upper jaw, already noticed, are their chief distinguishing characters; they have frequently a large flat head widened behind, and covered with small scales. The Horned Vipers (*Cerastes*) and the Hooded Snakes (*Naja*) of Africa and Asia, belong to this deadly Family, as do also the Rattlesnakes (*Crotalus*) of America, besides our native Viper or Adder.

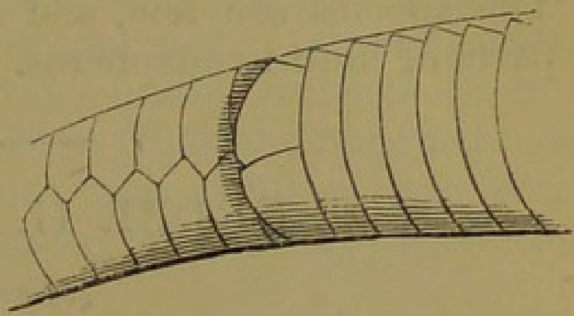


RATTLE SNAKE.

The Family *Colubridæ*, or the Harmless Snakes, is very extensive, including above half the number of species belonging to the Order. They have broad flat plates on the head, and the belly is shod, as it were, with wide parallel shields, which beneath the tail are arranged in two series. They have four rows of teeth above, and two below, but no fangs. These are scattered all over the world, and our Ringed Snake is a common British example.

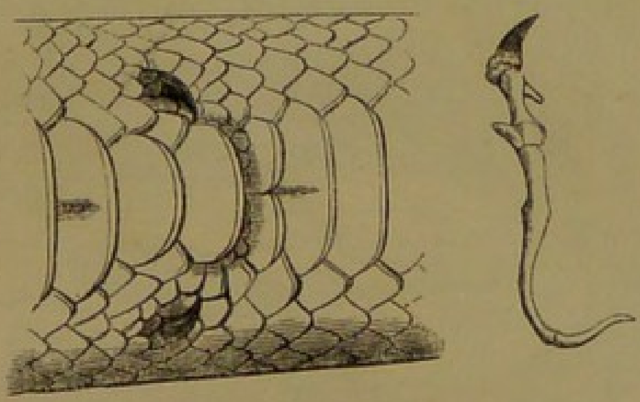


HEAD OF SNAKE.



BELLY AND TAIL-SHIELDS.

The mighty Boas and Pythons of the tropics, of whose size and strength many stirring tales are told, compose the Family *Boadæ*. In most of their technical characters they closely agree with the last Family, but they are distinguished by the presence of two hooks or spurs, the rudiments of hinder



VENT AND HOOK OF BOA.

limbs, placed one on each side of the vent. Minute bones are attached to these hooks, within the flesh, as shown in the right hand figure of the preceding engraving. The belly is covered with broad shields; those beneath the tail are single-rowed in the Boas of America, double in the Pythons of Asia and Africa.

In the fifth Family, *Amphisbœnadæ*, there is a visible approach to the Lizard Order. The bones of the skull and jaws are not loosely jointed, but soldered firmly together; so that these have not the power of dilating the mouth and throat. They have much resemblance to Slow-worms, feed chiefly on ants and other insects, and are perfectly harmless. The species are few, and are found in the tropical parts of both hemispheres.

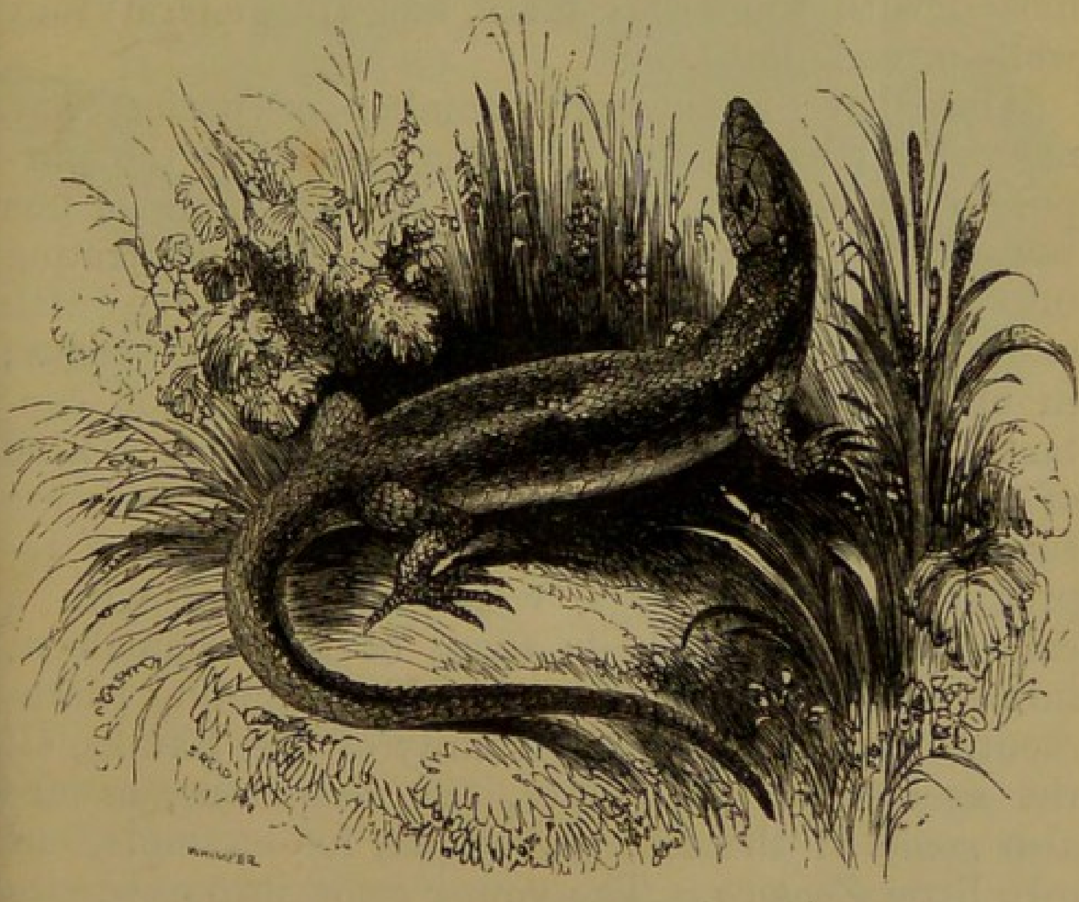
ORDER II. SAURIA.

(*Lizards.*)

The transition from the Serpents to the Lizards is happily exemplified by a pretty little animal, familiar enough in this country, much maligned because

SLOW-WORM.

much misunderstood. Who would not put dow the Slow-worm (*Anguis fragilis*) for a Snake? Eve Linnæus, Cuvier, and others, have placed it in th preceding Order: there is not the slightest appear ance of limbs; the body is very long and slender and the whole appearance Snake-like. Yet it i more closely allied to the Lizards, as its internal anatomy clearly shows. The bones of the *pelvis* (or arch to which the hinder limbs are jointed) are found to exist in a rudimentary state, though no outward indication of limbs appears. Other species, however, display other links in this curious chain; some have two minute feet in front and none behind, others have only the hinder pair. Others have both pairs, but small and weak, set very far apart on the



COMMON LIZARD.

lengthened body, and destitute of toes. In others they become gradually more developed, until we find them in full perfection, as exhibited by another interesting British form, that of the Lizards. We have two native species of the Order besides the Slow-worm, the common, or Viviparous Lizard (*Zootoca vivipara*), which is figured above, and the Sand Lizard (*Lacerta agilis*), larger and more rare.

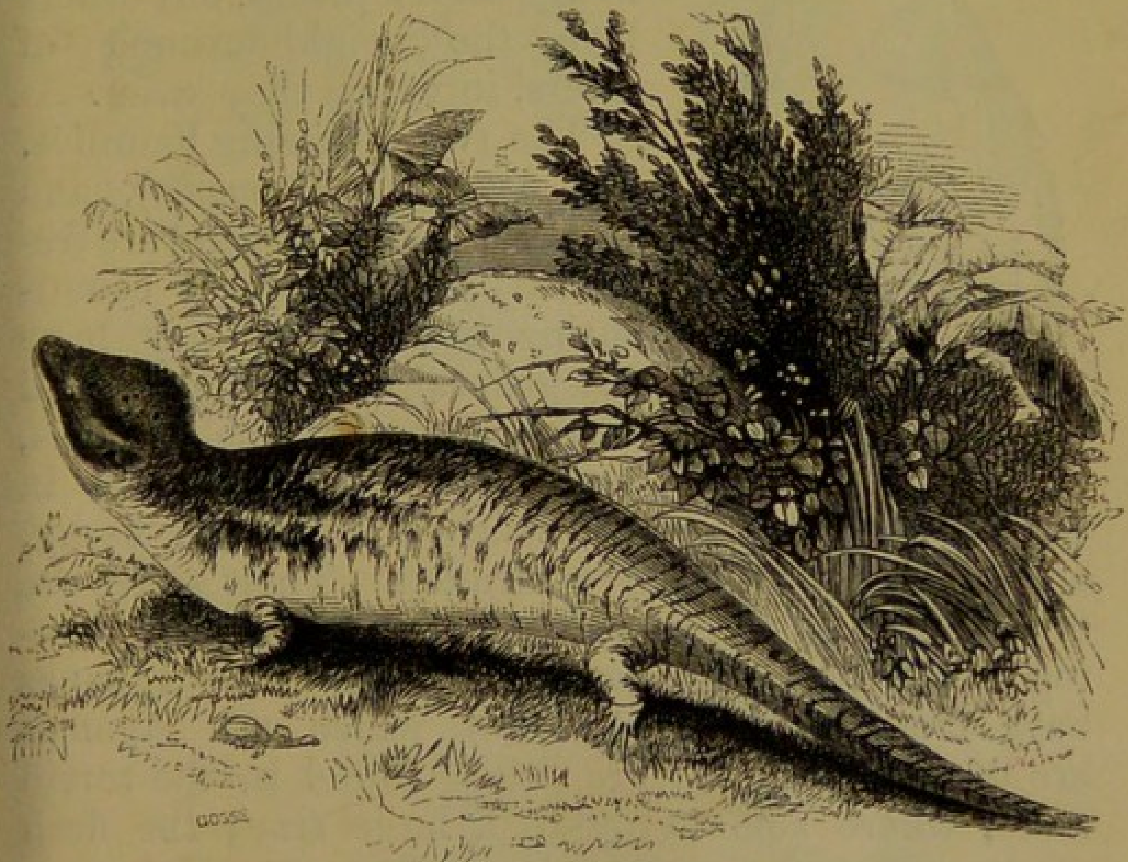
The food of these animals consists chiefly of insects, which are captured with great ease and dexterity. Some, however, feed on fruits and other vegetable substances. The greater number, particularly in that group to which our native species belong, are distinguished for the grace and fleet agility of their motions. They are timid, harmless creatures, darting away on the slightest alarm, and concealing themselves in some convenient retreat.

The Lizards are marked by a lengthened body and tail, tapering to each extremity; they are furnished with numerous teeth, and (in general) four well-formed limbs.

They have a moderate number of perfect and moveable ribs, capable of being raised for the purpose of respiration. The lung extends more or less toward the hind part of the body, often penetrating into the abdomen. Their skin is covered with scales, which in many overlap at the hinder edges; in others are flat, with the edges in common contact, and in some are so minute as to impart a kind of granulated or shagreened surface. The eyes are furnished with eyelids. The ordinary mode of reproduction is by eggs, which are coated with a calcareous, brittle shell: those of the Chameleon, however, have the covering tough, resembling parchment. In the extensive Family of the Skinks, all the species, as we believe, are viviparous, as are also some of the Lizards proper, for example, our own little *Zootoca*. The young come into existence in the same form which they retain through life.

The Families of this Order we can only briefly indicate: they are seven in number.

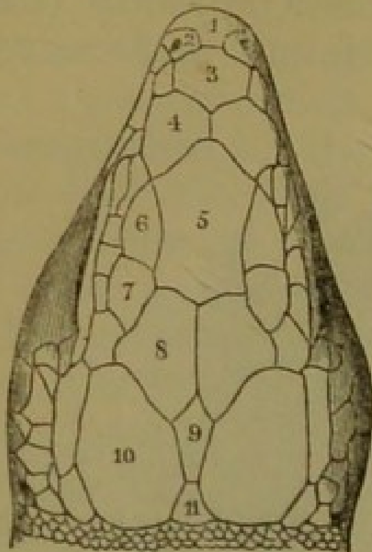
The first Family is that of the Snake Lizards (*Scincidæ*) which contains the singular connecting forms already noticed, our own Slow-worm among the rest. The limbs, in those genera which possess them, are small, feeble, and set far apart; the head is covered with large angular plates, and the body is clothed with overlapping scales, which do not differ on the belly from those on other parts. The tongue is fleshy, notched, and scaly. They are harmless, mostly feeding on insects, but the Gallywasp (*Celestus occiduus*), a large species found in Jamaica, feeds on fruits.



GALLYWASP.

We then come to the true Lizards, (*Lacertadæ*) which agree with the Skinks in having broad plates on the head, but are distinguished by having the belly covered with wide flat plates set in rows, differing greatly from the overlapping scales of the rest of the body. Some of the scales around the neck are larger than the rest, and form a sort of collar. Most of these are small, but very beautiful; they are often of gay colours, elegantly diversified with spots, and gleaming with metallic radiance. This Family is confined to the Old World.

The Monitors (*Varanidæ*) have a protrusile, sheathed, and forked tongue; and are covered with tubercle-like scales, set in rings or circular bands round the body and tail. They are large sized Reptiles, which have some of the habits of the Crocodiles; they are said to devour quadrupeds of considerable size. Some of them are found in dry barren places, but others love the neighbourhood of rivers, in which they swim.



HEAD OF LIZARD.*

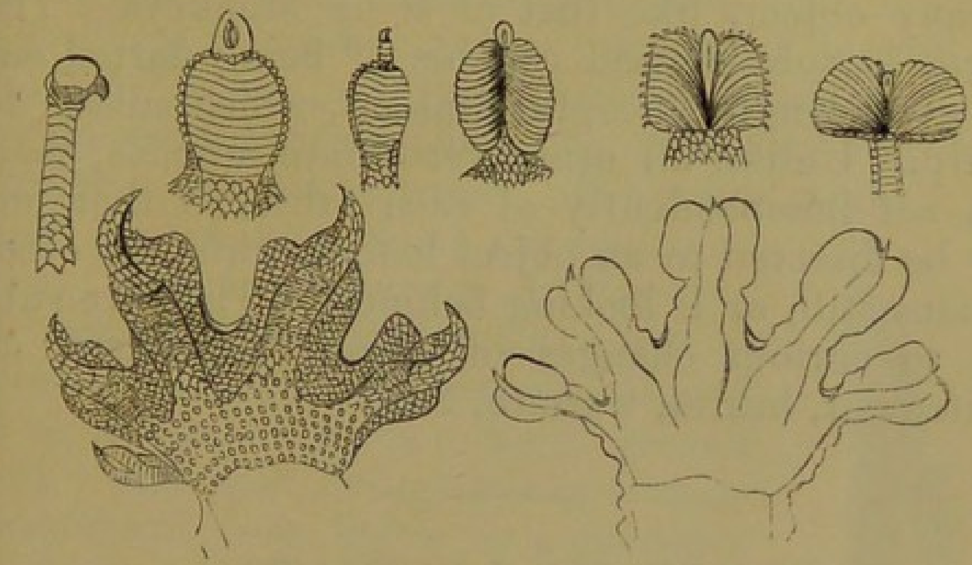
The two following Families, the Agamas (*Agamadæ*), and the Iguanas (*Iguanadæ*) are frequently considered as constituting but one. They have the general form, long tail, and unequal toes of the Lizards, but they differ from these in the form of the tongue, which is thick and fleshy, and incapable of being protruded. Their scales are often angular, ridged or spinous; frequently forming a saw-like crest down the back. The Iguanas have teeth in the palate, of which the Agamas are destitute. They are chiefly found in the torrid zone, where some grow to a large size; the flesh of these is esteemed superior to that of a chicken.

All the preceding Families are active by day, but the Geckos (*Geckotidæ*) are nocturnal. They are rather clumsy and stoutly built, of dull lurid colours with large flat heads, and great eyes, the pupils of which contract to a line like those of a Cat. The toes are nearly equal; their under surface is dilated and furnished with parallel plates, which overlap each other, by means of which they are enabled to cling to perpendicular surfaces, and as it is said even to walk on a ceiling, like the house-fly. They are much dreaded in tropical countries, but without reason, as they have no power to do any harm.

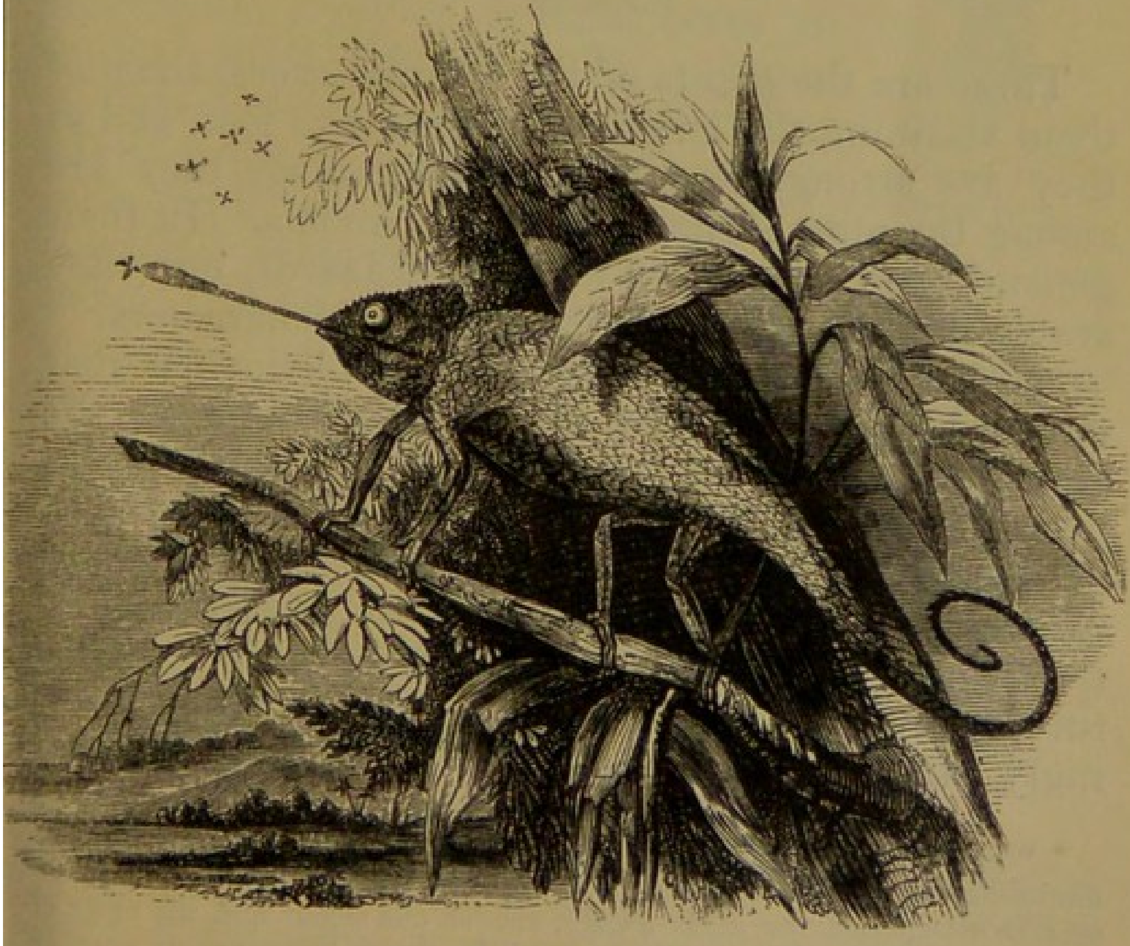
* On the slight variations of form or relative position in these plates generic distinctions often rest, and hence, for the sake of perspicuity in description, these have received names.

The plate marked 1 is termed the rostral ; 2, the nasal ; 3, internasal ; 4, fronto-nasal ; 5, frontal ; 6, anterior palpebral ; 7, posterior palpebral ; 8, fronto-parietal ; 9, inter-parietal ; 10, parietal ; 11, occipital.

They utter singular unmusical cries, by night, some of which have been thought to resemble the word 'Gecko.'



FEET OF GECKOS.



CHAMELEON.

The last Family, named *Chamæleonidæ* (Chameleons), are the most singular of Reptiles, and perhaps of all vertebrate animals. Their toes, five in number, are arranged, three before and two behind, and form a grasping hand. The tail is capable of holding any object, like that of some Monkeys. The tongue is tubular, and capable of being darted out to a great length to capture insects, which adhere to its tip. Unlike all other vertebrate animals, their eyes act independently of each other, so that one may be directed to an object before, while the other remains still, or is looking behind.* They are subject to curious changes of colour dependent on excitement, health, warmth, &c.

ORDER III. LORICATA.†

(*Crocodiles.*)

These are the giants of the Reptile races, some of them attaining the length of twenty-five feet, and as they are strong, ferocious, and cunning, they are among the most formidable of all animals. In their general form they agree with the Lizards, but they are distinguished by several important characters.

"Of these the most tangible and obvious is that upon which the name of the Order is founded; the covering of the whole of the back part of the neck, body, and tail, with distinct series of bones, of moderate size, imbedded, as it were, in the substance of the skin, and covered externally with a thick cuticle. These dermal bones are usually furnished with a crest, which renders them exceedingly strong, and they altogether form a panoply

* "These most singular creatures are particularly remarkable for the diminished sympathy of the two sides of their whole frame, one of which may be asleep and the other awake, one of one colour and the other of another, &c.; the separate movement of their eyes being merely another phase of the same phenomenon. Hence it is remarkable, that unlike most other animals, the Chameleon is totally unable to swim, from the incapability of its limbs of acting in due concert."—Blyth's *Cuvier*, 278.

† From *lorica*, a coat of mail.

of defence which can resist the attacks of the most powerful enemies of whatever kind."*

The bones of the skull in the Crocodile are much stronger and more consolidated than those of most Reptiles; the lower jaw is prolonged behind the base of the skull, and this structure causes the upper jaw to seem moveable, but this is merely a mistake, though a very ancient one. There is a single row of teeth in each jaw, which are conical in form. There is a cavity at the root of each tooth which serves as a case or sheath for the germ of the tooth destined to replace it, which is to be of greater bulk; and each being thus gradually pushed out from below by a successor ready to supply its place, the jaws of the Crocodiles present, at all ages, their formidable array of pointed teeth in undiminished number. The tongue is flat, and is free only at the very edge, so that these formidable animals have often been described as destitute of a tongue. The mouth has no lips, hence the long and close array of grinning teeth is always visible, imparting a very repulsive aspect to the countenance. The strong bony scales which form these animals' coat of mail are frequently ridged, and those of the tail are elevated into a deeply notched or saw-like crest, which at the basal part is double.

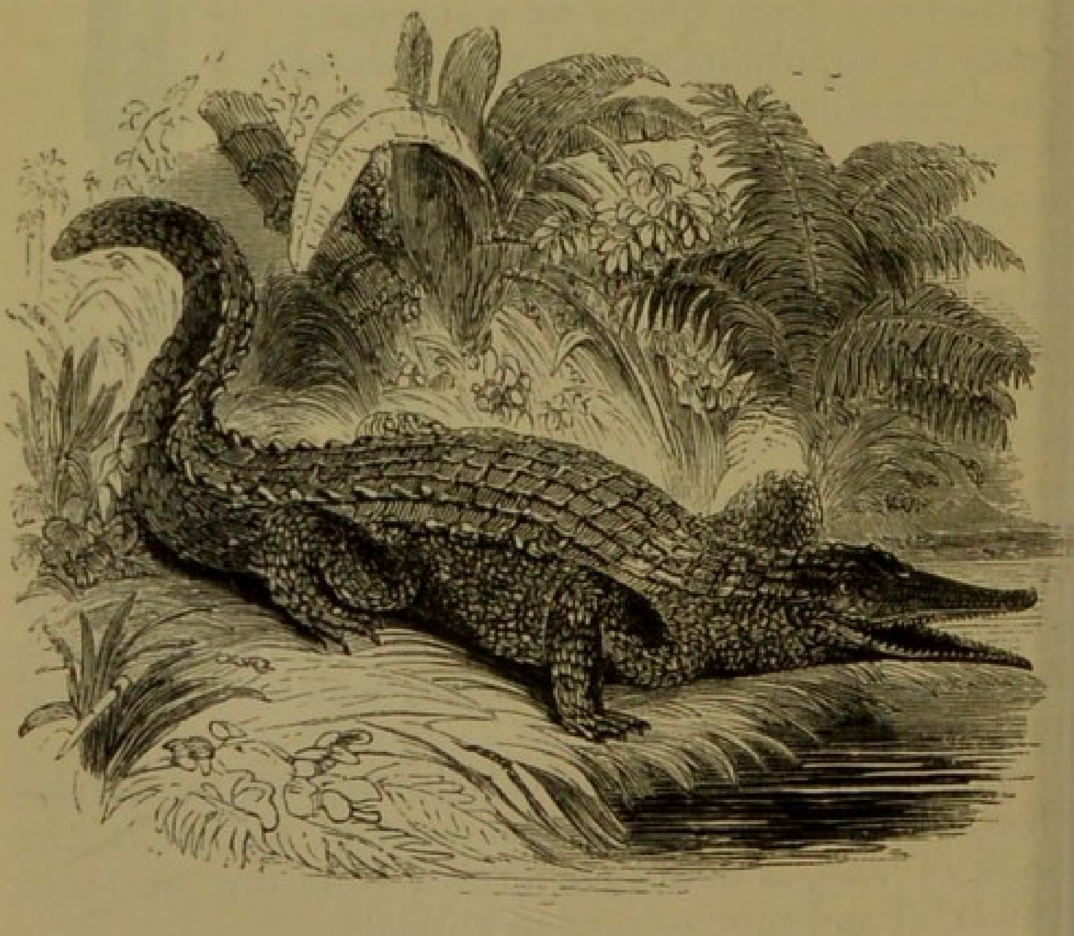
TOOTH OF CROCODILE.

The magnificent poetical description of Leviathan, in perhaps the most ancient of all books, the book of Job, is doubtless drawn from one of these powerful and much-dreaded animals.

Who can open the doors of his face? his teeth are terrible round about. His scales are his pride, shut up together as with a close seal. One is so near to another, that no air can come between them. They are joined one to another, they stick together, that they cannot be sundered. By his neesings a light doth shine, and his eyes are like the eyelids of the

* Bell, Brit. Rept. xix.

morning. Out of his mouth go burning lamps, and sparks of fire leap out. Out of his nostrils goeth smoke, as out of a seething pot or caldron. His breath kindleth coals, and a flame goeth out of his mouth. In his neck remaineth strength, and sorrow is turned into joy before him. The flakes of his flesh are joined together: they are firm in themselves; they cannot be moved. His heart is as firm as a stone; yea, as hard as a piece of the nether millstone. When he raiseth up himself, the mighty are afraid: by reason of breakings they purify themselves. The sword of him that layeth at him cannot hold: the spear, the dart, nor the habergeon. He esteemeth iron as straw, and brass as rotten wood. The arrow cannot make him flee: sling-stones are turned with him into stubble. Darts are counted as stubble: he laugheth at the shaking of a spear. Sharp stones are under him: he spreadeth sharp pointed things upon the mire. He maketh the deep to boil like a pot: he maketh the sea like a pot of ointment. He maketh a path to shine after him; one would think the deep to be hoary. Upon earth there is not his like, who is made without fear. He beholdeth all high things: he is a king over all the children of pride.—Job xli.



CROCODILE.

The order comprises three genera; the Gavials of the Indian rivers, which have the muzzle very long and slender, the true Crocodiles, which have it oblong, and considerably wider; and the Alligators, which have it very broad and rounded at the tip. The latter are peculiar to continental America, but the Crocodiles are found in both hemispheres, several species inhabiting the West Indian islands, as well as South America. The habit of these huge animals is to lurk in the reeds, and other coarse vegetation of the river margins, until the approach of an unsuspecting victim, when they spring forward, seize it with their serried jaws, and rush beneath the stream to devour it at leisure. The ferocity of these animals has been by some naturalists much under-rated; in the countries which they inhabit they are much and deservedly dreaded, and many fatal instances of their power and malignity are recorded.

The following painfully interesting anecdote, of recent occurrence, has been lately communicated to us by Richard Hill, Esq., of Jamaica.

"Black River, Jamaica,
"14th July, 1849.

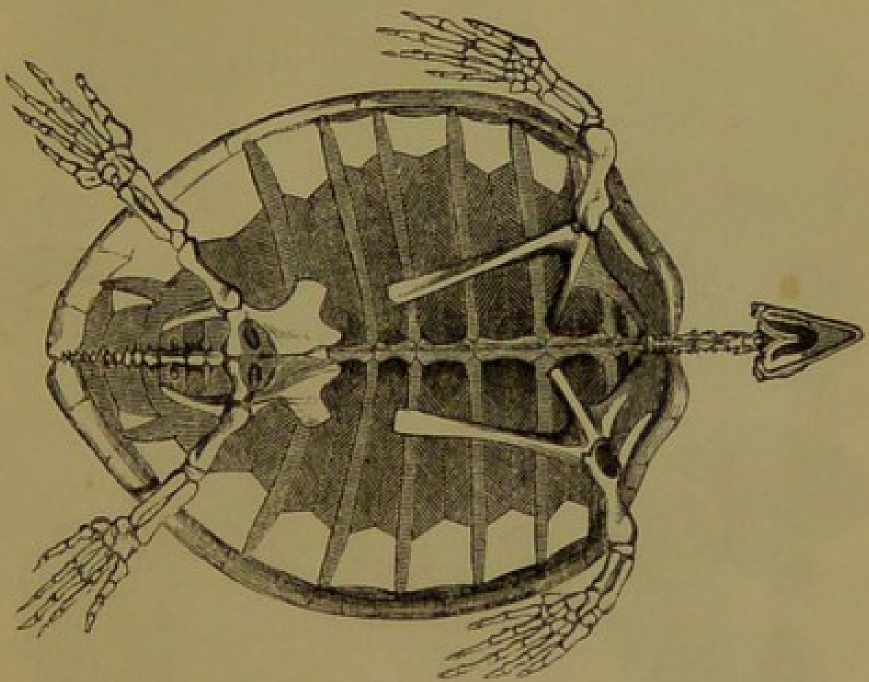
"On the eastern bank of the river, just above the bridge, and right within a quay and jutting crane-house attached to a long line of stores, a Crocodile, some twelve months ago, snatched off from the beach a young girl thirteen or fourteen years of age, who was washing a towel at the river in company with an elder companion, at night fall. She had been warned that it was dangerous to stand at all within the water after dark, for *Alligators*, as these crocodiles of ours are erroneously called, would be then prowling, and fatal casualties had occurred. Just as the little braggart boasted that she heeded no such danger, a scream for help, and a cry, 'Lord have mercy upon me! Alligator has caught me!' apprised her companion, intent on her own washing, that the girl was carried off. She was instantly snatched under water, and drowned. The body was found some days after half-devoured, and two Crocodiles, one nine feet long and the other seventeen, were hunted down, and taken with portions of the flesh undigested within them."

The species alluded to in this note, was doubtless *Crocodilus acutus*.

ORDER IV. TESTUDINATA.

(*Tortoises.*)

The Tortoises are among the most singular of Vertebrated animals. On taking one into our hands —perhaps a family pet, that has slowly marched about the garden, summer after summer, for a period beyond remembrance,—and looking at the curious bony box covered with angular plates, from which protrude the grotesque head, and thick ungainly limbs, we shall surely see that we are holding a strange creature. But if we have an opportunity of examining it when dead (for death at last will come even to the long-living Tortoise), we shall find some peculiarities equally curious in its structure. We have long ago done, it is true, with that extensive series of animals, whose skeleton is external, but we may perhaps be here reminded of them, when we see the shoulder-blade, and all the muscles that move the fore-limbs and the neck—instead of being attached to the exterior of the ribs and spine, as in other Vertebrate animals—placed within, as well as the bones of the pelvis, and the muscles of the thighs; and we may be disposed to concur with those who describe the Tortoise as an animal turned inside out. Nor will the form of some of these parts surprise us less than their position; for we shall find the vertebræ of the trunk immoveably soldered into one piece, and the ribs so widened and flattened out as to join each other along their edges, the whole spine and ribs forming a broad continuous bony surface, more or less vaulted. The breast-bone (*sternum*) in like manner forms a broad plate of bone; and these two shields are united to each other along the sides, leaving only an opening in front for the protrusion of the head and fore-limbs, and one behind, for that of the hind limbs and tail.

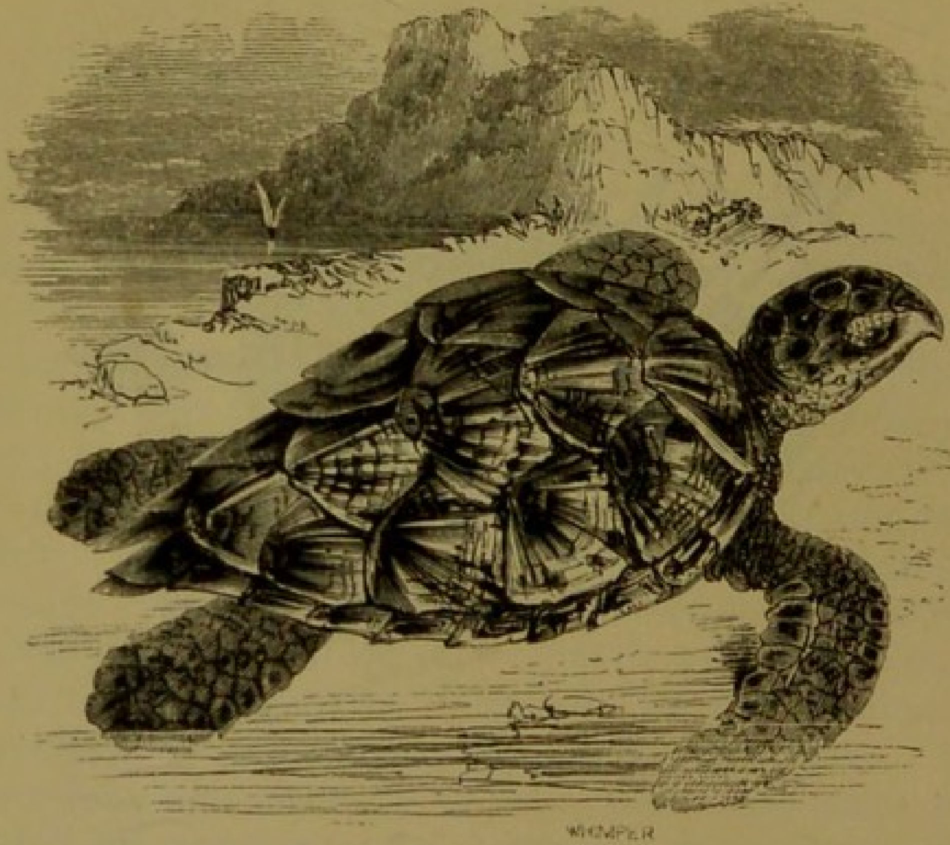


SKELETON OF TURTLE.

The outer surface of these shields, as well as also the other parts that are exposed, is covered with a series of horny plates (sometimes, however, leathery), of regular angular forms, fitted to each other. The jaws have no teeth, but are clothed with horn, like the beak of a bird, which they much resemble in appearance and action.

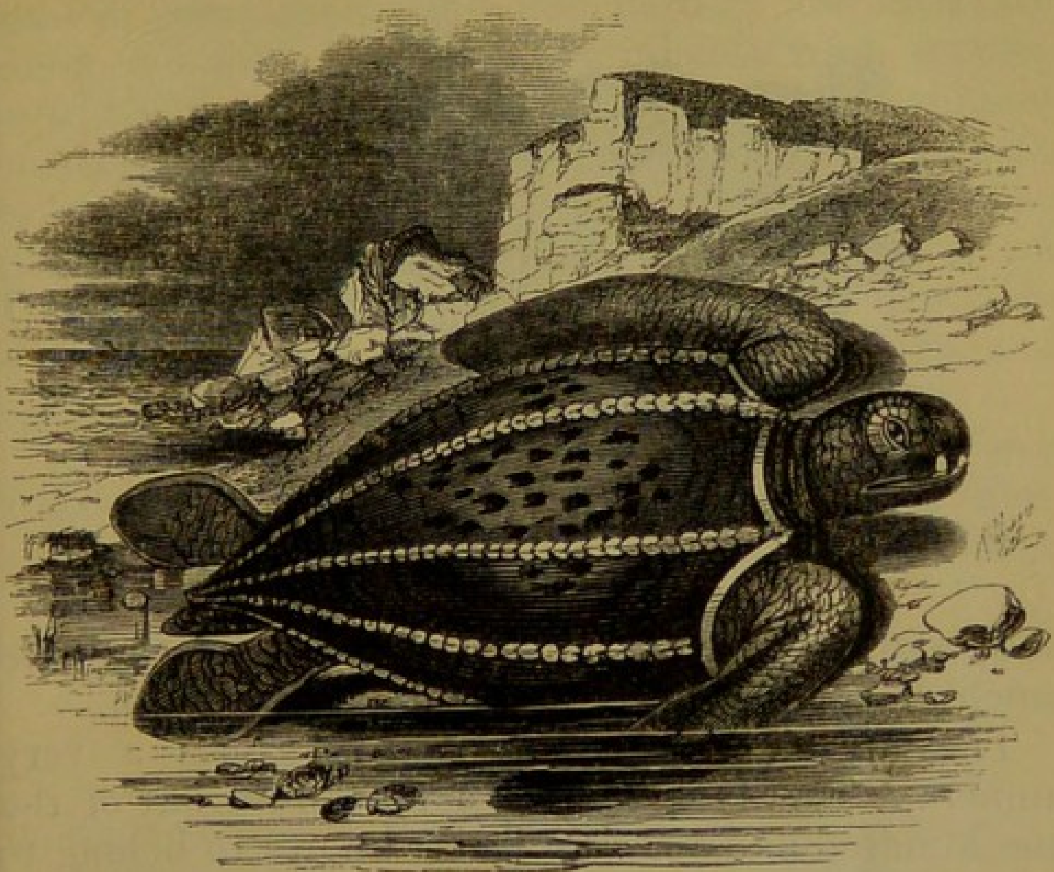
The increase of the race is by means of eggs, which are covered, like those of birds, with a hard brittle, white shell; they are laid in heaps in the warm sand, with which they are then slightly covered, and left to be hatched by the sun. In general these are considered delicate eating.

The tortoise-shell, whose high-polish, semi-transparency, and richly clouded colours are so much esteemed is obtained from the upper plates of the Hawksbill Turtle (*Chelone imbricata*), one of the Family of *Cheloniadæ*, or Marine Turtles. The flesh of this species is not valued, but there is another kind (*Chelone mydas*) belonging to the same Family, which is so highly esteemed for the delicacy of its



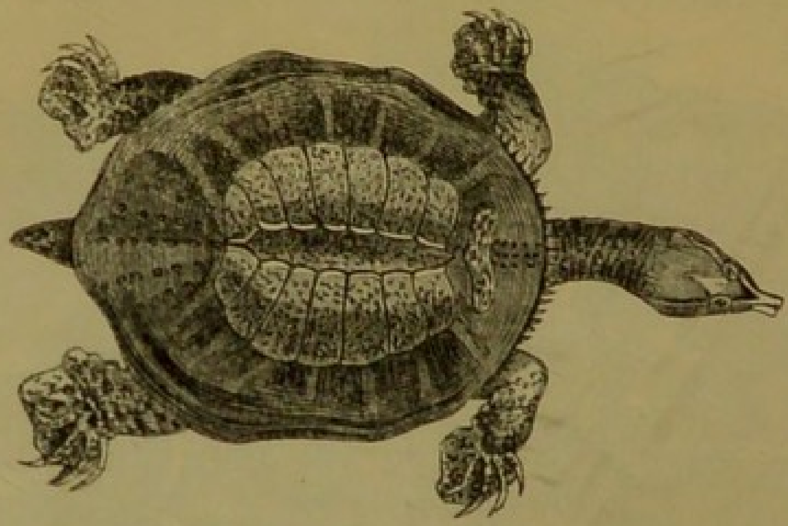
HAWKSBILL TURTLE.

flavour, that great numbers are annually imported alive into our great commercial cities from the tropics for the sake of the flesh alone. They are packed one upon another in casks of seawater, headed up, and the water is changed daily by the bunghole and a cock. Both of these species have been taken on the British coast, but such an occurrence can only be considered rare and accidental. Occasionally also, another species has been captured on our shores, the great Leather-back (*Sphargis coriacea*), the largest of the whole Order, which sometimes has been known to measure nine or ten feet. It is covered with a leathery skin instead of horny plates, which is marked by several ridges running lengthwise down the body. This single species is considered to represent another Family, named *Sphargidæ*.



LEATHER TURTLE.

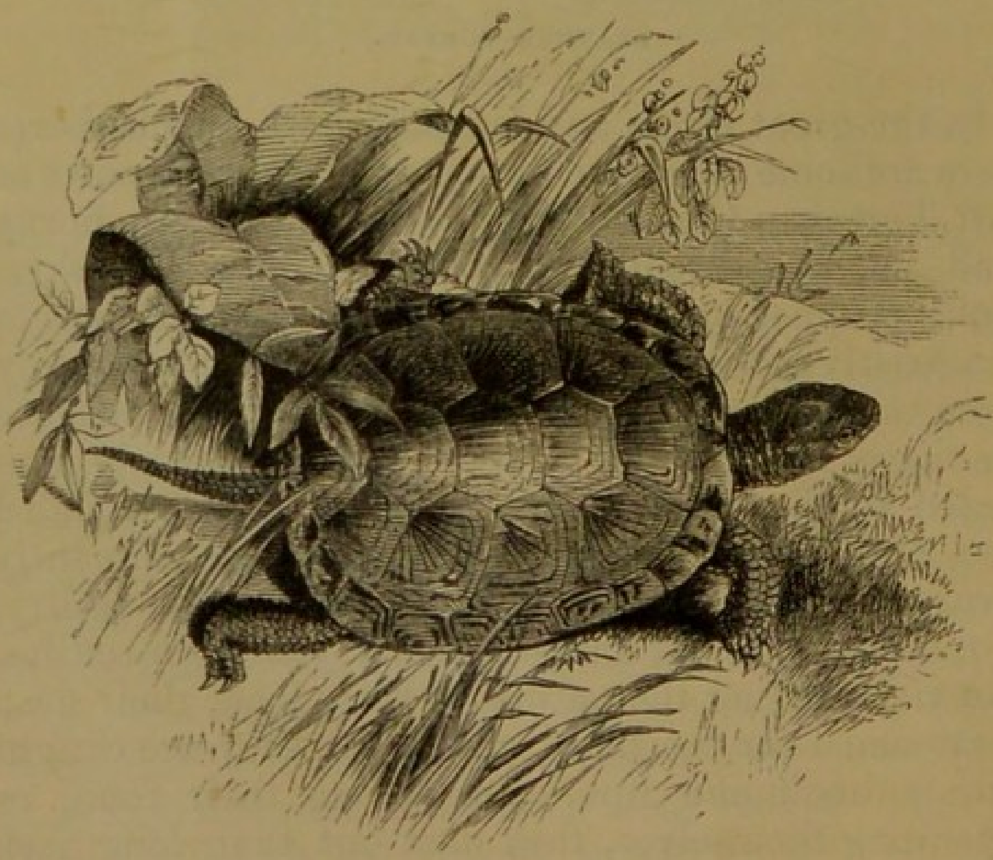
In the great rivers and lakes of both hemispheres there are some large and ferocious creatures known as Soft Tortoises (*Trionychidæ*). They have no horny shell, but the shields are covered with a soft skin, and the upper one is surrounded by a broad margin of a gristly substance. Their feet are webbed; only three toes of each are furnished with claws, whence the name *Trionyx*. The beak is horny, partly concealed by fleshy lips, and the muzzle is extended into a short trunk. These animals are eminently carnivorous and voracious, and pursue with agility, in the water, fishes, and especially young crocodiles. Notwithstanding the nature of their food, their flesh is esteemed for the table, and hence they are caught with a hook and line. In seizing their food, or defending themselves, they dart out their long neck with the sudden rapidity of an arrow. The grasp of their powerful and trenchant beak is sharp and deadly, nor is it relaxed until the piece is taken clean



SOFT TORTOISE.

out; and as they are bold and ferocious, they are much dreaded even by those who fish for them.

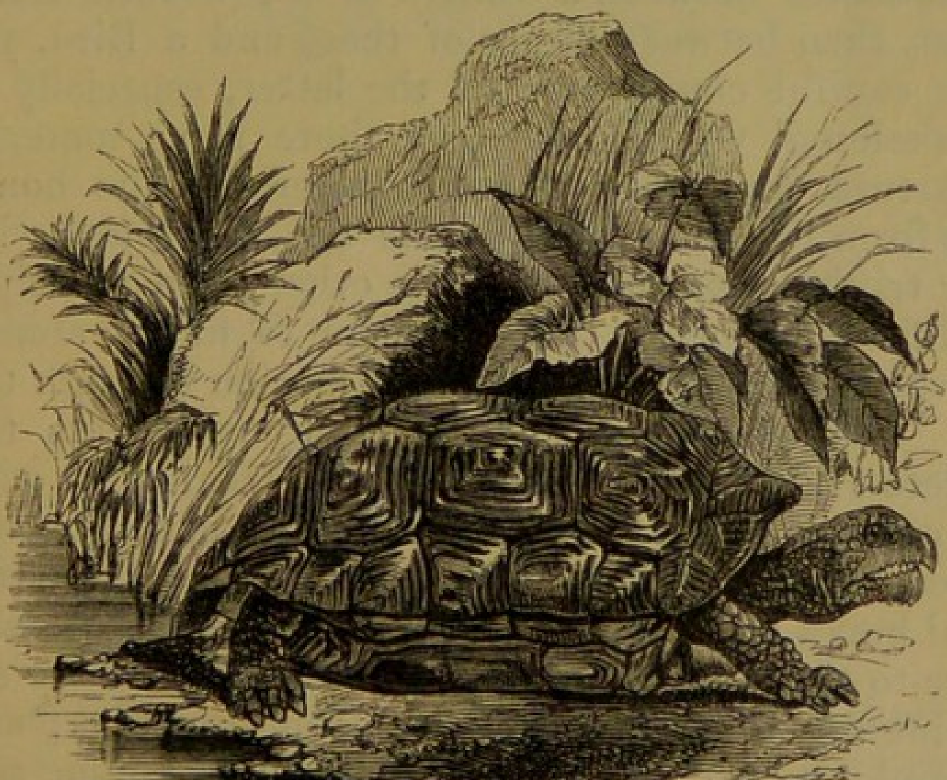
The Marsh Tortoises (*Emydidæ*) form a very numerous Family, including seventy-four out of the one hundred and twenty species known to belong to



EUROPEAN MARSH TORTOISE.

the Order. More than half of them are American. These resemble the common Land Tortoises in general appearance, but are flatter; the toes are connected with a web. They inhabit fresh waters, in which they swim with facility, and even stagnant ponds and morasses. They feed on small aquatic animals. Many of the species are esteemed for the excellence of their flesh; the common European Terrapin (*Terrapene Europæa*) represented on p. 318, is taken in great numbers, fattened in cellars, and sold in the markets of Germany.

In the Land Tortoises (*Testudinidæ*) where our little old-fashioned friend the common Greek Tortoise (*Testudo Græca*) finds its place,—the upper



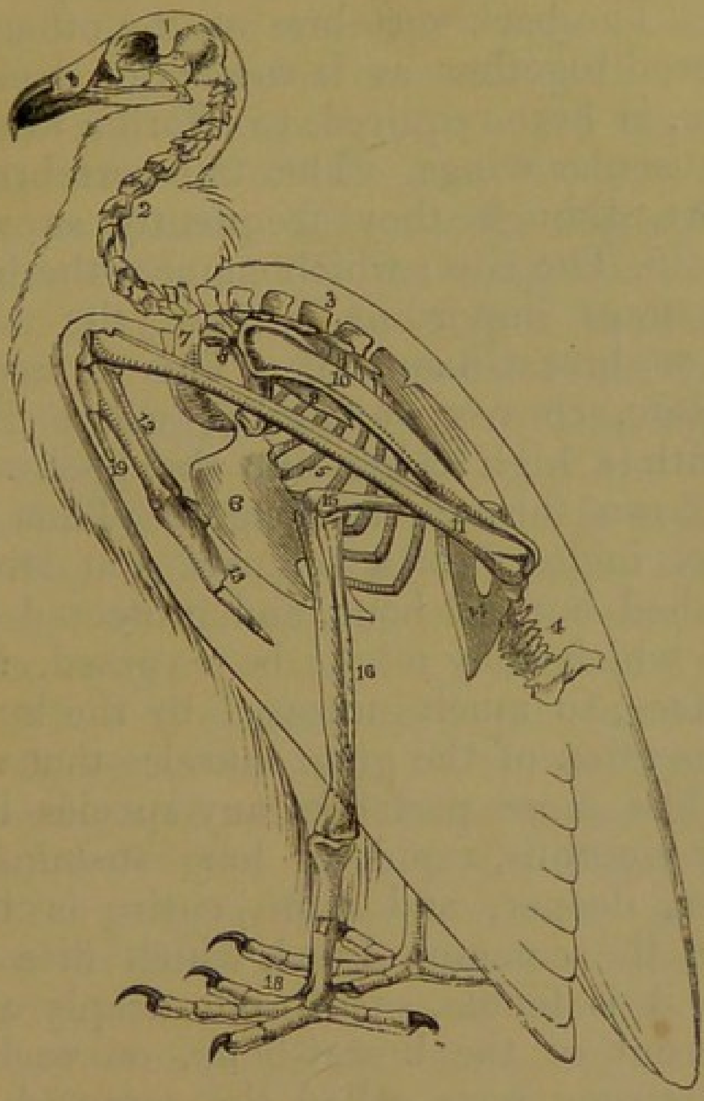
GALAPAGOS TORTOISE.

shell is very high and convex, and the limbs are short and stumpy, appearing as if cut off, terminated on the outside by horny hoof-like claws. They live exclusively on vegetables, such as leaves and fruits; do not seek the water; are heavy and slow in their motions; and burrow in the earth in cold weather: they attain vast longevity. In the tropics there are species of great size, as the Galapagos Tortoise, (*Testudo nigra*) some of which are so heavy, that it requires six or eight men to lift one from the ground; one will sometimes afford two hundred pounds of excellent meat.

CLASS III. AVES.

(*Birds*).

Though there seems at first sight much more resemblance between a Lizard or a Crocodile and a Beast, than between either of these and a Bird, yet on a careful comparison of the latter, especially of its skeleton, we discover that there is no material departure from the common pattern. The bones that form the framework of the one, are found with very trifling exceptions in the other; the principal modifications being those needful to fit the animal for voluntary elevation into, and motion through the air. The accompanying engraving represents the skeleton of a Vulture, a bird of powerful wing, with the contour of the bird drawn in outline, as it would appear if clothed with flesh and feathers. The principal bones are numbered in the figure, and we will refer to them by name, as it is important to be acquainted with their appellations and functions; and it would be no useless exercise for our young readers, to attempt to identify by this means the bones of a sparrow, or other familiar bird, or even those which in the case of the common fowl are so often brought to table. 1, The skull; it is jointed to the spine by a single process; which structure allows great freedom in turning, a very convenient provision for animals, the majority of which rest with the head turned quite round, beneath the wing. The jaws are entirely destitute of teeth, but their place is supplied by a casing of strong horn, brought to an edge on each side of each jaw. The beak of the Falcon cuts the flesh of its prey as readily and



SKELETON OF VULTURE.

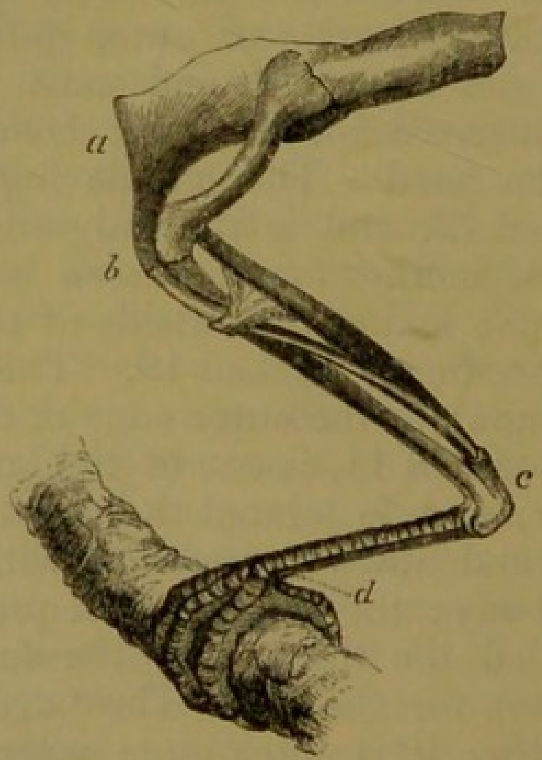
smoothly as a keen knife; that of many other birds bruises and divides hard and woody seeds; with it the Woodpecker and others chisel out neat chambers in the trunks of trees for the lodgement of themselves and progeny; in short the uses to which the beak is capable of being applied are endless.

The series of bones represented at 2, are the vertebræ of the neck; these are much more numerous than in other animals, to give flexibility to this part. No quadruped, not even the long-necked Giraffe, has more than seven neck-joints; but the Swan has twenty-three; thus it is enabled to reach the bottom and take its food, at various depths, as it swims, and thus it can make its beautiful white neck to assume those graceful curves which are so much admired. The back vertebræ on the other hand, 3, are soldered together as it were; for strength, not flexibility, is here required, to afford a firm support to the muscular wings. The tail vertebræ, 4, are very short, though they frequently support long feathers. 5. The ribs; which connect the back-bone with the most important bone of the whole, the *sternum* or breast-bone, 6. This forms a large arched plate, convex outwardly, where it is furnished with a high ridge like the keel of a boat, running down through its length. Thus the vital organs are inclosed in a compact and strong, but light, arched box of bone, and protected from the injury to which they might be exposed, while the large surface, so much increased by the keel, serves for the insertion of the great muscles that move the wings. The more perfectly any species is constituted for vigorous, rapid, or long sustained flight, the larger, deeper, and more entire is this bone found; in the common Fowl, which flies very imperfectly, it is feeble, small, and deeply cut away. To the front of the breast-bone, on each side is jointed a strong bone called the *coracoïd*, 8, which carries the shoulder-blade, 9, formed somewhat like a sword. The bones of the wing, which we shall presently describe, are articulated to this. The force with which they strike the air in flight, would press the shoulder-blades towards each other, were it not for the intervention of an arch of bone placed between them, which by its strength and elasticity keeps them apart. This arch is well known as the merry-thought (*furcula*), and is analogous to the collar-bone in man: it is marked 7 in the figure.

The wings represent the fore legs of quadrupeds or the arms of man. The shoulder or upper arm, 10, is attached, as we have said, to the shoulder-blade, at the point where the latter meets the coracoid and the merry-thought: it carries at its other extremity the two united bones, 11, of the fore-arm, the longest bones in the skeleton. Along the larger of these are inserted the secondary quills of the wing; and the primaries or outer quills, which are the longest and strongest, and most important in flight, are inserted on the next bone, 12, which represents the hand. The middle finger has three joints, marked 13, and is the only one developed; a rudiment of another finger is seen beside the first of these joints; and at the outside of the hand-bone is a small fore-finger marked 19. This last carries the little winglet, at the outer edge of the wing.

The part marked 14, is one of the lateral portions of the *pelvis;* to it is jointed the thigh, 15, a rather short bone, and always concealed within the outline of the body; the leg, 16, is frequently but improperly called the thigh, and the foot, or *tarsus,* 17, is mistaken for the leg. The 'drumstick' of a Fowl is the leg; it is much more muscular in those birds which have the powers of flight feeble, and which walk a great deal, as the species just named. The tarsus, or foot, is elevated, and does not rest on the ground in walking, as do the toes, 18. These are generally placed three before, and one behind; but not invariably; and sometimes one (in the Ostrich even two) is wanting.

It may have often excited wonder that a bird sleeps so securely when sitting on its perch, instead of falling off as we naturally expect it to do, when the muscular action is relaxed during repose. But this arises from the structure of its leg and foot. The tendons of the muscles that bend the toes pass over the joint of the heel, and are there joined by another muscle, which passes over the knee, so that the bending of the heel necessarily produces a bending in of the toes. When a bird therefore alights on a twig, the weight of its body bends these joints, and thus stretches the tendons; the toes are at the same time strongly drawn in, and thus clutch the branch without any effort of the will, nor can the grasp be relaxed until the bird voluntarily raises its body.



LEG OF A BIRD PERCHING.

The above engraving will illustrate this subject. At *a*, is a muscle, which, arising from the haunch-bone, becomes suddenly tendinous, and passes the outer angle of the thigh-joint at *b*; then winding round the leg-bone, it slips over the heel at *c*, proceeds forwards along the tarsus to *d*, when it divides, and is inserted into the bones of the toes. The grasping action of the latter by the bending of the other joints will thus be clearly perceived.

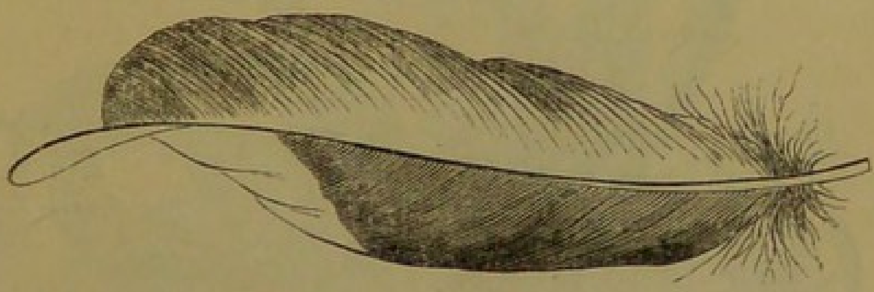
As flight is the grand characteristic action of Birds, so the whole body is constructed (not to speak of individual exceptions) with a view to this sort of motion. The greatest amount of muscular energy is spent upon the wings, which by their forcible strokes upon the air give the impulse which bears the body forward, while to diminish the weight of the mass, the bones are hollow, and penetrated with air, communicating with the lungs. Large reservoirs of air are also irregularly placed all about the body; the lungs themselves are very large; and as respiration is performed in very high perfection, a large amount of animal heat is produced, so that the volume of air collected within the body is rarefied and made much lighter than the atmosphere. When we read of such beautiful and effectual contrivances wrought out by the wisdom of God for the safety and comfort of His irrational creatures, we are reminded of the words of our Blessed Lord:—"Are not two sparrows sold for a farthing? and one of them shall not fall on the ground without your Father!"

The peculiar clothing of Birds is also formed with respect to the same design. It is light, close, and very warm, all qualities needed by animals which career through the thin cold atmosphere among the clouds. No apparatus could be devised so well suited to give the powerful stroke upon the air, which sends a bird forward, as the firm, slightly arched, overlapping quill-feathers of the wing. We have already named the primaries, and the secondaries, which are the chief instruments of this action; the tertiaries are weaker, and usually shorter, and lie within the secondaries; they are inserted along the upper arm. The feathers that overlap the bases of all these series of quills are called *coverts*, of which there are three rows, and still nearer to the body are feathers called *scapulars*. The tail consists of strong feathers resembling the quills of the wing, but having both sides equal; they are usually, not always, twelve in number. Above them as well as beneath is a range of *tail-coverts*. All these, as well as the general scale-like feathers of the body, are beautifully and smoothly laid one upon another, an arrangement that materially facilitates the action of flying; for while on the one hand they offer no resistance to motion forward, but lie closer and closer as the pressure of the air is increased, on the contrary, the impulse backward produced by the bringing forward of the wings after each stroke, is resisted by the free edges of the feathers rising and catching the air; a resistance which increases with the pressure.

Each feather consists of two parts; a light but firm shaft formed of a pithy substance, hollowed at the lower end into a horny tube, containing the blood-vessels by which it is sustained; and the vane, a double series of parallel thin plates, one on each side the shaft, set at an angle to it, which are themselves furnished at their edges with a similar though smaller series. In all feathers which are destined to strike the air, these branchlets are hooked into one another, so as to present a continuous surface of astonishing firmness.

The feathers of Birds are shed and renewed at certain times, as is well known to every one who has a tame Canary or Goldfinch, who is probably also aware that the period of *moulting*, as the process is termed, is one of discomfort or even sickness to the Bird. There are periodical changes in the colours of the plumage, however, which are not produced by moulting, as has been explained by Mr. Yarrell. He thus enumerates the modes in which changes are effected:—1. By the feather itself becoming altered in colour. 2. By the Bird's obtaining a certain portion of new feathers, without shedding any of the old ones. 3. By an entire or partial moult, in which the old feathers are thrown off, and new ones produced in their places. 4. By a wearing off of the lengthened lighter-coloured tips of the feathers, by which the brighter tints of the plumage beneath are exposed.

The forms of feathers are very various; sometimes they are greatly lengthened, or widened, either throughout or in parts, or singularly curled. The barbs in some are loose, thin, and set far apart; in other cases a portion of the shaft is destitute of barbs, on one or on both sides, giving a singular appearance to the part which is barbed. The outline of the vane is sometimes cut or notched into fantastic forms. The elegant crest of the Peacock, and the hairy tuft on the breast of the Turkey are modifications of feathers. In the Bohemian Waxwing (*Ampelis garrulus*) the shafts of some of the

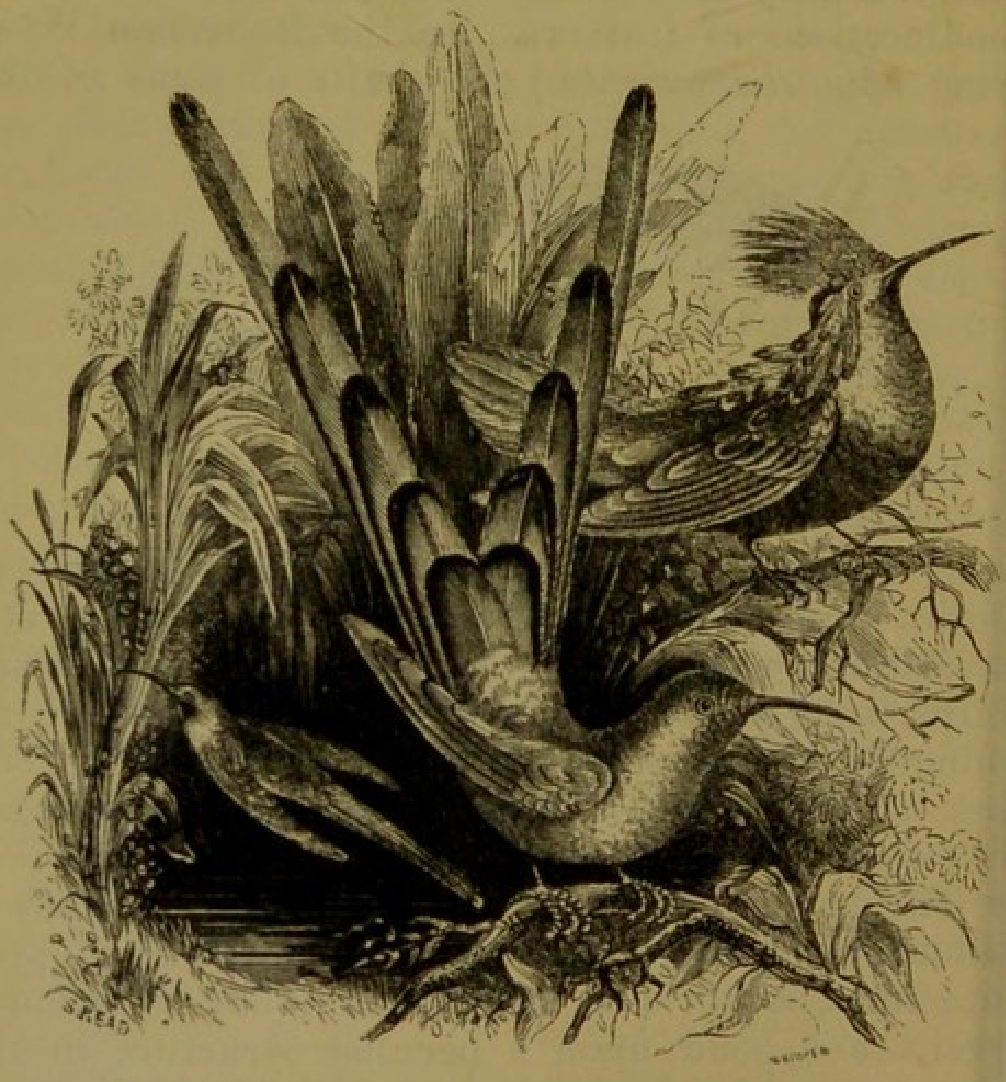


FEATHER OF WAX-WING.

wing-quills have their tips extended beyond the barbs, and dilated into a flat oval plate exactly resembling red sealing-wax. The feathers of many birds, such as the Birds of Paradise, and the Humming Birds, are endowed with the power of reflecting the most rich and varied hues with a refulgence like that of burnished metals or precious stones.

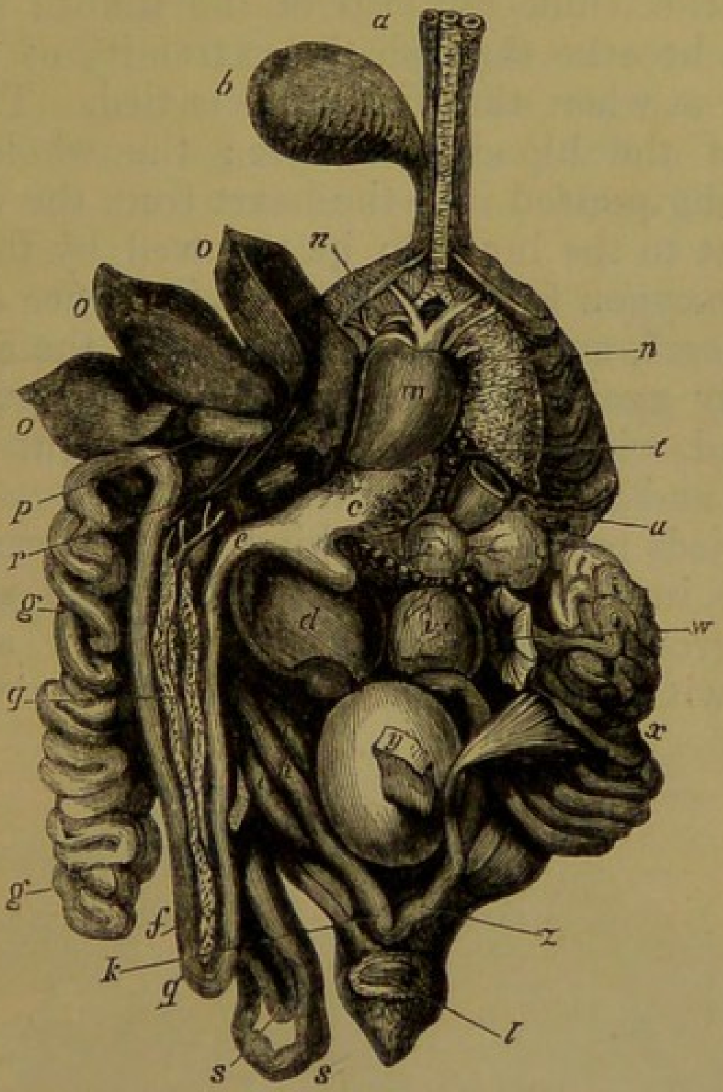
The cause of these brilliant gem-like reflections of colour, changing in different lights to the most opposite hues, is not well understood; they seem, however, to depend upon a peculiar structure in the close, scale-like feathers with which these birds are clothed, and are usually seen in the highest perfection on the throat and crest.

As the beak of a bird is destitute of teeth, its food is not susceptible of any chewing in the mouth; it is therefore for the most part swallowed as soon as taken. But in such species as feed on hard grains and seeds, as the Poultry Birds, for instance, and the Finches, it is needful that there should be some provision for grinding down their solid food. A glance at the inside of a Fowl about to be drawn for the table, will show how the process of digestion is effected. The food passes from the mouth through a wide gullet, which about the middle opens into a large bag called the *craw* or *crop*. The food lies some time in this receptacle, where it is softened by the heat and moisture ; it then passes down into the



HUMMING BIRDS.

membranous stomach, another enlargement of the gullet. The sides of this organ are studded with a number of little glandular cells (*follicles*) which pour out a copious secretion of fluid to be mingled with the food while it is undergoing the process of grinding in the next chamber, called the gizzard. This is formed of two hemispherical muscles of great density, the two faces of which work on each other like the stones of a mill, so effectually as to bruise and wear down the hardest substances in a very short time. Their action is aided by gravel, pebbles, and similar matters which the instinct of grain-eating birds teaches them to swallow. The food thus ground down and digested, passes into the intestines. In some birds the crop can hardly be distinguished;



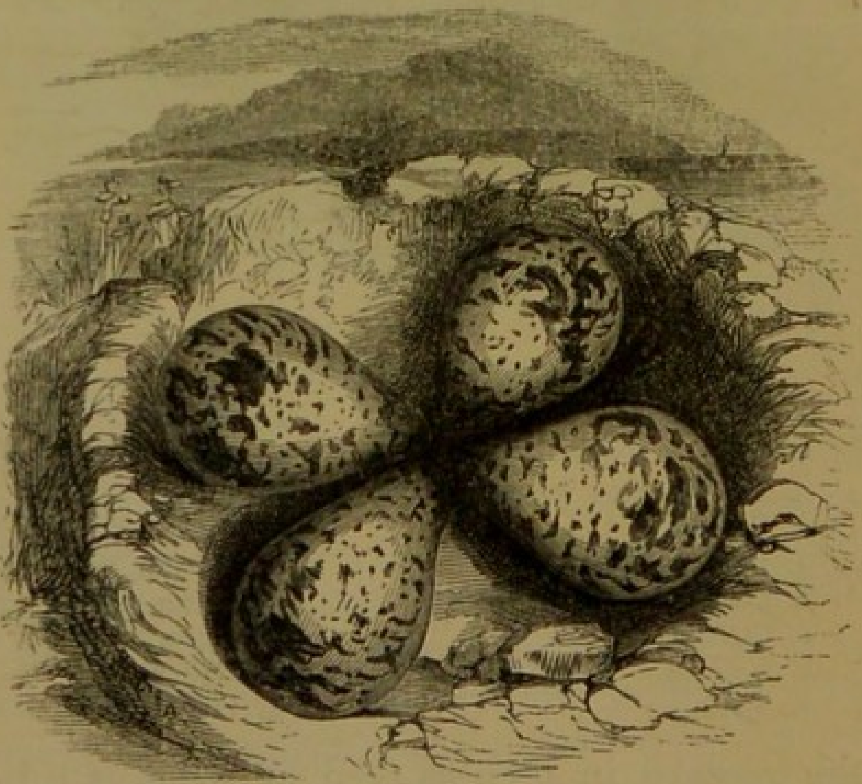
VISCERA OF FOWL.

a. Trachea.	*m.* Heart.
b. Crop.	*n.* Lungs.
c. Membranous Stomach.	*o.* Liver.
d. Gizzard.	*p.* Gall-bladder.
e, f, g. Duodenum.	*q.* Spleen.
h. Colon.	*r.* Spleen-ducts.
i. Cæcum.	*s.* Cæca.
k. Rectum.	*t, u, v.* Ovary.
l. Vent.	*w, x, y, z.* Oviduct.

and the gizzard in such as feed on flesh, is thin and almost membranous.

Breathing in birds is carried on wholly in air, and is performed by means of lungs. These organs are spongy bodies fastened to the inner surface of the ribs along each side of the spine. The cells of the hinder portion are larger than those of the front part; and extend themselves into every part, not only of the trunk but also of the limbs; so that a bird can breathe through the extremity of a broken bone, even when the wind-pipe is tied. The circulation of the blood is double; the whole of this fluid being poured into the heart from the veins, and then sent to the lungs to be renewed by the admixture of oxygen from the air. It is thence sent back to the heart, and distributed through the arteries to the body again. The heart for these purposes is furnished with four chambers, the right and left auricle, and the right and left ventricle.

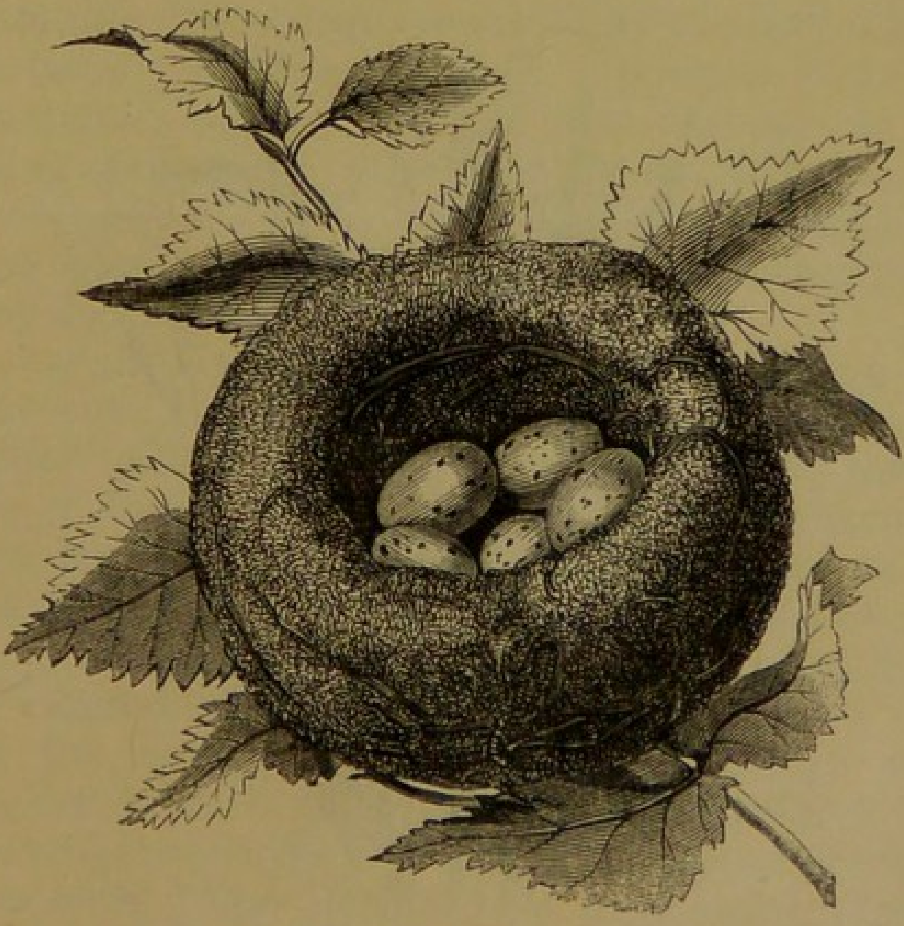
All birds produce their kind in the form of eggs inclosed in a brittle shell of calcareous substance. Their ground-colour is usually white, sometimes tinged with brown, and more frequently with blue



NEST OF THE DUNLIN.

or green. Some are unspotted, others are studded with specks and blotches of various hues; more abundantly towards the larger end. The term *oval* sufficiently expresses their common form, but some are nearly globular, others lengthened, and many, especially of marine birds, somewhat conical. As an instance of the last form we give a figure of the eggs of a common Sandpiper, the Dunlin (*Tringa variabilis*). One reason for this pointed shape is suggested by the late Bishop of Norwich in his pleasing History of Birds.

"Most of the little birds of this tribe make no regular nests, but deposit their eggs, four in number, either in a slightly-scratched cavity among sand and pebbles, which they so much resemble in size and colour that they are not easily discovered, or, like



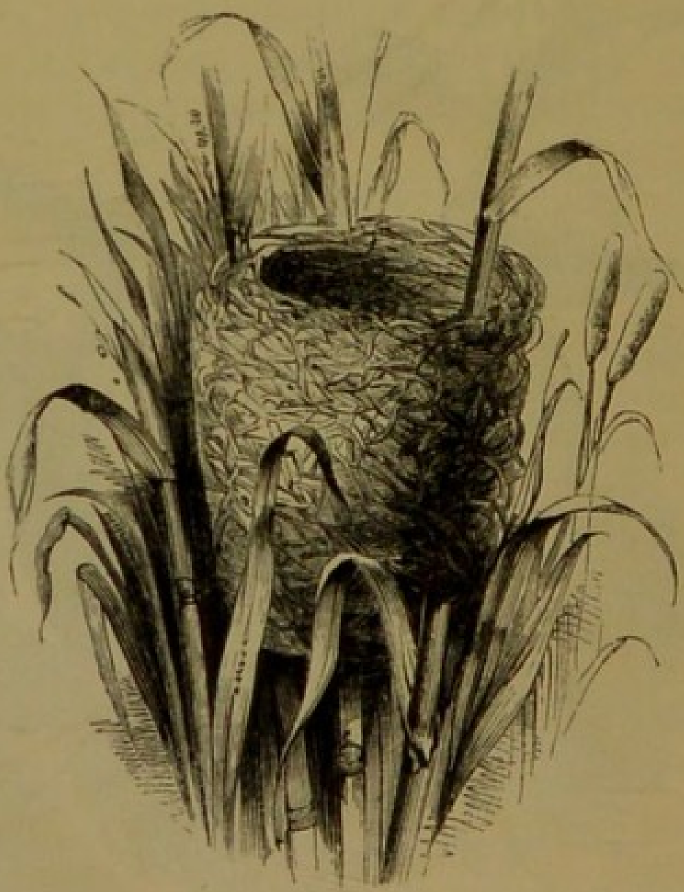
NEST OF GOLDFINCH.

the Sea-Snipe, on the ground, among long grass and heather; they construct a nest of a little moss, and some dry leaves and fibres. The bird contrives to place her eggs so that they occupy the smallest possible space; and this she effects by making them all meet at their smaller ends, which also taper much more than most other birds'."*

From the eggs, we are naturally led to speak of the nest, that miracle of instinct.

> "A bird's nest. Mark it well, within, without!
> No tool had he that wrought, no knife to cut,
> No nail to fix, no bodkin to insert,
> No glue to join;—his little beak was all;
> And yet how neatly finished! What nice hand,
> With all the implements and means of art,
> And twenty years' apprenticeship to boot,
> Could make me such another?"

One great essential in the nest is that it shall form a defence against the cold of the external air, from



NEST OF SEDGE WARBLER.

which both the eggs and the tender young might otherwise suffer. Hence though the materials are

* Familiar History of Birds, 360.

exceedingly various, they are generally such substances as are non-conductors of heat; moss, twigs, grass, straw, wool, cotton, the down of plants, fur, feathers, are among the most common materials.

Another important point is, that it shall form a cradle in which the eggs and helpless young may lie safely. A few birds there are, as the Pigeon tribe, which make merely a flat and rude platform of twigs, but in general the nest is more or less hollow. A great variety indeed is observable in their forms, as well as in the modes in which they are fixed to the surrounding objects. Some take the form of a deep cup, as that of the Sedge Warbler (of which there is a beautiful specimen in the British Museum). "It is closely woven of roots, wool, and hair, admirably adapted for the warmth required by so small a bird; it is usually built over water, supported in an elegant manner between three or four rushes. In this floating cradle, even if rocked by the tempest, the hen securely sits without fear or dread, though every strong blast of wind bends the reeds to which it is suspended, close to the water."

Some are built in the form of a globe, with a hole at one side for the entrance of the parent bird; the common cup receiving the addition of a vaulted dome of similar materials. The nest of the common Wren is a British example, as is also that of the Long-tailed Tit, which sometimes has a sort of neck or lengthening of the mouth. This is a most beautiful example of a domed nest.

In the tropical regions, and other foreign countries, many birds build purse-like nests, which they suspend between the slender twigs, beyond the reach of enemies. The Banana bird of Jamaica (*Icterus leucopteryx*) weaves horse-hair into a sort of haircloth to form its deep hanging nest; and the Baltimore bird of North America (*Icterus Baltimorus*) forms a similar structure. Few receptacles for future progeny possess such convenience, warmth, and security, as the nest of this industrious little bird. It generally fixes on the upper branches of an apple, willow, or tulip-tree, in the vicinity of a farm-house, fastening strong strings of hemp, or flax, round two forked twigs, corresponding to the intended width of the nest; with the same materials, mixed with quantities of loose tow, it interweaves or fabricates a strong firm kind of cloth, not unlike the substance of a hat in its raw state, forming it into a

LONG-TAILED TIT AND NEST.

pouch of six to seven inches in depth, lining it substantially with various soft substances, well interwoven with the outward netting; and lastly, finishes with a layer of horse-hair, the whole being shaded from the sun and rain by a natural pent-house, or canopy of leaves.*

* Wilson's Amer. Ornith.

A still more ingenious artificer than any of these is the Tailor-Bird of Hindostan, so called from its ingenuity in forming its nest. It first selects a plant with large leaves, and then gathers cotton from the shrub, spins it to a thread, by means of its long bill and slender feet, and then, as with a needle, sews the leaves neatly together to conceal its nest.*

NEST OF BALTIMORE ORIOLE.

We shall only notice further the structures of those birds whose social instinct impels them to live in company; and to unite their powers in the construction of a common edifice; in this respect resembling the Beaver among quadrupeds, and the Bee among insects. Among these we may mention

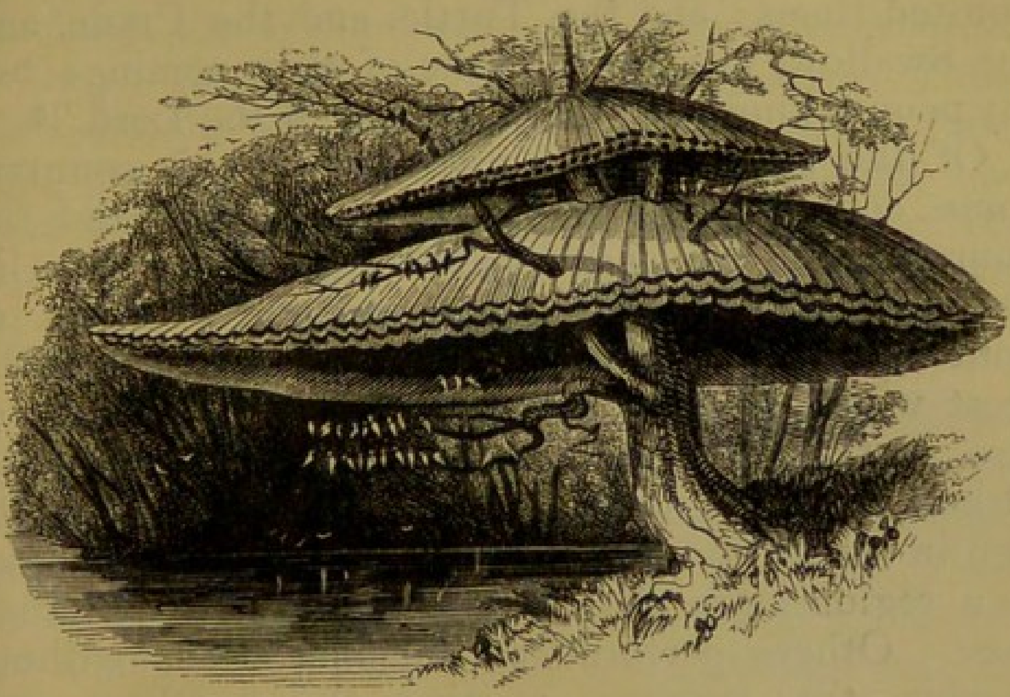
* Forbes, Oriental Mem. i. 55.

the Ani (*Crotophaga ani*) of the West Indies, the Pensile Grosbeak (*Loxia pensilis*) of West Africa, and the Bottle-nested Sparrow of India; but more remarkable than any of these is the Sociable Grosbeak (*Loxia socialis*) of South Africa, whose habits are described by Le Vaillant.

"Figure to yourself," says this enterprising traveller, "a huge, irregular, sloping roof, with all the eaves

NEST OF TAILOR-BIRD.

completely covered with nests, crowded close together and you will have a tolerably correct idea of these singular edifices." The birds commence this structure by forming the immense canopy of a mass of grass, so compact and firmly basketed together, as to be impenetrable to the rain. This sometimes sur rounds a large tree, giving it, but for the upper branches, somewhat the form of a mushroom. Beneath the eaves of this canopy, the nests are formed;



NEST OF SOCIABLE WEAVER-BIRD.

the upper surface is not used for this purpose, but as it is sloping, with a projecting rim, it serves to let the rain-water run off, and preserves each little dwelling from the wet. Le Vaillant procured one of these great shelters, and cut it in pieces with a hatchet; the chief portion consisted of Boshman's grass, so compact as to be impenetrable by rain. Each nest is three or four inches in diameter, which is sufficient for the bird; but, as they are all close together around the eaves, they appear to the eye to form but one building, and, in fact, are distinguishable from each other only by a little external aperture, which serves as an entrance to the nest. This large nest contained three hundred and twenty inhabited cells.

There is scarcely anything in the economy of birds more interesting than their migrations from clime to clime at certain periods of the year. The certainty and punctuality of these journeyings to and fro have been long noticed: thus the prophet Jeremiah uses them in one of his earnest and affectionate appeals to his backsliding countrymen. "Yea, the Stork in the heaven knoweth her appointed times; and the Turtle, and the Crane, and the Swallow, observe the time of their coming; but my people know not the judgment of the Lord."*

Of the birds that are migratory in this country, some come hither in spring to breed, spend the summer with us, and depart to southern climes in autumn. Others come to us on the approach of winter, from countries where the severity of the frost would shut up their sources of food, and retire northward on the opening of spring to breed. Others again are mere passengers, seen for a day or two in spring and autumn as they pass on their way to a region more northerly or more southerly than ours. Others perform partial migrations without leaving the country, visiting the northern and southern parts, or the coast and the inland regions periodically.

"When the primrose, the daisy, the violet, and other early flowers make their appearance," remarks a popular naturalist, "we begin to look for the return from southern climes of those birds which we are accustomed to observe during the summer months. The Wheat-ear is seen on the wall-tops and sandy downs, the Whin-chat among the thickets of furze, and the Ring-ouzel in the hilly districts. As the season advances, when the hawthorn displays its fresh young leaflets, and the sloe is covered with a profusion of sweet white flowers, the different species of Swallows enliven the air, seen at first one by one, or in small numbers in sheltered places, but soon swarming over the meadows and the groves. The shrill scream of the Swift, as it wheels its rapid flight over the houses, next informs us that the summer is about to commence. Then is heard from the wood or the hill-side the well known cry of the

* Jer. viii. 7.

Cuckoo, and in the quiet evening the singular 'crake' of the Land-rail issues from among the long grass of the dank meadows. By this time numerous warblers have arrived; the Nightingale, the Redstart, the Blackcap, the Willow-wren, and other species which nestle in the gardens, hedges, and groves. These birds remain with us during the fine season, rear their young, pursue their various avocations, and when the cold nights of autumn apprise them of the approach of winter, when food would fail them in our climate, they take their departure, and travel towards warmer regions.

"While the inland districts are thus gladdened with the return of these interesting Birds, the shores of the ocean swarm in many places with summer visitants. The Gannet, the different species of Tern, the Auk, the Guillimot, the Puffin, the Eider Duck, and many other birds, betake themselves to the rocky headlands, or the remote islets, where they find a retreat, not always secure from the violence of men, in which they deposit their eggs, and rear their young.

"Towards the end of summer the species which occur in these breeding places begin to disperse, their numbers becoming perceptibly diminished immediately after the young have begun to fly; and by the middle of September they have entirely deserted their summer residence, leaving it to its ordinary inhabitants, the Cormorants and a few straggling Gulls.

"About the same period, the numerous species of Sylviæ, Saxicolæ, and other small birds, the Swallows, Martins, Land-rails, and all those whose appearance in spring afforded us delight, as indicating the approach of the sunny season, disappear from the groves and fields. The Robin has already arrived in the gardens, the Yellow-bunting, the Linnet, and other small birds congregate in large flocks, frequenting the neighbourhood of the farm-houses, and the Snipes and the Plovers are occasionally met with in the low grounds. Now we begin to see Birds which had disappeared at the beginning of summer. Flocks of Fieldfares and Red-wings cover the fields: the Woodcock is found in the marshes and by the sides of rills; Snow-buntings are spread along the sandy shores, on which also we perceive the Purre, the Sanderling, and Turnstone; while the bays and arms of the sea are sprinkled over with Divers, Gulls, and Ducks that have escaped from the rigours of the arctic winter."*

The well known song of birds is associated with everything that is delightful in Nature; it is heard in its fulness and perfection in spring, when the long reign of winter is at last ended, and the fields and trees have put on their livery of pleasant green. We can well appreciate the beautiful imagery of the sacred Poet: "Lo, the winter is past, the rain is over and gone; the flowers appear on the earth; the time of the singing of birds is come, and the voice of the Turtle is heard in our land."† The music of Birds is certainly no less delightful to the performer than it is to the auditors. "Nobody can doubt," observes Bishop Stanley, "who sees a bird singing, clapping its little wings, turning from side to side, and glancing its bright eyes in all directions as if courting attention and admiration, that it feels delight and satisfaction. Did we require further proof we have but to recollect that the song-bird is most on the alert with the music of its voice, when its affections and interests are awakened by attention to its mate during the time of rearing its young."‡

The great variety and power we observe in the voices of birds depends on the construction of their windpipe, that cartilaginous tube by which the lungs communicate with the air. In man the modulations of the voice are produced by means of an enlargement of the windpipe, termed the larynx, situated just beneath the root of the tongue. But

* Fac. of Birds, 249. † Song of Solomon, ii. 11, 12.
‡ Fam. Hist. of Birds, 65.

in birds there is another enlargement of the wind-pipe, just where it separates into the two tubes, which go to each lobe of the lungs. It is this bony chamber, called the *lower larynx*, which is the organ of voice in birds. Attached to the sides of this box or chamber, there are, in singing-birds, five pairs of muscles, which by their contractions enlarge or diminish, or variously modify the cavity, and thus govern and modulate the sounds produced by the air, which is forced through it from the lungs. In Parrots there are but three pairs of vocal muscles; in many of the Waders and Birds of Prey there is but one pair; and in Poultry there is no special muscle for this purpose. In some birds whose notes are very loud and clanging, there is a tense membrane stretched within the *larynx*, that performs a part similar to that of the reed in a clarionet.

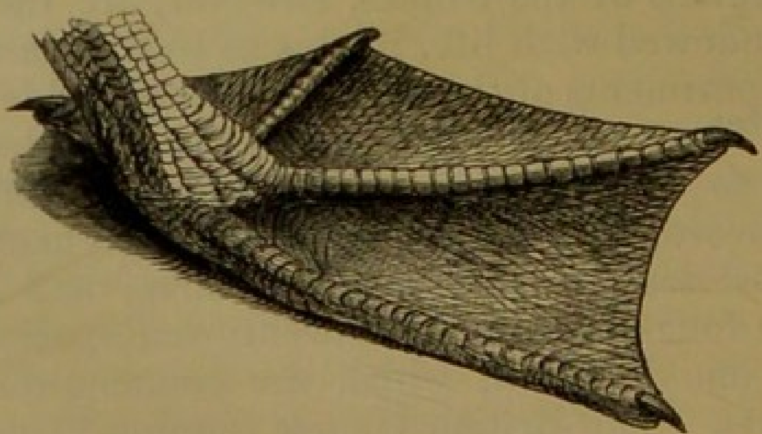
Birds rank next to Fishes in the extent of their geographical distribution. They are found in all climes, at all elevations, and under all circumstances. The teeming forests of the tropics, the ice-clad precipices of the polar seas, the barren deserts, the lofty mountain-tops, the rocky islets of the ocean, and even the boundless ocean itself,—all are tenanted by peculiar species of this interesting Class. The sunny regions of the tropics, however, are the most richly endowed with life, in this as well as in all the other departments of the Animal and Vegetable Kingdoms. The total number of species described, belonging to this Class, is about six thousand. Of these, according to the Prince of Musignano, Europe possesses five hundred and three, and North America four hundred and seventy-one species; including one hundred, which are common to both continents. The British Islands number three hundred and thirty-six species, all of which are figured in Mr. Yarrell's beautiful "British Birds;" nearly one third of the whole belong to the Natatorial Order, or that of Waterfowl, in which from her great extent of coast, and her numerous rivers, bays, and coves, Great Britain is particularly rich. The numbers of the different Orders are thus arranged:—Waterfowl, ninety-eight; Waders, sixty-seven; Poultry, eighteen; Perchers, one hundred and twenty-one; Birds of Prey, thirty-two. These orders are respectively denominated,—*Anseres, Grallæ, Gallinæ, Passeres,* and *Accipitres.* We must content ourselves with a brief notice of each of these.

ORDER I. ANSERES.

(*Waterfowl.*)

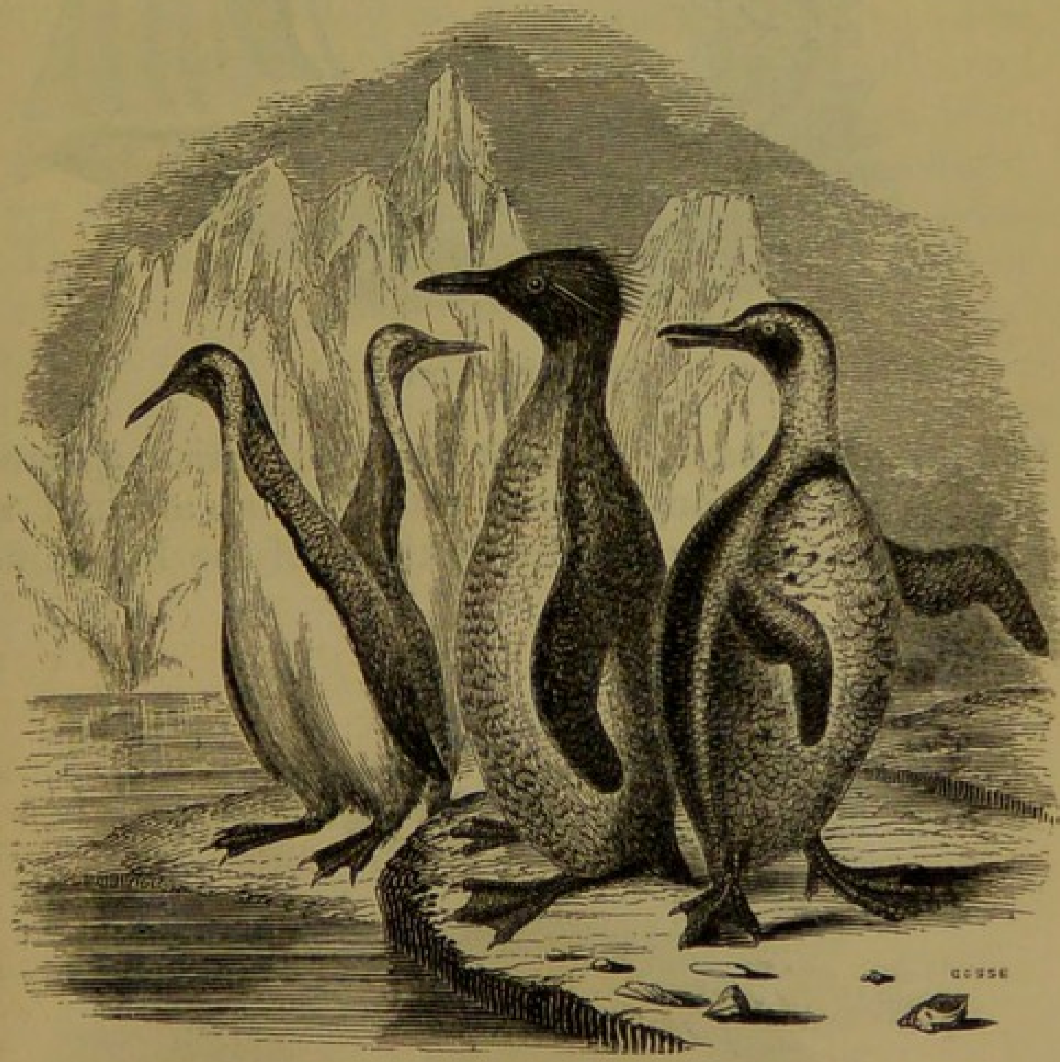
This extensive and universally distributed Order is marked by a character easily recognized. The toes are united to each other by a membrane stretched between them, commonly termed a *web;* which gives to the foot the form of a broad, flat, and powerful oar, and at once marks the possessor as an inhabitant of the water. The feet are usually placed far back on the body, whereby their power, as oars, is much increased. The body is flattened horizontally, the better to float on the surface.

It may seem fanciful to seek any connecting link between animals so different as Reptiles and Birds,



FOOT OF PELICAN.

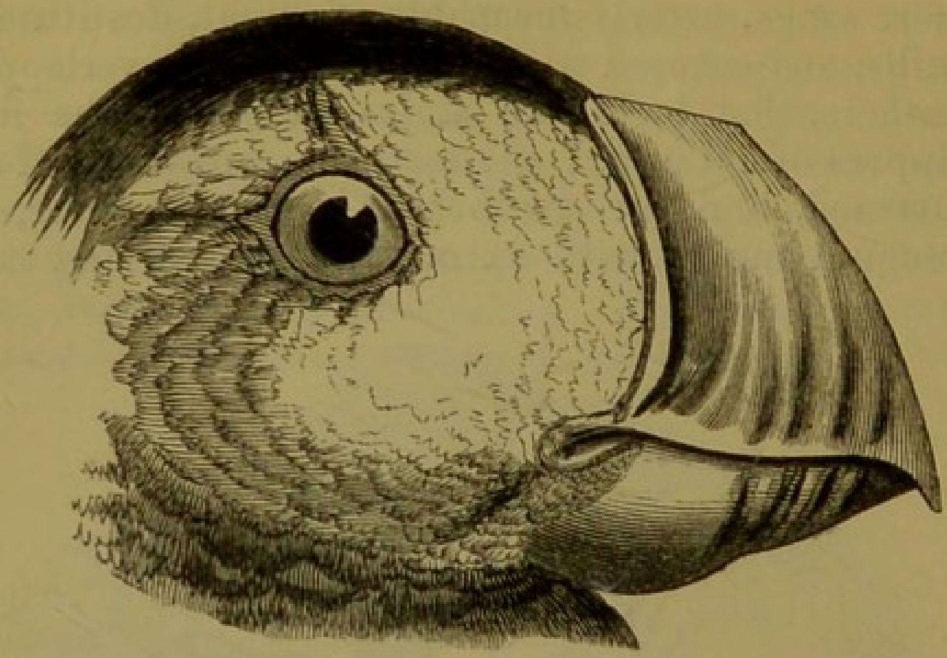
yet there is a tribe of birds, which we can hardly look upon without being forcibly reminded of the former; it is that of the Penguins (*Alcadæ*). The short wings, utterly incapable of flight, destitute of quills, and covered with close-set, stiff, overlapping feathers, that look like scales, resemble the fore-flippers of a Turtle; the feet, too, are widened and flattened, and set far behind. In the water, the Penguin moves with extraordinary ease and fleet-



PENGUINS.

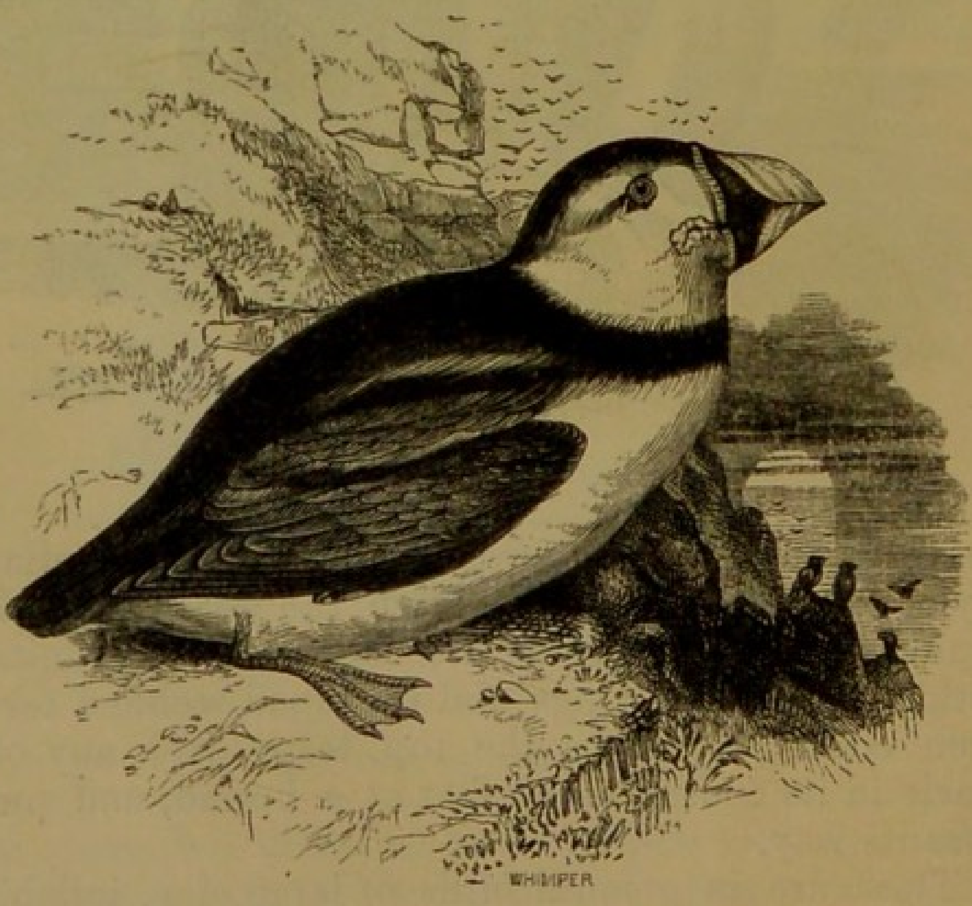
ness; it dashes along over the surface in gallant style, or diving, shoots through the water with the rapidity of a fish, urging its course by the united action of its finny wings and its broad webbed feet; then coming again to the top, leaps over any obstacle in its course, many feet at a bound, and pursues its way.

These are in general birds of large size, inhabiting the rocks and desolate shores of the southern



BEAK OF PUFFIN.

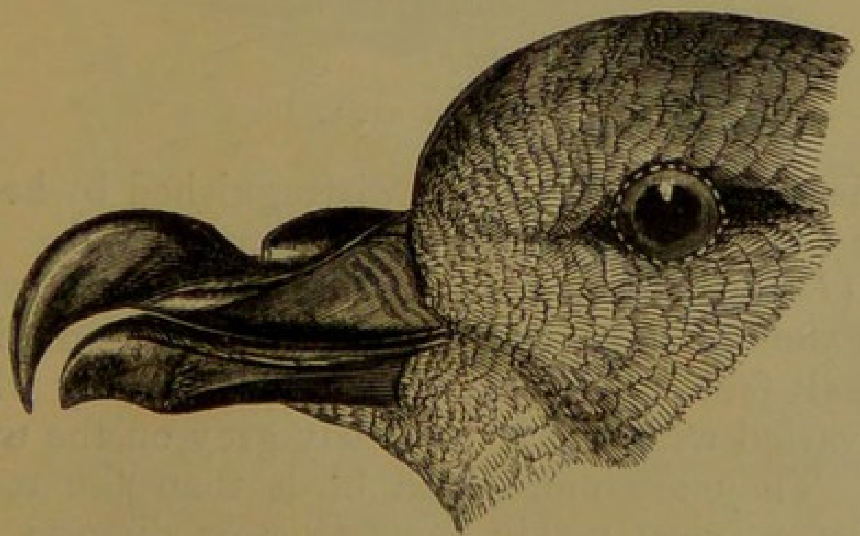
Ocean. We have, however, several British species, whose wings, though short and feeble, are not so utterly incapable of flight, as those of the Penguins.



PUFFIN.

One of the most remarkable is the Puffin (*Fratercula Arctica*) the beak of which is very deep vertically, but thin; it is furrowed, and marked with bright colours. This grotesque bird resorts in summer to our rocky coasts, for the purpose of breeding. It lays a single egg in the clefts of the rocks, or on the ledges of the cliffs, where hundreds may be seen sitting in an upright attitude. The feathers are very abundant, and being soft and downy, are valuable for beds: therefore these, with other Water-fowl of similar habits, are much sought after by the hardy inhabitants of the Scottish isles.

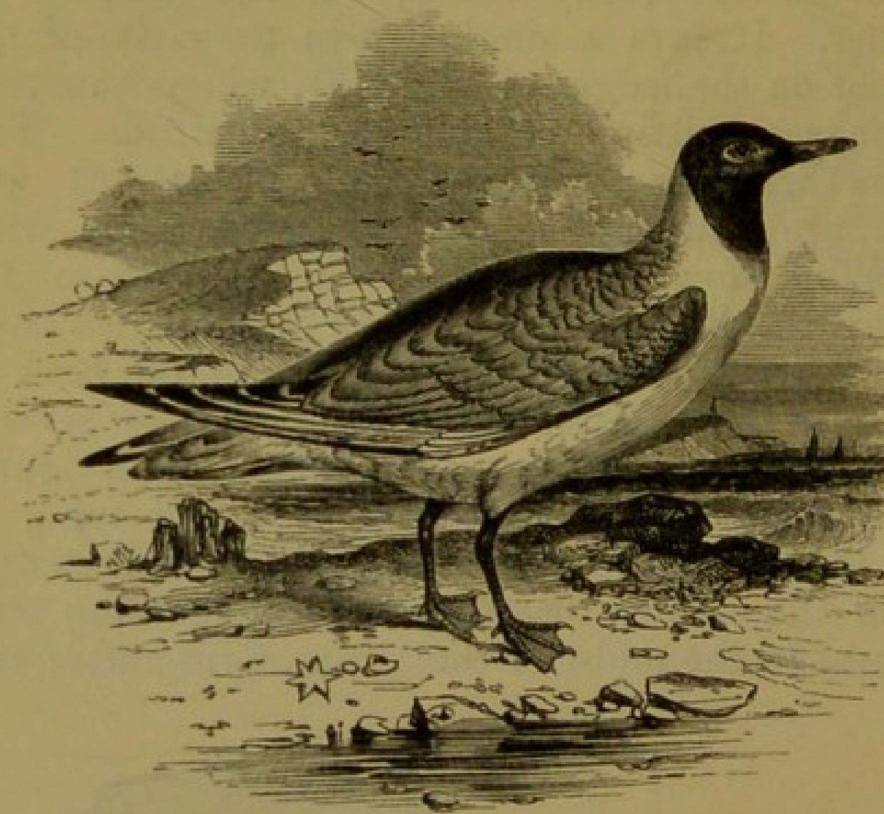
The Petrels (*Procellariadæ*) also have the beak of a singular form, apparently composed of several pieces, as will be seen from the accompanying figure. The upper mandible carries a projecting tube, in which the nostrils terminate. These are eminently birds of the ocean; they may be seen coursing over the waves in the midst of the storm, flying after and



BEAK OF PETREL.

around ships, to pick up fragments of grease, or other food, frequently patting the wave with their little webbed feet, as if walking on its surface. From this action they derive their name Petrel, as if, like Peter, they walked upon the water. The Stormy Petrel, and one or two other species, are sometimes seen on our coasts: they are the smallest of web-footed birds.

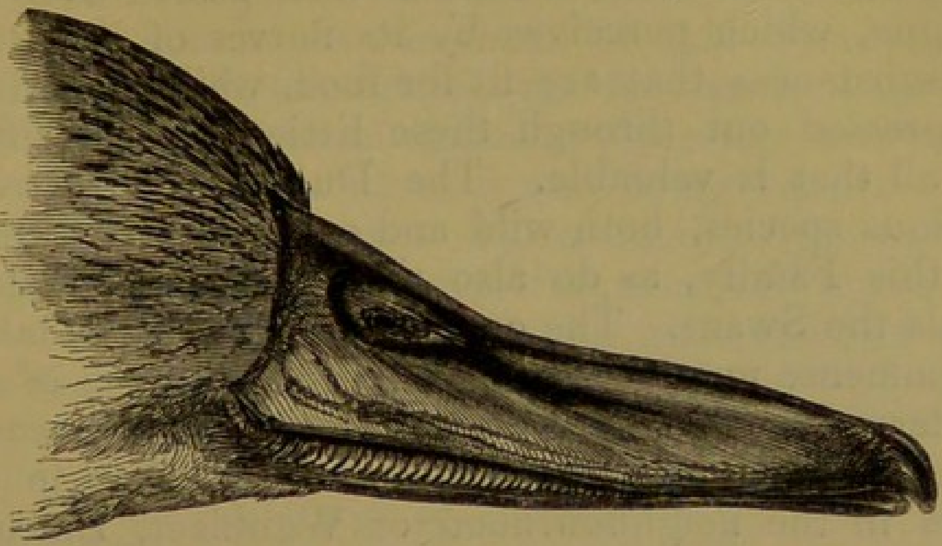
We can only just allude to the Pelicans (*Pelecanidæ*), represented by our voracious Cormorants;



LAUGHING GULL.

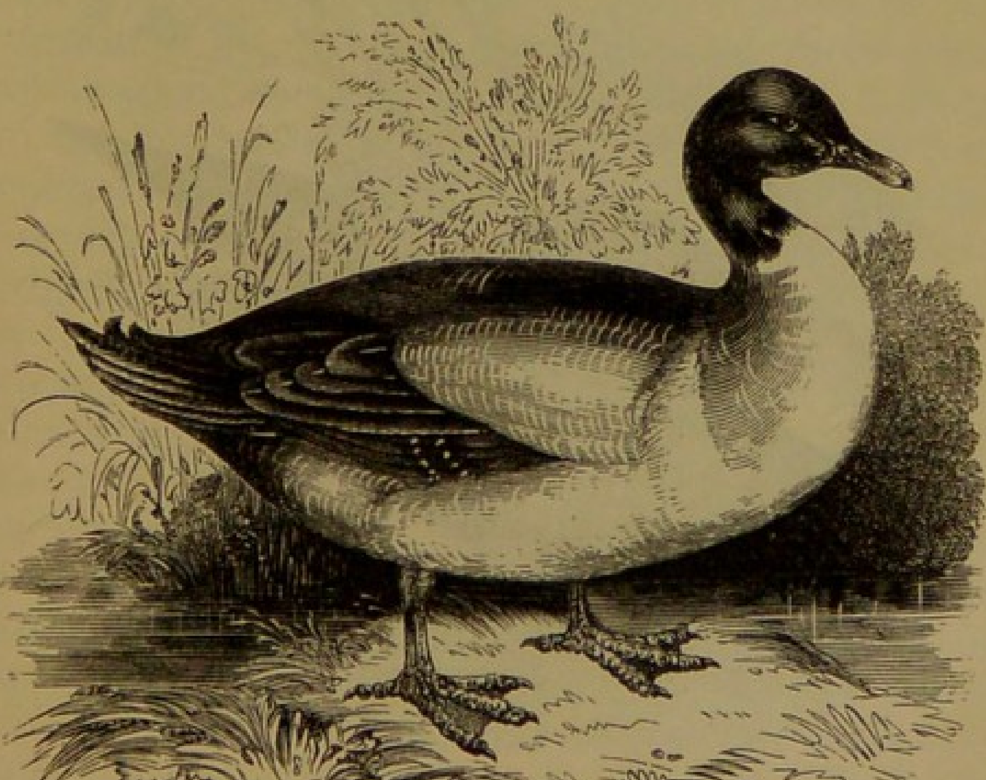
these feed on fishes, and are distinguished by having all the four toes united in the common web. The Gulls (*Laridæ*) also we must briefly dismiss, which have a slender compressed beak, long pointed wings, and small feet. Their plumage is commonly white, often varied with black or pearly grey on the upper parts. They are more land birds than the rest of this Order, very rarely swimming or diving: they fly and walk with ease and elegance. The Terns, or Sea Swallows (*Sterna*), remarkable for their long forked tails and pointed wings, belong to this Family, of which we have many British species.

The Ducks (*Anatidæ*) form an extensive and valuable Family, from the flesh being in general juicy, tender, and well flavoured. Their feathers also are prized for their softness and elasticity. The principal character is the beak; it is thick, broad, high at the base, covered with a soft skin, except a nail-



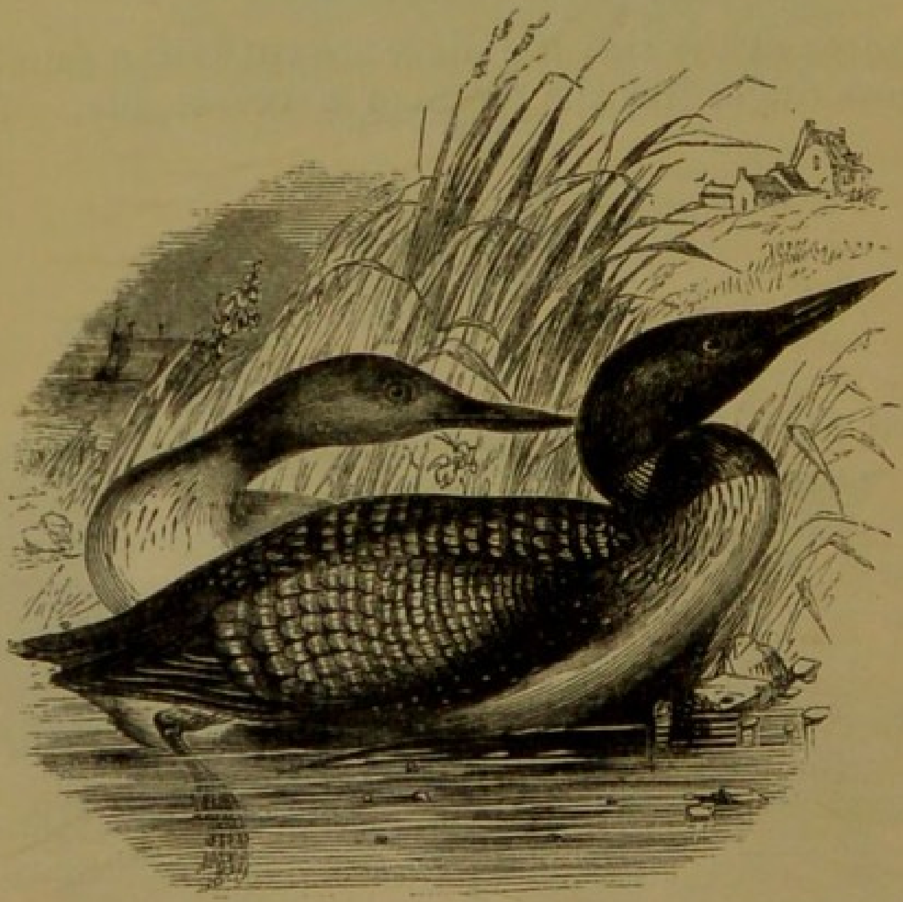
BEAK OF DUCK.

like piece at the tip; the edges are cut into a number of cross ridges like the teeth of a coarse file. The



DUCK.

edges of the tongue, which is thick and fleshy, is set with teeth, corresponding to these. Those who have watched a Duck dabbling in the soft mud, may perceive the advantage of this structure. A beak-full of mud is taken in, which is then passed over the tongue, which perceives by its nerves of sensation all substances that are fit for food, while the refuse is pressed out through these little furrows, sifted of all that is valuable. The Ducks and Geese of various species, both wild and domesticated, belong to this Family, as do also those noble and elegant birds the Swans. The common Wild Duck is taken in immense numbers in the fens and morasses of our eastern counties: Pennant records that in one season thirty-one thousand two hundred were taken in decoys in the neighbourhood of Wainfleet, Lincolnshire.



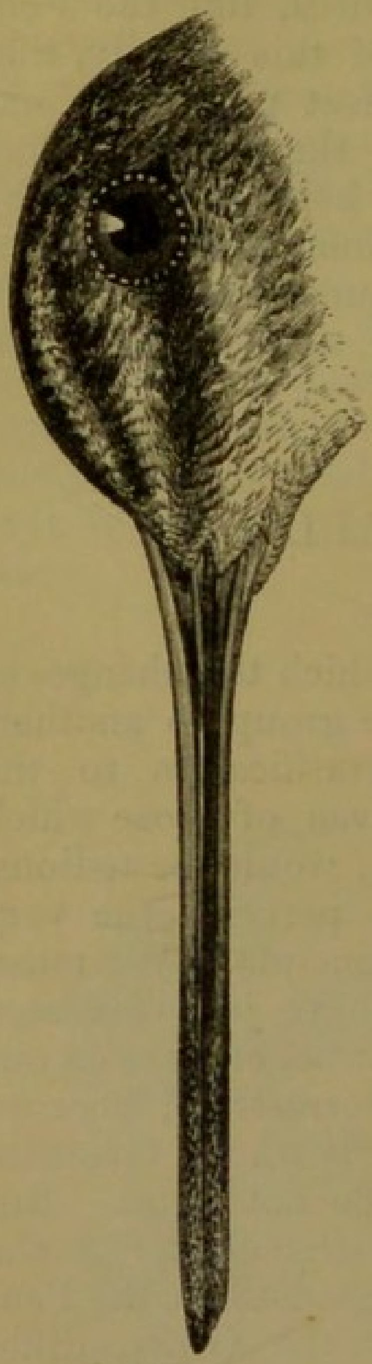
NORTHERN DIVER.

The remaining Family of the Divers (*Colymbidæ*) resemble the Ducks, but are more aquatic. They can remain beneath the surface of the water for a long time. The beak is narrow and pointed; the wings feeble, short, and hollow; the feet are placed very far behind, so that these birds, like the Penguins, sit erect. In one genus of this Family, that of the Grebes (*Podiceps*), the feet present an exception to the general character; the toes not being united by a web, but each one being bordered by a broad oval membrane. These inhabit fresh waters, but the Divers (*Colymbus*) frequent the shores of the ocean. They all feed on the small animals that live in water.

ORDER II. GRALLÆ.

(*Waders.*)

The insensible gradations by which the changes of form and habit proceed from one group to another, afford a great and ever fresh gratification to the naturalist. To enumerate all, even of those which have occurred in our brief course, would be tedious, but the reader will not fail to perceive the very numerous applications of the principle. We must, however, notice one here. We have just dismissed the birds which are properly aquatic, and are on our way to those which are entirely terrestrial; here we have an intermediate Order—birds whose favourite haunt is the water, but which do not swim. But these are not the only links in the chain: in the true Water-fowl there are many gradations, the Penguins, the Divers, the Ducks, the Gulls, differ greatly in the degree in which they are fitted for an aquatic life; the last-named being indeed almost Waders in habit, while Water-fowl in structure. So in the first Family of the present Order we have birds which, though not web-footed, are really swimming and diving-birds; and these we may call Water-fowl in habit, but Waders in structure. And thus we proceed till as we leave the Order at the other extremity, we find birds which, as the Cranes, are essentially terrestrial in their habits, while retaining the distinctive structure of the true Waders.



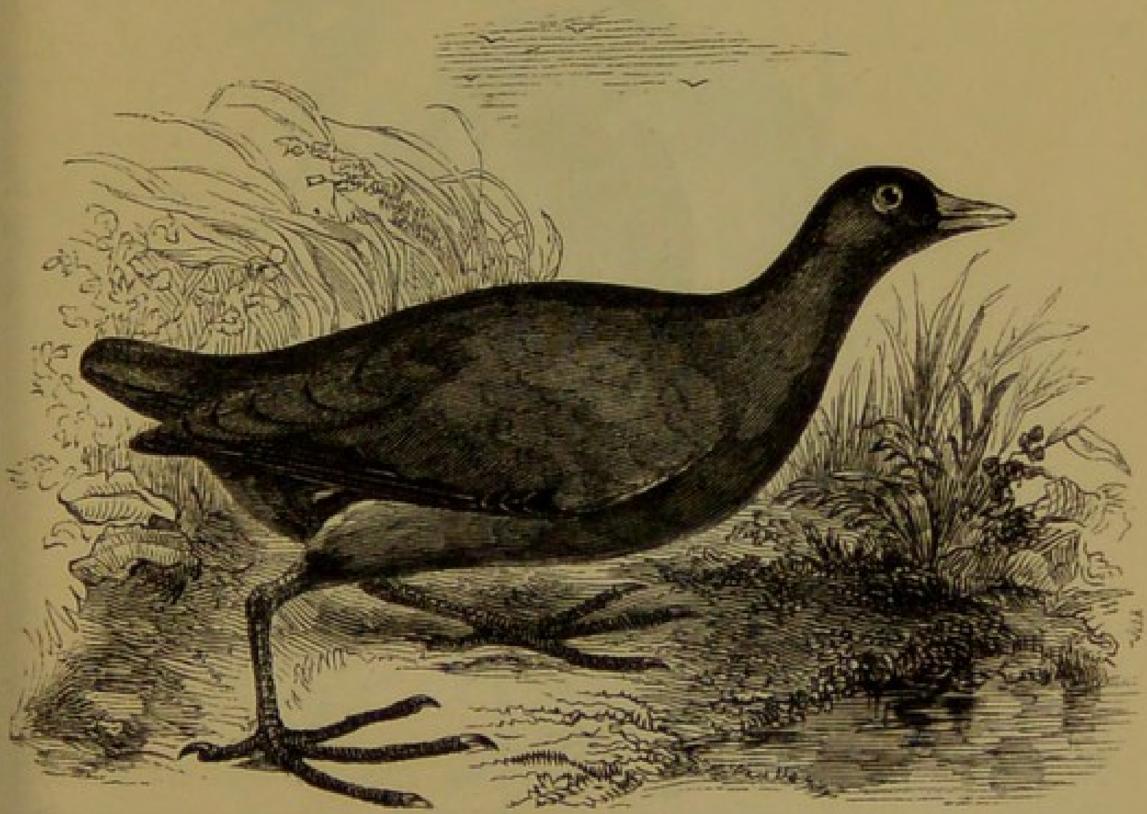
HEAD OF SNIPE.

So beautifully does the whole creation display, that one mighty Intelligence has planned, and one master Hand has executed, the grand design!

The Waders are marked by the great length of the tarsus and leg; and by having the lower part of the latter covered with scaly plates like the former. They are thus enabled to wade in shallow water for the procuring of food, which is generally crustacea, mollusca, fishes, frogs, water-insects, and other aquatic animals. The beak is often lengthened, and so is the neck; the wings are commonly long and powerful.

The family of the Rails (*Rallidæ*), as already intimated, resembles the web-footed birds in habit. Their toes are not furnished with a true web, though in the *Gallinules* (including our Moor-hen) they are bordered with a narrow membrane, which in the Coot is broad and scalloped. Their feet and toes are generally of great size and length; and their wings short, hollow, and feeble. They swim and dive with great facility, but fly with difficulty.

Another peculiarity of these birds is the thinness of their bodies, which are compressed sidewise. This structure enables them to run with great ease through thick grass or reeds, so as to leave little trace of their motion; thus their safety is often effected. Their voices are loud and particularly harsh. They live more on seeds than the rest of the Order, and hence their flesh is of delicate flavour. Like the Poultry they make large coarse nests, and lay many eggs.



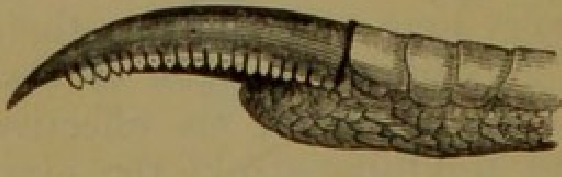
MOOR-HEN.

The chaste and elegant Herons (*Ardeadæ*) exhibit the characters of the Wading-birds in perfection. Their legs and feet are very long and slender; their neck is long, and very flexible; the beak is also long, straight, sharp, and powerful, an effective spear for transfixing with lightning-stroke the nimble and slippery prey on which they feed. The wings are ample, and flight is powerful, though somewhat flagging. It must be remembered, that species are associated with the Herons which present deviations from the above characters in different degrees. Thus the beak in the Curlews is curved and more feeble, while in the Spoonbills it is singularly dilated at the tip. The Cranes also are less aquatic than the rest, rather affecting cultivated fields, and feeding more on grains and herbage.

The middle claw of the foot has in all the species of this Family a singular peculiarity. Its inner

HERON.

edge is widened, and cut into narrow parallel slits, somewhat like a comb. The object of this structure, which is found in a few other birds, seems to be the combing of the plumage in order to free it from annoying insect-parasites.



CLAW OF HERON.

If our young readers have ever examined the beak of a Snipe (see engraving in p. 350), they will have perceived that it is long, slender, weak and flexible; that the tip is clothed with a soft skin, which after death becomes pitted over with little cavities. This organ in life is highly sensitive; it is employed as a probe to feel about for food in soft mud, into which the bird every moment plunges

CROWNED CRANE.

it up to the eyes. They will also see that the bird is able to do this the more extensively by the position of the eyes, which are placed very far back, giving a singularly foolish expression to the visage. The eye too is very large, which indicates nocturnal habits.

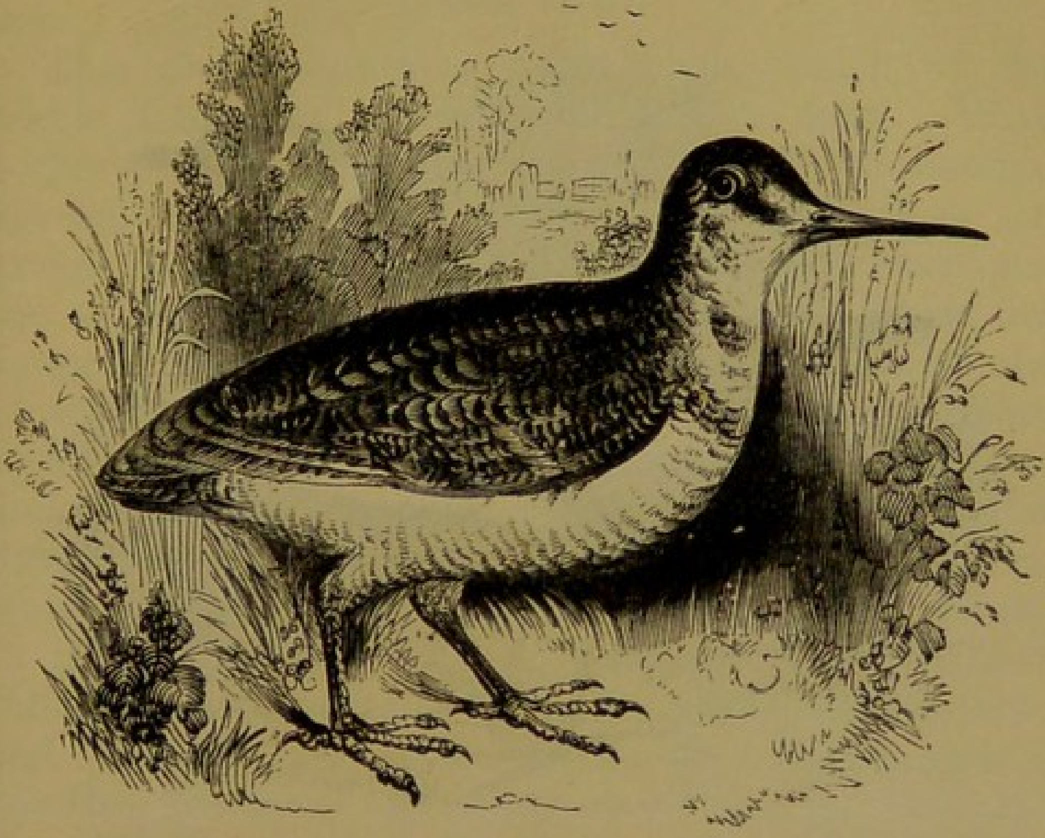
The Family *Scolopacidæ*, or that of the Snipes, may be known in addition to the above characters, by that of having the hind toe fixed on the tarsus above the level of the other toes, so as to be unable to touch the ground in walking. Their plumage is generally mottled with hues of black, white, and brown, in a pleasing manner. They frequent, for the most part, bogs and marshes, the borders of lakes, or the sandy shores of the sea: they run as well as fly with facility.

Many species of the Family are found in this country; some remaining all the year, others spending the summer, others the winter with us. The true Snipes and the Woodcock (*Scolopax*) are among the last described; arriving in the autumn, and leaving us in the spring, though some individuals certainly remain to breed in our marshes and woods.

COMMON SNIPE.

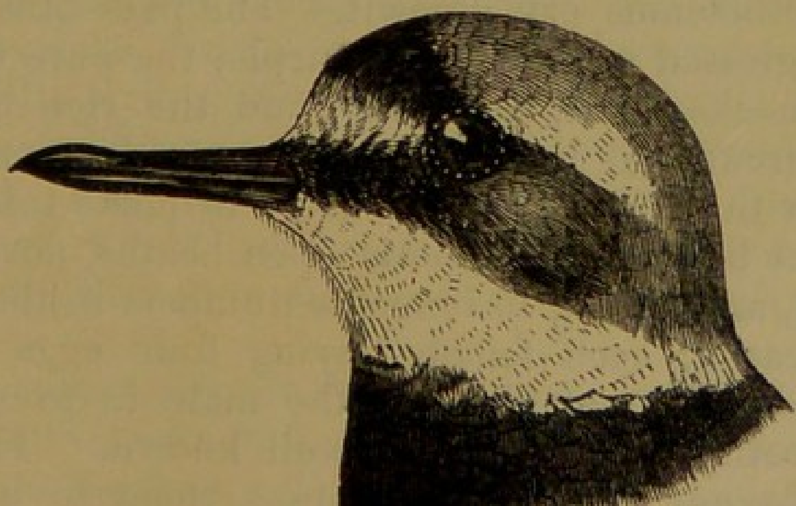
The flesh of all is highly esteemed, and none more than that of the Woodcock (*S. rusticola*), the sportsman's favourite. A Woodcock has been shot which weighed twenty-seven ounces.

There is some resemblance between the Snipes and the Family of Plovers (*Charadriadæ*) in general figure and manners; but the latter are much less attached to watery localities. Indeed they chiefly affect dry exposed commons, though some run on sandy shores. The wings are long and pointed, and the flight powerful; the head is large, with the eye placed far back; the hind toe is almost always wanting. The beak is comparatively short, the basal



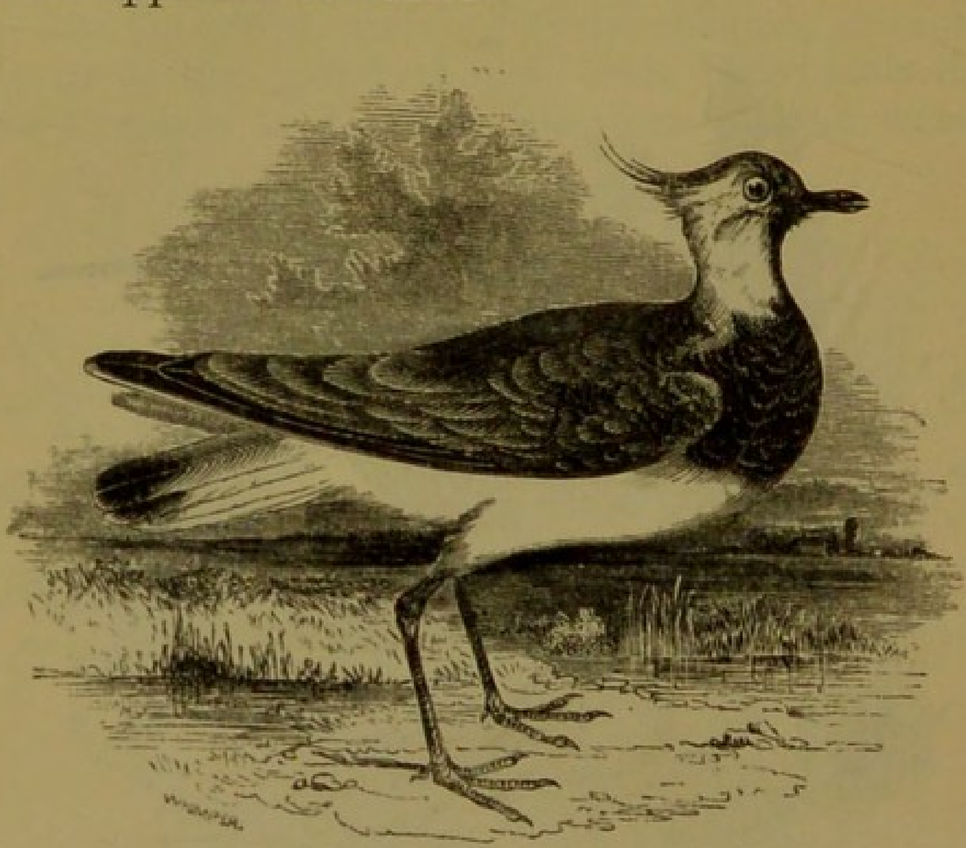
WOODCOCK.

part soft and compressed, the tip abruptly swollen, hard, and often slightly notched. Their colours are



HEAD OF PLOVER.

similar to those of the Snipes, but more apt to be disposed in broad masses; generally a gayer dress is assumed for the nuptial season, which is laid aside on the approach of winter.



LAPWING.

One of the most beautiful of the whole Family is the Lapwing (*Vanellus cristatus*), often called from its pertinacious cry, Peewit. The pale olive upper parts glossed with metallic purple, the pure white of the cheeks, neck, and belly, and the rich black of the throat and breast, with green reflections, combine with its long slender crest to make this a very elegant bird. It frequents open heaths, downs, and moors, associating in immense numbers in the breeding season, each female laying four eggs on the ground. The artifices of the male to prevent his nest being discovered, are well known. The delicate flavour of the eggs causes them to be much sought for the table, and great numbers are sent to the London market in the spring months. Women and children carefully search for them, and even dogs are trained to this employment.

ORDER III. GALLINÆ.

(*Poultry Birds.*)

This Order contains those birds which of the whole Class are the most valuable to man. With scarcely any exceptions their flesh is wholesome, agreeable, tender, and easy of digestion, their increase is rapid, and most of them are very susceptible of domestication. The largest of all birds are found in this Order, and many are adorned with the most gorgeous plumage, often set off with reflections like the lustre of polished metal or precious stones; and they are often furnished besides with singular developments of the skin, in the form of warts, wattles, eyebrows, or combs, of rich colours. Flight in this Order is performed for the most part with difficulty; the wings are short, wide, and hollow, and the quills are feeble. When they do attempt to fly, the heaviness and slowness of the motion, and the whirring sound produced, show that it is a difficult operation. The tenderness and digestibility of the flesh is a result of the unfitness for flight in these birds; for where this power exists in perfection, the great muscles are dense and hard, and the flesh generally lean, tough, and dry. How wisely and bountifully is it ordained, that such valuable qualities as excellence of flesh, delicately flavoured eggs, large size, and numerous progeny, should be associated with a ready susceptibility of domestication, sociability, and an unwillingness to wander far from home!

The general characters, in addition to those mentioned, are that the tail contains more than the usual number of feathers; that the feet are robust; that the hind toe, when present, is set on a higher level than the rest; that the beak is strong, short, and arched; that the nostrils are covered with a scale; and that the crop and the gizzard are strongly developed. We must again remind our readers that the characters of any group do not belong in an equal degree to all the members of it, but are found in perfection only in such as are considered the *types* or representatives of it. In the present Order the Family *Phasianidæ*, or the Pheasants and Barn-

HASTINGS'S TRAPOGAN, ARGUS PHEASANT, AND CROWNED PIGEON.

door Fowls, are typical; while the Ostriches on the one hand, and the Pigeons on the other, deviate most widely.

The Ostriches (*Struthionidæ*) are the largest of all birds; some of them attaining a stature considerably exceeding that of man. They chiefly affect vast plains and deserts, where their long and powerful legs enable them to course over the ground with great fleetness, while their elevated stature gives them a wide extent of view over the level surface. The African Ostrich (*Struthio camelus*) is said to surpass in running the swiftest horse; and the Great

AFRICAN OSTRICH.

Bustard, the noblest of British birds (*Otis tarda*) used to be run down with greyhounds. This fine bird is almost extirpated, though it is still occasionally seen in wide open plains. The last recorded to have been killed in England, was shot near the Lizard, in Cornwall, in February, 1843. The male Bustard stands nearly four feet high.

Another large bird, formerly found in the northern parts of this island, but now extinct, will represent the second Family of this Order, that of the Partridges and Grouse, (*Tetraonidæ*). We refer to the Capercailzie, or Cock of the Wood (*Tetrao urogallus*) a bird as large as a Turkey. Some of the Scottish nobility have recently made successful efforts to naturalize this fine bird again,

GREAT BUSTARD.

by procuring a large number from Norway, where they are still common. These imported birds are breeding, and doing well. Some of the species of this Family, which seems to belong (though not exclusively) to the northern regions of the globe, are defended against the snows over which they wander, by having the feet feathered to the claws; and by their plumage becoming white in winter. The Partridges and the Quails belong also to this Family, which thus is one of great interest to the

CAPERCAILZIE.

sportsman. Nor is it less interesting to remark that there is good reason to believe that the "feathered fowl as the sand of the sea," with which the Lord fed the murmuring children of Israel in the wilderness, were identical with the species so common in this country, *Coturnix vulgaris*. The members of this Family are commonly marked with a patch of naked scarlet skin above the eye. The tail is short; the hind toe is small and sometimes rudimentary. They commonly feed on grains, seeds, and the buds of trees.

The Pheasants form a magnificent Family (*Phasianidæ*) comprising many species of large size, imposing aspect, and plumage of the most splendid hues. Of these, the Peacock (*Pavo cristatus*) affords an illustrious, though a familiar example. Who can look upon this gorgeous fowl, "gleaming in purple and gold," with its expanded train studded with eyes, without a tribute of admiring praise to Him, "for whose pleasure it is, and was created?" The greatest king upon earth, even he who of old introduced it in his triennial fleets from

PEACOCK.

the distant East, was never "arrayed like one of these."

The Barn-door Fowl (*Gallus domesticus*) is, like the Peacock, a native of farthest India; but both of these birds were transported to Europe at a period so remote that history does not go back far enough to record it. The Pheasant (*Phasianus colchicus*) is said to have been brought into Greece by the Argonauts about three thousand years ago.

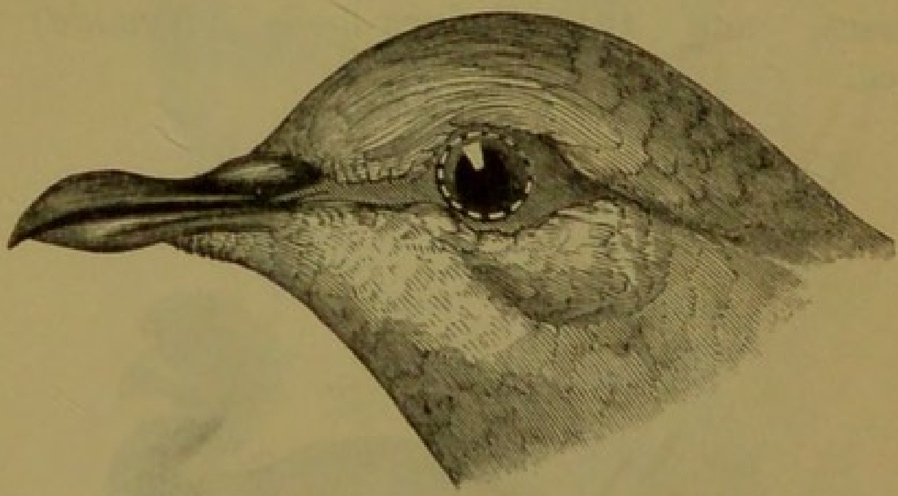
In all this Family the beak is vaulted, and the nostrils are covered with a scale. The wings are short and rounded; and flight is very feeble. The feet are robust, covered with large scales, and furnished with spurs. The tail has eighteen feathers, some of which are commonly much developed. India and China yield the most magnificent species; but the fine Turkeys (*Gallopavo*) are natives of America, and the Guinea-fowls (*Numida*) of Africa.

CRESTED CURASSOW.

South America produces some large fowls called the Curassows, which, from some peculiarities, are considered to form a distinct Family by the name of *Cracidæ*. They somewhat resemble the Turkey, but the hind toe is set on the same level as the others, so that the foot is like that of a Perching-bird. In agreement with this structure, the Curassows reside in trees much more than other Poultry-birds, building their nests among the branches.

They are destitute of spurs. The flesh of these large fowls is white and delicate; and attempts are being made to introduce them into our Poultry-yards. Our engraving represents the Crested Curassow (*Crax alector*).

We have already said that the Pigeons (*Columbadæ*) vary widely in their characters from the rest

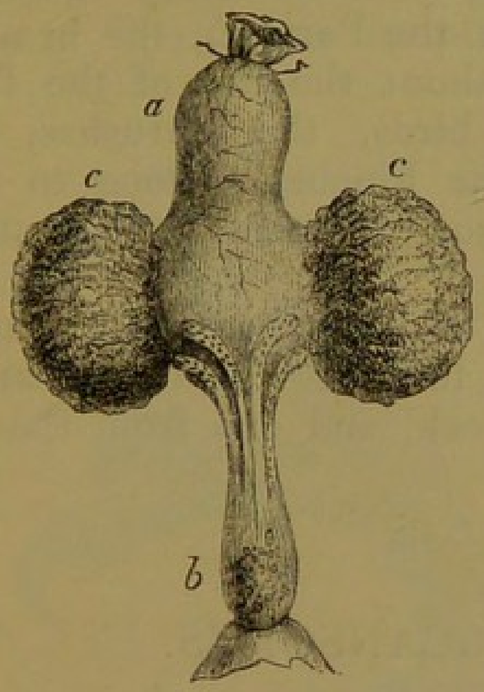


HEAD OF PIGEON.

of the Order; they are, indeed, by some naturalists, made to constitute an Order by themselves. As they form but a single Family, however, we prefer in the present volume to place them here. Their wings are long, and their flight easy and powerful; the hind toe is jointed as in the Perching birds; the nest is made on trees; and but two eggs are laid. In addition, the young, when hatched, are blind, naked, and peculiarly helpless. In all these respects they differ from the true Poultry.

The form of the beak in the Pigeons will be perceived from the above engraving. It is slender, nearly straight, swollen towards the tip; the nostrils are covered with a bladder-like scale.

One part of the economy of these birds is very curious. The crop in its ordinary state is thin and membranous, and the internal surface smooth; but when the young are about to be hatched, the whole, except that part which lies on the windpipe, becomes thicker, and puts on a glandular appearance, having its internal surface very irregular. In this organ food is prepared for the infant progeny; a milky fluid is secreted by these glands, and poured into the crop among the seeds undergoing digestion, and is vomited into the gaping beak of the expectant young. This fluid turns to a curd by the action of acids, and in the process of digestion, very much like real milk; and the apparatus and its product presents a singular approach to the peculiar structure and economy of the MAMMALIA.



CROP OF PIGEON.

The accompanying engraving represents the crop of a Pigeon turned inside out, while breeding; (*a*), inner surface of the gullet; (*b*), that of the membranous stomach; (*c*, *c*), that of the two lobes of the crop.

ORDER IV. PASSERES.

(*Perching Birds.*)

The importance of this Order will appear when we consider that it contains about as many species as all the other Orders put together. This large assemblage is associated by negative rather than by positive characters, and it may be defined as including all species which will not fit either of the other Orders. They are for the most part small birds, endowed with the power of grasping a perch with the feet, the toes of which are set on the same plane. The wings are well-developed, and the faculty of flight exists in all. The beak is more or less conical in form, sometimes short and thick, at others lengthened and slender, sometimes curved, sometimes straight. In almost every instance (perhaps excepting only the Parrots), the beak is used to obtain food, without the use of the feet. All the sweet singing birds, the Thrushes, the Warblers, the Larks, the Finches, belong to this Order. It contains, also, the most perfect nest-builders.

This vast assemblage of birds has been usually divided into five Tribes, four of which are named from the form of the beak, and one from that of the feet.

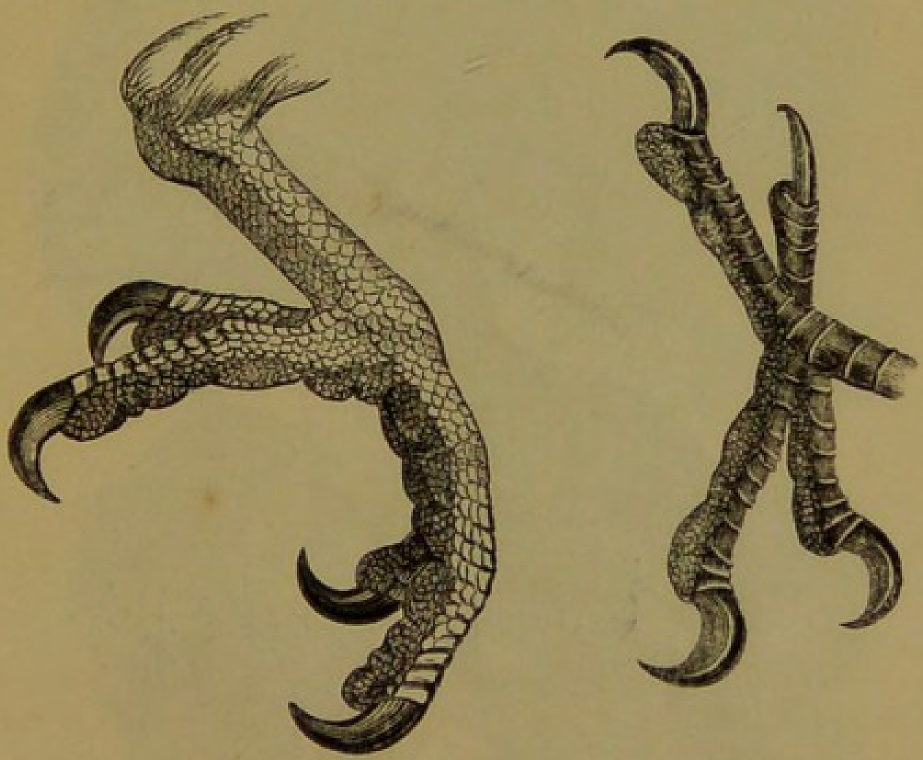
TRIBE I. SCANSORES.

(*Climbing-birds.*)

The ordinary arrangement of the four toes of a Perching-bird is, three in front, and one behind; but the birds which compose this tribe have the outer toe capable of being turned back, so that the arrangement is, two in front and two behind. The accompanying figures of the foot of two birds of this structure, will render it easy to identify a Climbing-bird. It will be readily seen that this arrangement of the toes assists the Bird to climb up the perpendicular trunks of trees.

The Family of the Toucans (*Rhamphastidæ*) is composed of South American birds, with very large beaks; their colours are usually black or green, with large masses of red or yellow; the beak is often brilliantly coloured: they feed on fruits and small animals.

The next Family contains the Parrots (*Psittacidæ*), whose docility, gay plumage, and ability to utter human words have made them general favourites. The beak in these beautiful birds is very much hooked, and the base of it is covered with a skin, called the cere, in which the nostrils are pierced. The tongue is large, round, and fleshy, and is doubtless a highly sensitive organ of taste. The upper mandible is capable of being



FOOT OF PARROT AND OF WOODPECKER.

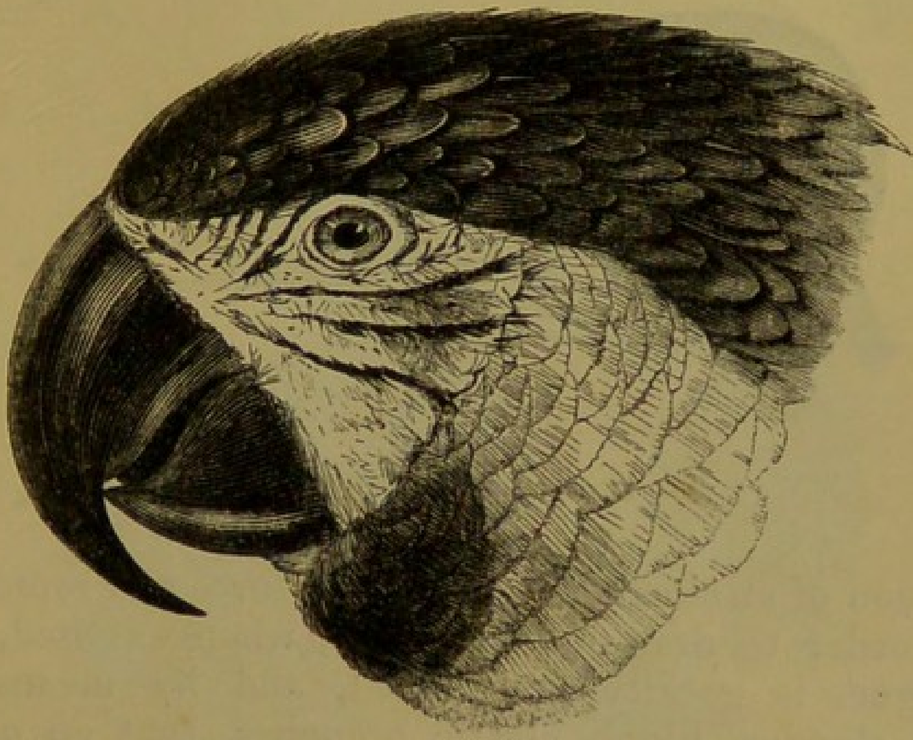
moved in birds generally, but most of all in the Parrots. The accompanying figure of the skull of the Macaw, shows that it is actually jointed with the skull. This structure is useful to it in climbing; in which it uses the beak like a third hand.

The natural voices of the *Psittacidæ* are loud and extremely harsh; and of none more so than the Macaws, the largest and most richly coloured of the race. They are natives of South America and the adjoining isles; the species which we have used as an illustration, is the Blue and Yellow Macaw, (*Ara ararauna*) very common in menageries. The

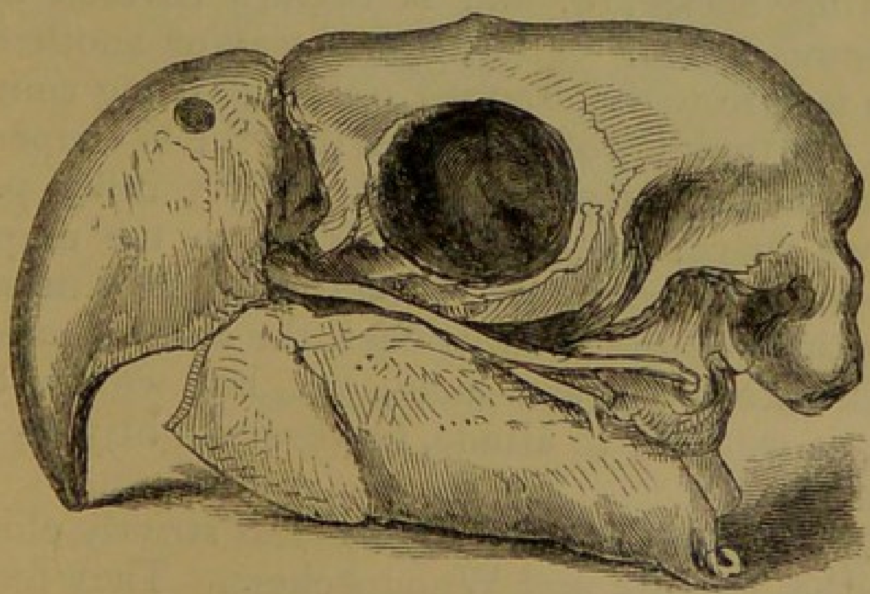
Grey Parrot (*Psittacus erythacus*) from Africa, is esteemed the most fluent speaker. Some of this Family are scarcely larger than a Sparrow, as the pretty and affectionate little Love-birds (*Agapornis*) of Australia.

KEEL-BEAKED TOUCAN.

No birds are better calculated to excite our admiration of the Wisdom of God in creation than the Woodpeckers, forming the Family *Picidæ,* of which we have several native species. They are formed for clinging to the trunks and limbs of trees in a perpendicular or even inverted position, and for procuring a subsistence by digging into the solid wood, for the various larvæ of insects that riot there. For

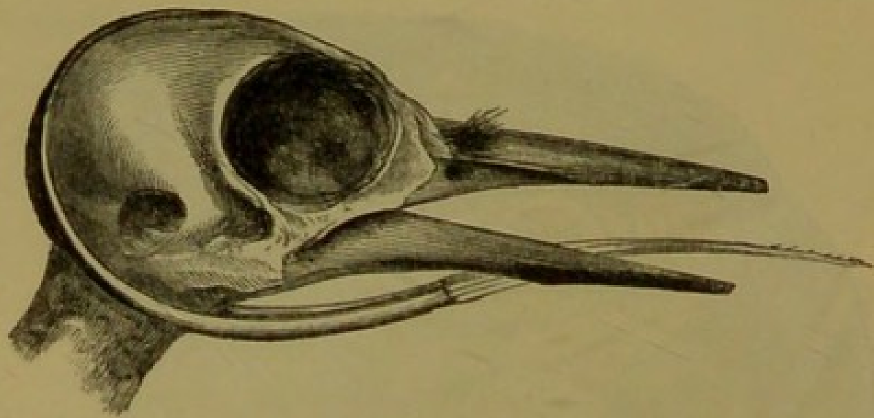


HEAD OF MACAW.



SKULL OF MACAW.

this purpose the beak is extremely hard, straight, and pointed, the point having a sort of chisel-like edge. The head acts as a hammer, of which the beak is the face, and the curved neck the handle, and being moved by powerful muscles, the sharp and cutting point is urged against the tree in a suc-



SKULL OF WOODPECKER.

cession of strokes given with great force and rapidity. In order to drag out the worm, when exposed, the tongue is greatly lengthened, and by means of two slender, highly elastic branches, that go quite round the skull, it is capable of being projected to a considerable distance. The tip is set with barbs pointing backward, and is besides covered with a glutinous saliva. Thus, in one way or another, the grub is sure to be dragged out, and being conveyed with the rapidity of lightning into the Woodpecker's throat, is instantly swallowed. Many other points, had we space, we might speak of, in the exquisite adaptation of structure to habit in these interesting birds, such as the peculiar feet, the stiff spinous tail, the low-keeled breast-bone, &c., but we must forbear, as we have to allude, however slightly, to other forms.

The Cuckoos (*Cuculidæ*) are less strictly climbers than the Parrots and Woodpeckers. They feed on insects, but these they seize on the leaves and twigs. Our native species (*Cuculus canorus*) is a favourite with all; for its singular double call-note reminds us that spring with all its pleasant accompaniments is set in. The habit of laying its eggs in the nests of other birds, to be by them hatched and nursed, is a singular peculiarity of the Cuckoos.

GREAT BLACK WOODPECKER.

TRIBE II. CONIROSTRES.

(*Cone-billed Birds.*)

These, which are sometimes known as Hard-billed Birds, constitute a vast assemblage, more or less clearly marked by the conical form of the beak. It is generally short, thick, and strong, usually destitute of any notch at the tip, though in the brilliant Tanagers of America, the beak, though conical, is distinctly notched. Seeds and grains of various kinds form the chief food of this Tribe, but some of the larger eat flesh, and some are partial to an insect diet.

Passing by some tropical forms, as the Hornbills (*Bucerotidæ*), with their fantastically enormous beaks, the beautiful Touracos (*Musophagadæ*) of Africa and the Colies of the same continent,—we come to the Finches (*Fringilladæ*) a Family that comprises many familiar little birds. The elegant Canary, the Goldfinch, the Linnet, the Bulfinch, the Chaffinch, the Buntings, the Sparrow, and the Larks, and scores of others, find their place in this extensive Tribe, which is considered typical in the Class.

The neat and cheerful Goldfinch (*Carduelis elegans*), one of the most elegant of British Birds, affords an example of a beak almost perfectly conical. The docility and affection of this pretty bird are very great, and next to the Canary no small bird is so great a favourite as a caged pet, and perhaps none bears confinement so well. Its song is cheerful and pleasing, and is continued almost through the year. The nest, (see p. 331) is a structure of exquisite neatness; the various materials, whether moss, wool, cotton, twigs, or what not, being most compactly felted together, and rounded without ragged ends. The eggs are four or five, of a pale bluish-white, dashed with purplish specks.

The Birds of Paradise (*Paradiseadæ*) are a very limited but a very renowned Family. The few species are confined to the most distant islands of the Indian Archipelago, where they inhabit the ancient forests. They resemble Crows in size and

BIRDS OF PARADISE.

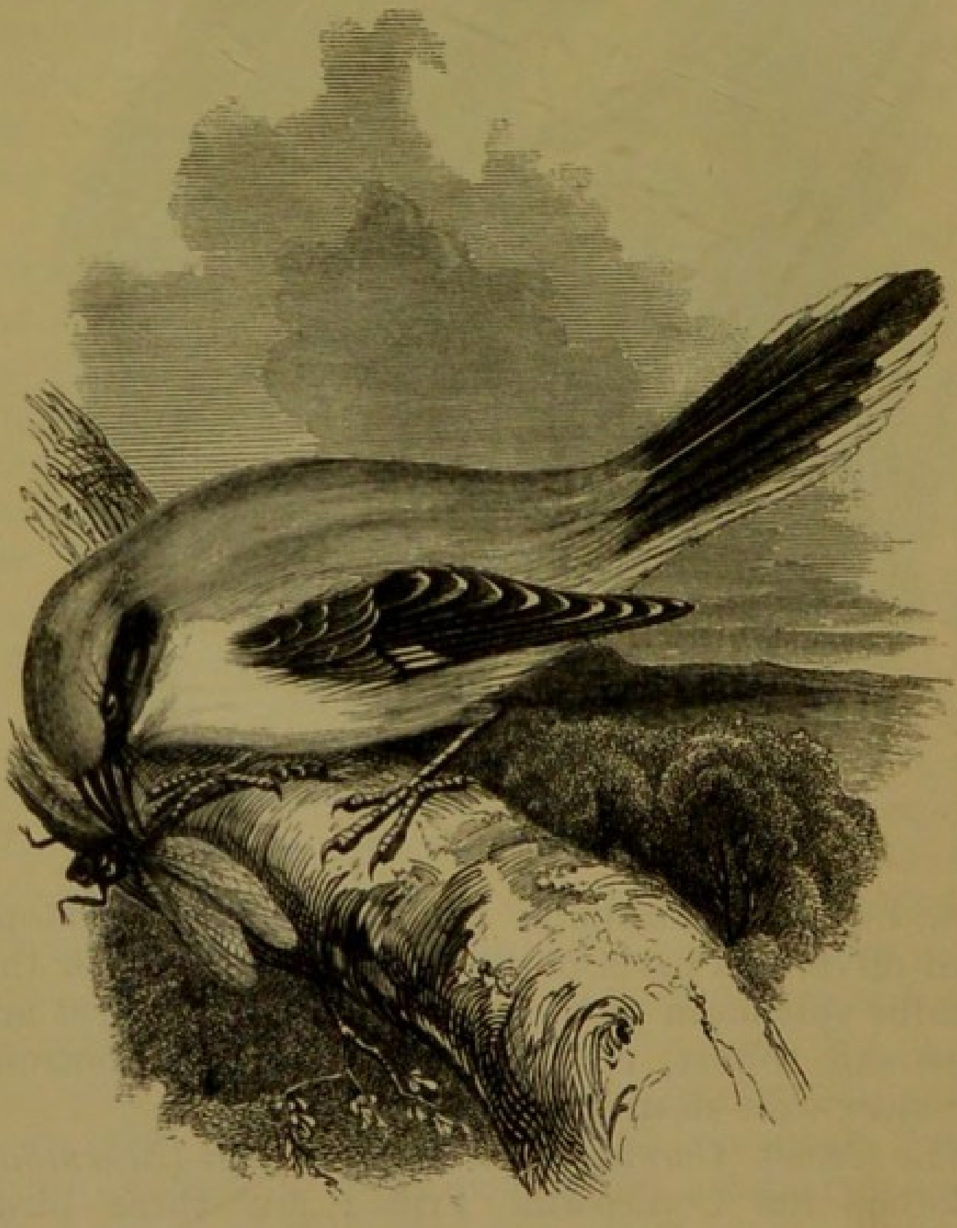
form, but are remarkable for the singular development of various parts of their plumage, and for the metallic splendour of their rich hues. Their feet are large and robust, notwithstanding the old notions that they were destitute of these organs.

The Crows (*Corvidæ*) and the Starlings (*Sturnidæ*) make up the Conirostral Tribe; and these birds are sufficiently well known to be merely alluded to. Their sagacity and docility are remarkable, as is also their ability to pronounce words: the common device of slitting the tongue to facilitate this faculty, is as useless as it is cruel.

TRIBE III. DENTIROSTRES.

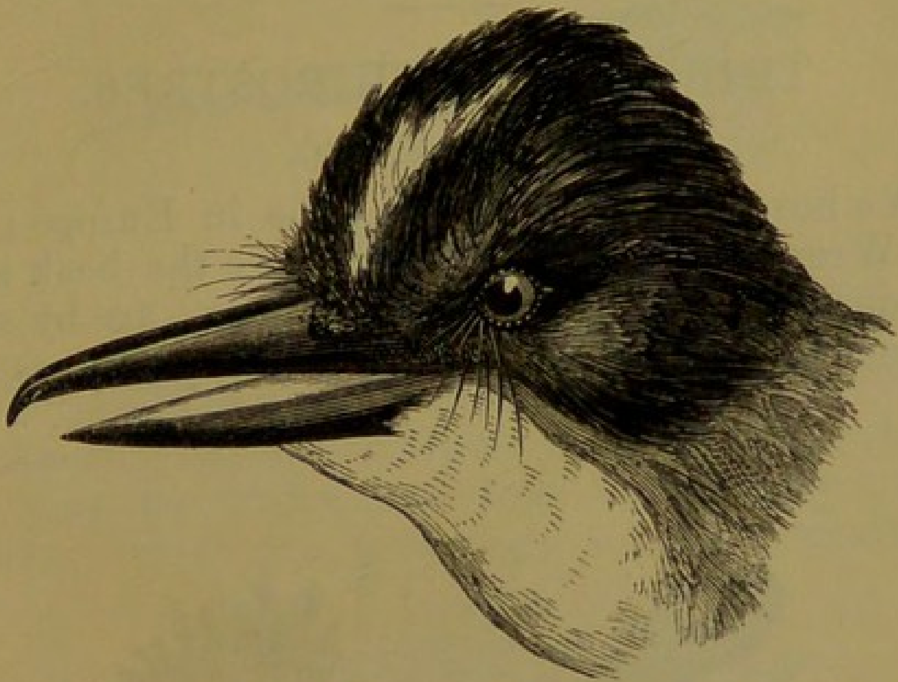
(*Toothed-billed Birds*).

Here again we have an extensive assemblage of small birds associated by the character of a notch on each side of the tip of the upper mandible; this notch for the most part indicates an insect-diet.



GREY SHRIKE.

The Shrikes (*Laniadæ*) have this structure very strongly marked, so as indeed to approach the form of the beak in the Birds of prey. And this structure is accompanied by a carnivorous appetite, which likewise reminds us of the Hawks. The Shrikes not only devour large insects, but also small birds and quadrupeds; and they have the curious habit



HEAD OF TYRANNUS.

of sticking their prey upon a strong thorn, while they tear it to pieces. Hence they are called Butcher-birds; and the scientific name of the genus, *Lanius*, signifies the same thing.

In a less degree the same structure is found in the Fly-catchers (*Muscicapadæ*), some of the foreign species of which are almost as ferocious as the Shrikes. They commonly pursue and catch insects in flight, returning to the twig from which they sallied out to eat it. Our little Spotted Fly-catcher (*Muscicapa grisola*) is one of the very latest of our summer visitors, and one of the earliest to depart.

The Thrushes (*Turdidæ*) and the Warblers (*Sylviadæ*) do not differ much from each other; the latter, however, are smaller and more delicate; and have the beak more slender. Both of these Families contain renowned songsters; the Mocking-bird, the Song-thrush, the Redwing, and the Blackbird belong to the former; and to the latter the Redbreast, the Reed-Warbler, the Blackcap, and above all, the Nightingale, a theme of admiration to naturalists and to poets in all ages.

TRIBE IV. TENUIROSTRES.

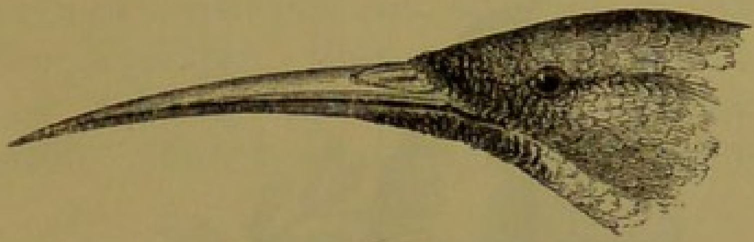
(*Slender-billed birds*).

We have not many of this tribe in Europe; but the Wrens and Creepers, which have the beak more slender and pointed than the Warblers, are by some placed in it; and the Hoopoe (*Upupa epops*), an

HOOPOE.

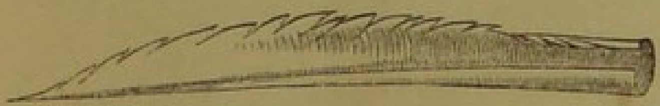
occasional visitor to our southern counties, certainly belongs to it. But the splendid Sun-birds (*Nectariniadæ*) of Africa and India, and the Humming-birds (*Trochilidæ*) of America and the West Indies, are the principal families included in this Tribe.

The beak is long, slender, compressed, and frequently curved; the tongue is generally divided at the tip into filaments, which assist in sucking or licking up the honeyed nectar of flowers, in which are commonly found multitudes of minute insects.



HEAD OF A SUN-BIRD.

In the Sun-birds these filaments often take the form of a brush; but in the Humming-birds, their structure may be understood from the accompanying drawing, which we took from a recent specimen.



TIP OF A FILAMENT OF HUMMING-BIRD'S TONGUE.

The whole tongue is slender and capable of protrusion to a great extent; when recent it presents the appearance of two tubes laid side by side, united for half the length, but separate for the remainder. The substance of these is transparent in the same degree as a good quill, which, under a microscope, they much resemble. Each tube is formed by a *lamina* rolled up, yet not so as to bring the edges into actual contact; near the tip the outer edge of each *lamina* ceases to be convoluted, but is spread out, and split at the margin into irregular points, directed backward.

Both of these Families contain birds of small size; they are indeed the most minute of all birds, but are at the same time the most elegant and gay. They glitter in the sun like gold and gems; and parts of their plumage often gleam with a refulgence in certain lights, that almost dazzles the eye to look upon. The Humming-birds usually suck flowers, and catch flies on the wing; but the Sun-

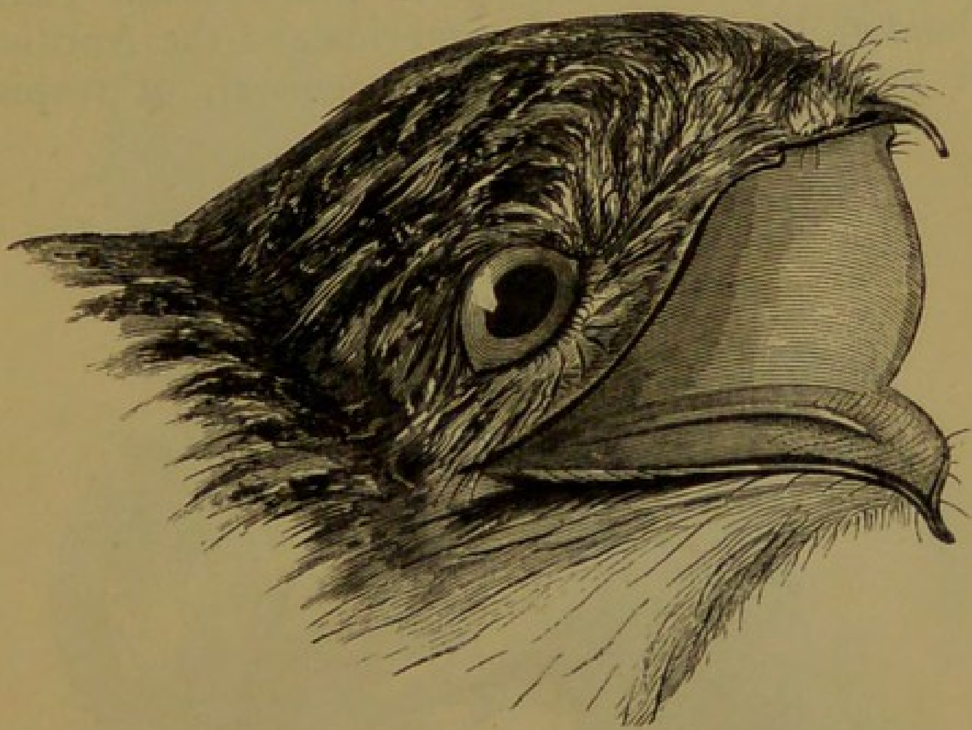
LONG-TAILED HUMMING-BIRD.

birds creep about the stems and leaves for the same purpose. We have had living Humming-birds so familiar as to fly down at a call, cling to the lips or chin, and suck sugar from the mouth.

TRIBE V. FISSIROSTRES.

(*Gaping-birds.*)

If any of our young friends have ever examined the mouth of a Swallow, or, still better, that curious bird, the Nightjar, they will understand what is meant by a Fissirostral mouth better than by any description. The beak is very small, though flat-



HEAD OF NYCTIBIUS.

tened out; but the mouth opens enormously, the gape in many cases reaching behind the eyes. The purpose of so wide a mouth is to engulf insects, which are pursued and captured on the wing. Hence the wings are long and powerful, but the feet are small and feeble.

The Swallows (*Hirundinidæ*) are day-fliers; their plumage is close and glossy, usually black, blue, or green above, richly burnished, and often white beneath. We have four or five species of this Family, all summer residents only; and every one knows the pleasant feelings with which we hail the appearance of the first Swallows.

The Night-jars (*Caprimulgidæ*) are active during the night; their plumage is soft, loose, and downy, and is minutely freckled with different shades of brown, black, and white. These are also migratory summer birds.

There are two or three other Families commonly placed in this Tribe, but which have the characters less obviously marked; such as the King-fishers (*Alcedinidæ*), of which we have one radiant little species; these feed chiefly on fishes:—the Todies (*Todidæ*), birds of South America and the Antilles; the magnificent Trogons (*Trogonidæ*), of tropical

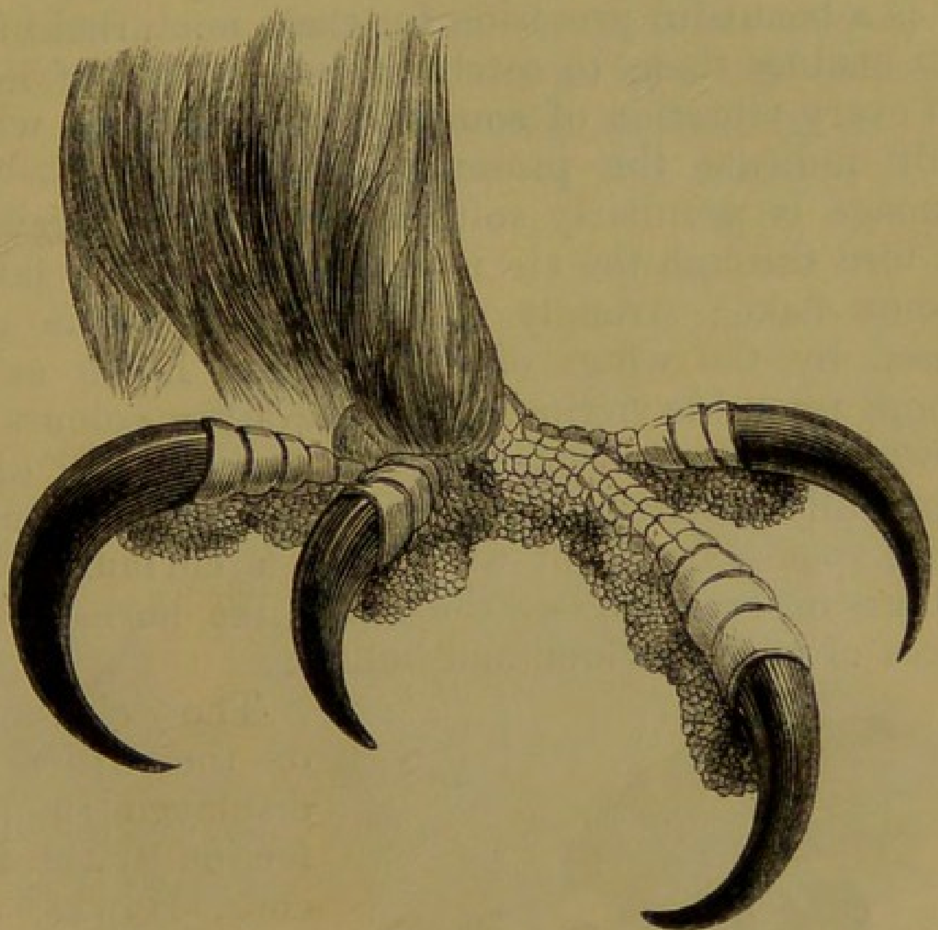
BEE-EATER.

America; and the Bee-eaters (*Meropidæ*), of which a beautiful species occasionally strays as far as our islands. It is common in Southern Europe.

ORDER V. ACCIPITRES.

(*Birds of Prey*).

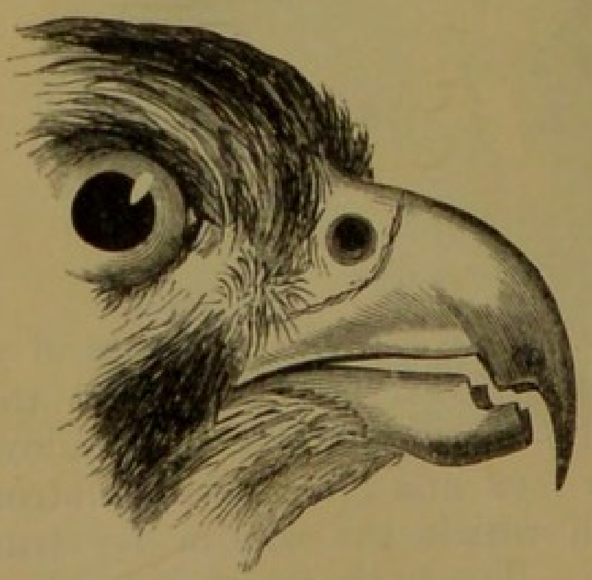
The term Birds of *Prey* sufficiently indicates the habits of this the last Order of birds; they live upon flesh, mostly recent and living, captured by their own prowess, but in one Family, that of the Vultures (*Vulturidæ*) where the natural weapons of



FOOT OF EAGLE.

destruction are less effective, flesh in a state of decomposition forms the usual food. To arm them for their warfare the Preying Birds are endowed with stout muscular legs and feet, and with strong, hooked talons, with which the victim is struck, pierced, and grasped. The beak, which is used only for dividing, not for killing prey, is powerful, dense in texture, with the point curved downward, and the edges cutting. The base of the beak is enveloped in a naked skin called the *cere*, as in the Parrots. The wings are long and pointed, and the power of flight well developed.

The Family of Owls (*Strigidæ*) are all nocturnal, and bear considerable resemblance to the Nightjars. They have a very large head, great staring eyes, looking forwards, each surrounded by a sort of saucer-like concavity of radiating feathers. The ears are enormously large, and are placed just behind the concave disks. The great size of the eye and of the ear is a beautiful provision for these nocturnal birds, as it enables them to catch every faint ray of light, and every vibration of sound in the darkness, which could indicate the presence of their prey. The plumage is peculiarly soft, so that the progress of the bird through the air is as noiseless as the fall of a snow-flake; strongly contrasting with the roar caused by the wings of the rushing Eagle as he swoops upon his victim. The prevailing colours are brown of various shades, yellow, and white; often beautifully mottled and pencilled. We have many native species, some of which have a curious tuft of feathers on each side of the head, like horns. The voices of most are loud and hollow.



BEAK OF FALCON.

The characters of the Order are displayed in perfection by the Falcons, Hawks, and Eagles, constituting the extensive Family *Falconidæ*. In these, however, there is considerable gradation in the development of the raptorial structure. Our engraving shows the form of the beak as it appears in the most typical of the Order, the famed Peregrine

Falcon (*Falco peregrinus*). This was the species most valued in the ancient sport of falconry, and various names were given to it, distinctive of sex or age.

The Eagles belong to this Family, which, though much larger and more powerful than the typical Falcons, have the raptorial structure less perfectly developed. The Golden Eagle (*Aquila chrysaëtos*) is one of the noblest of the feathered inhabitants of the British Isles. It is of large size, its countenance and aspect are grand, and its motions majestic; whether it be viewed as it sits in its awful solitude on the edge of some lofty crag, or sailing on its broadly expanded pinions above the clouds. It is

GOLDEN EAGLE.

reputed to have the power of gazing undazzled on the unclouded sun.

Sir H. Davy once saw a very interesting sight above one of the crags of Ben Nevis. Two parent Eagles were teaching their offspring, two young birds, the manœuvres of flight. They began by rising from the top of a mountain, in the eye of the sun; it was about mid-day, and bright for this climate. They at first made small circles, and the young birds imitated them. They paused on their wings, waiting till they had made their first flight, and then took a second and larger gyration, always rising towards the sun, and enlarging their circle of flight, so as to make a gradually extending spiral: the young ones still slowly followed, apparently flying better as they mounted; and they continued this sublime kind of exercise, always rising, till they became mere points in the air, and the young ones were lost, and afterwards their parents, to the aching sight.

"What an instructive lesson to Christian parents," observes Mr. Kirby, "does this history read! How powerfully does it excite them to teach their children betimes to look towards Heaven and the Sun of Righteousness, and to elevate their thoughts thither, more and more, on the wings of faith and love; themselves all the while going before them, and encouraging them by their own example."*

Of the carrion-eating Vultures (*Vulturidæ*), we have no truly British species, though individuals of two species have occasionally been known to stray hither. They are very useful in hot countries, performing the office of scavengers, rapidly devouring the flesh of dead animals, which otherwise would taint the air and produce disease. Hence, notwithstanding their disgusting odour, and repulsive appearance and habits, they are frequently protected from injury by law.

Thus we close our very brief notices of the feathered denizens of the air, the multitudinous tribes of "fowl that fly in the open firmament of heaven," the most pleasing and perhaps the most interesting, of all the Classes of animate beings which were placed under the dominion of man.

* Bridgewater Treatise.

CLASS V. MAMMALIA.*

(Beasts.)

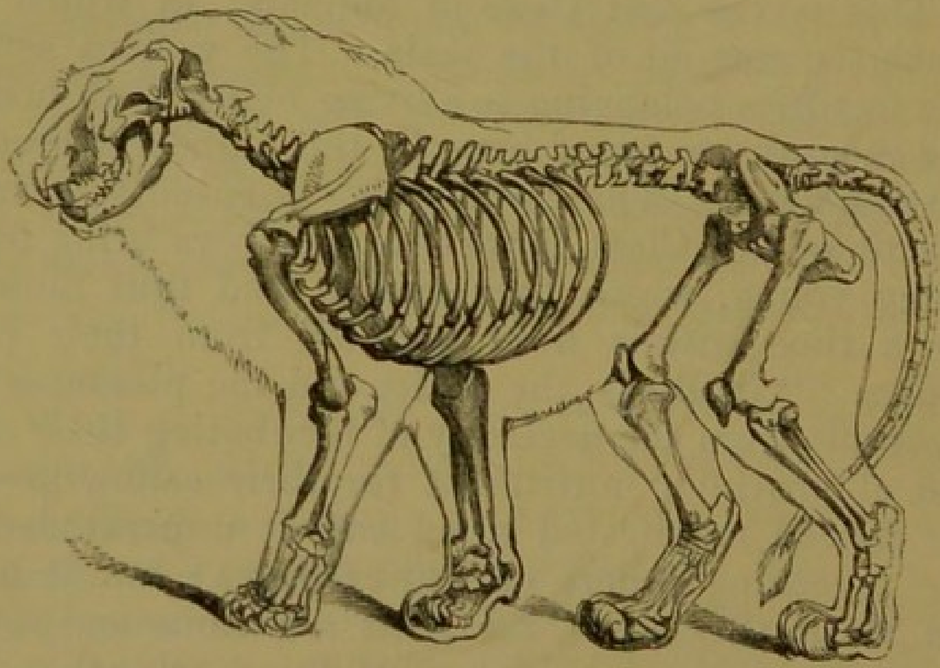
This is the last Class of animals; in which we reach the summit of the scale. The various senses and faculties belonging to a living being, both bodily and mental, are found here in the highest degree of development. That which is essentially characteristic of this Class, is that its members bring forth living young, which they suckle, and thus nourish for a time with a fluid secreted from their own bodies. "In Birds, the duties and the pleasures inseparable from the necessity of incubating their ova, and of providing nutriment for their callow brood, are indeed manifested to an extent unparalleled in the preceding orders of VERTEBRATA; but it is to the MAMMALIA alone, the most sagacious and intelligent of all the inhabitants of this world, that the Creator has permitted the full enjoyment of paternal and maternal love, has thrown the offspring absolutely helpless and dependent on a mother's care and solicitude, and thus confers upon the parent the joys and comforts that a mother only knows, —the dearest, purest, sweetest, bestowed upon the animal creation."†

A general view of the bony framework of the body in this Class will be obtained from the accompanying figure of the skeleton of the Lion, which may be with advantage compared with that of the Vulture in p. 321, and with that of Man on p. 437. It will be observed that the spinal column is carried in a horizontal position, supported by four limbs which rest on the ground. This is the general rule; but there are some animals, which carry the body in

* A term derived from "*mamma*," the female breast.

† Prof. Jones.

a posture approaching the perpendicular, as the Jerboas and the Kangaroos; and one Order, that of the Whales (CETACEA), is destitute of the hinder pair of limbs. In the Bats (CHEIROPTERA), the fore limbs are greatly lengthened, as are particularly the fingers,



SKELETON OF LION.

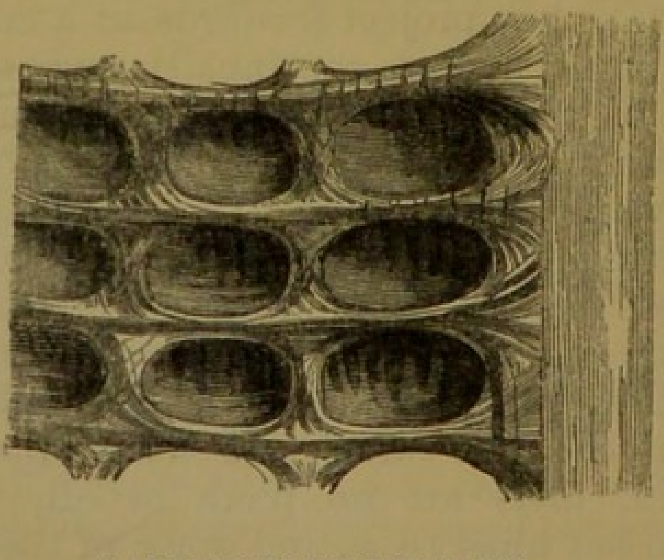
which carry upon them a delicate membrane, stretched like the silk of an umbrella, constituting a pair of effective wings. The Whales inhabit the seas, and present both in form and habits an analogy with Fishes; the Bats, less strongly, with Birds, but both are true MAMMALIA in structure.

The respiration and the circulation of the blood, in Beasts, do not very materially differ from the same operations in Birds; the lungs, however, are freely suspended in the chest, instead of being attached along the spine. The air is admitted only into these organs, there being no accessory air-sacs; and therefore, the heat of the blood, which depends upon its aeration, is not so great as in Birds.

The teeth in MAMMALIA are organs of great importance. They are solid pieces of bone, covered with a much harder substance, called enamel, which grow out of sockets in each jaw. They are placed in single series, and vary much in form, according to the nature of the food which sustains the animal, as well as according to their position in the mouth. In Man there are in each half of each jaw, two front teeth with a chisel-like edge, called Incisors or cutting teeth; one more pointed, called the Canine or Dog-tooth, or sometimes Eye-tooth; two somewhat flattened on the top, with single fangs, called False Molars; and three behind all with compound fangs, and broad, somewhat hollow surfaces, called True Molars or grinders. For simplicity naturalists have invented the following mode of expressing the number and arrangement of the teeth, which is called the dental formula: I. $\frac{2-2}{2-2}$; C. $\frac{1-1}{1-1}$; F. M. $\frac{2-2}{2-2}$; M. $\frac{3-3}{3-3}$ $=32$. In those races which feed exclusively on flesh, the molar teeth partake of a cutting character: while in those that subsist on grain and herbage, the molar or grinding structure prevails throughout the whole. Sometimes the incisors are curiously developed; in the Squirrel, Rat, and similar animals (RODENTIA), they project forwards in a curve meeting at an angle, and are continually growing; in the Elephant they stand out in the form of huge curved tusks; and in the Narwhal one is commonly undeveloped, while the other grows into a long spirally-twisted straight tusk like a horn in front of its head. The Whale has no teeth, but a series of horny plates, parallel to each other, depends from the upper jaw, and constitutes the valuable substance called whalebone. In the Ant-eaters, and some others of the EDENTATA, there are no teeth at all, while the Armadillo has ninety-six, and some of the Dolphins have a hundred and fifty.

The organs of digestion do not need much remark except in the Ruminating tribes. These have four distinct stomachs, differing in their structure and function; the first three of which are so arranged that the animal can direct the swallowed food into either of them at pleasure. The herbage, after having been slightly chewed, passes into the first and largest stomach, called the *paunch;* hence, after maceration, it passes into the second, or *honeycomb*, distinguished by the *laminæ* which stand up from its inner surface, dividing the whole into elegantly arranged six-sided cells, like those made by bees. The food is here pressed into little pellets, which one by one are forced up into the mouth to be slowly chewed over again. This second chewing is evidently a very pleasant operation, performed usually during repose. Being once more swallowed, it passes into the third division, called, from its numerous longitudinal folds, the *manyplies;* and thence into the fourth, or stomach proper, or *red*, where true digestion takes place. It is only by receiving large quantities of herbage, that the paunch becomes enlarged; in the sucking animal, it is very small, the milk passing at once to the fourth stomach.

The Camels (*Camelidæ*) are furnished with an additional apparatus, which enables them to abstain



WATER-CELLS OF THE CAMEL.

long from drinking, and thus to traverse wide deserts of burning sands, where no water is to be obtained. On the walls of the second stomach, there are formed several rows of deep four-sided cells; these have muscular orifices, by the contraction of which they can be closed, and the water preserved from mingling with the food; while by relaxation in various degrees, the contents are allowed to exude in any quantity, to moisten the food in the process of digestion. When full, the stomach-cells of the Camel are capable of storing up a quantity of water equal to about six quarts.

All the parts of animal structure are in beautiful harmony with each other, and with habits and instincts. The short and powerful jaw in the Cats (*Felidæ*), the lacerating teeth, the muscular fore-limbs, their freedom of motion, the sharp curved talons, the flexibility of the spine, and the straight and simple digestive canal, have all a relation to each other, and to the sanguinary and carnivorous habit of the animal. In the Camels the prominent lips, the structure of the teeth, the broad spongy soles of the feet, the callous pads on the limbs, the complex digestive apparatus, and the water-cells, all point out an animal fitted for feeding on coarse and thorny herbage, and for traversing sandy deserts. Neither of these animals could interchange any portion of its structure with the other, without serious derangement of the whole. This correspondence of part with part, and adaptation of every organ to the mode of life prescribed, is so exactly maintained, that a skilful comparative anatomist can, from a single tooth or bone, build up in imagination the whole structure of an animal which he never saw, indicate its form, and pronounce with considerable confidence upon its food, its habits, and its manner of life.

Upon the teeth and the feet depend the classification of the MAMMALIA. These are the organs which most affect the conditions of existence, under which each is found. There is, however, one group almost limited in geographical extent to Australia and its islands, which manifests a grade of organization so inferior to the MAMMALIA generally, as to warrant their being separated as a Sub-class. In some respects they seem to approach the Birds, and in others the Reptiles; and may be considered as the link which connects the Class before us with those just named.

SUB-CLASS I. MARSUPIALIA.*

(*Pouched Quadrupeds.*)

The most remarkable characters of these animals are that the young are born in an extremely immature condition; and are received at birth into a pouch, or fold of the skin of the abdomen of the mother. Here their naked and feeble bodies are protected from exposure to the air and from all injury until they are advanced in growth and strength. The teats are situated within this abdominal pocket, to one of which the infant animal very early attaches itself, and from which it derives the nutriment which gradually enables it to sustain an independent life. The Kangaroo thus carries about its young for a period of eight months. A little Kangaroo may then sometimes be seen putting its head out of the pouch, and nibbling the high grass at the same time with its mother. At length it ventures forth from its hiding-place, and tries its strength alone; but on the least alarm it springs again into its wonted hiding-place. It also puts in its head occacasionally to suck.

While the presence of the pouch, and the phenomena connected with it, are the most obvious external peculiarities of the MARSUPIALIA, there are many others that the anatomist discovers, which distinctly show an inferior grade of organization to that of the PLACENTALIA, approaching nearer to that of oviparous VERTEBRATA, and especially to that of the REPTILIA. These peculiarities we cannot here detail: they are found in the reproductive organs, in the arterial system, and in the structure

* From "*marsupium*," a purse.

of the brain; the skull is loose and open, its component bones remaining permanently separate; there is a tendency to increase the number of the teeth; the bones, whose office it is to support the sides of the pouch, are found even when the pouch itself is not developed, proving how essentially characteristic this structure is; and finally none of these animals have the power of uttering a true vocal sound.

The continent of Australia is the great home of the Marsupial animals; with the exception of the Opossums, which are an American group, the whole of the known species belong to New Holland, and the islands lying in its vicinity. It is observable also that Australia scarcely possesses any other quadrupeds than these, for of the total number of terrestrial MAMMALIA that inhabit that continent, amounting to about a hundred species, almost the whole are of Marsupial structure.

These animals, thus agreeing in general organization, yet exhibit great variety of structure, dentition, digestion, prehension, progression, food, &c., affording us parallels to the QUADRUMANA, CARNIVORA, INSECTIVORA, RUMINANTIA, RODENTIA, and EDENTATA. The species described amount to about a hundred and twenty, which are distributed by Mr. Waterhouse into eight Families. The first of these forms a distinct Order, while a second includes the remaining seven.

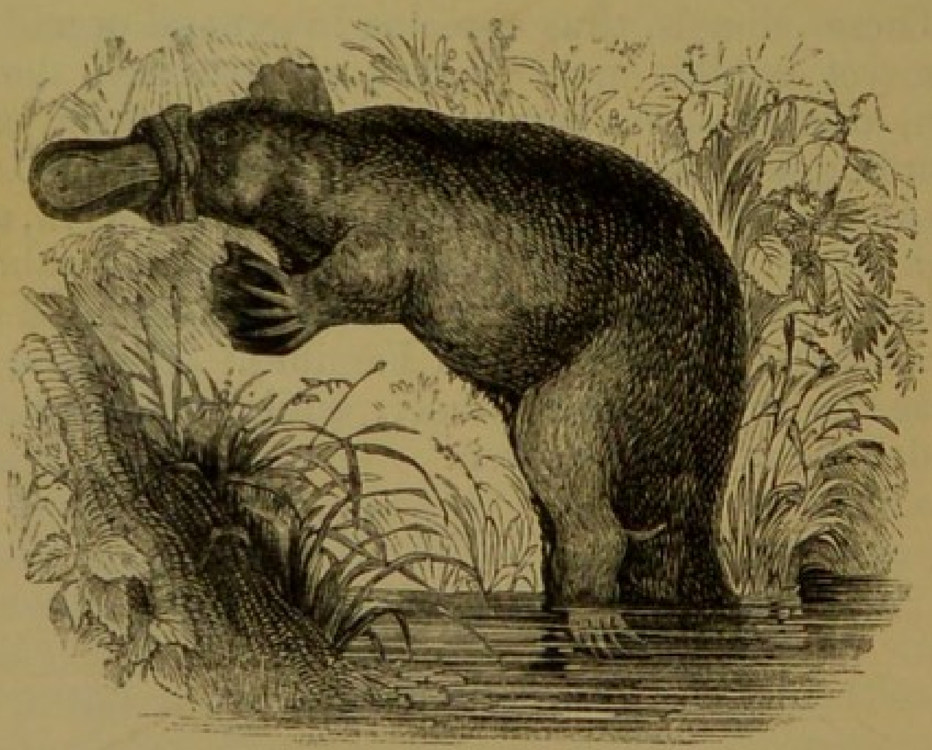
ORDER I. MONOTREMATA.*

(*Beaked Marsupials.*)

Australia produces the most strange and anomalous of all animals. It is a quadruped, about two feet in length, with a rounded, flattened body, covered with short, soft fur, of a deep brown hue:

* Animals having "but one orifice" for the evacuations of the body.

it has a short, flat tail; very short legs, the toes united by a web, which in the fore feet spreads out considerably beyond the tips of the claws. This formation enables it to swim with ease and grace; but as it also burrows in the earth, the free part of the web folds back when thus engaged, and leaves the claws unincumbered. The muzzle very much resembles the broad flat bill of some of the Ducks; it is covered with a blackish skin, which overlaps at the edges, and folds back at the base into a broad margin. The place of molar teeth is supplied by eight broad, horny excrescences (two on each side of each mandible), of an irregular form, which probably serve as grinders, but have no roots. The eyes are small but brilliant, and the orifice of the ear is readily detected by its opening and closing, in a living animal, though scarcely perceptible after death.



THE DUCK-BILL.

This animal is commonly known as the Duck-billed Platypus (*Ornithorhynchus paradoxus*), but by the colonists it is named, from its aquatic predilections conjoined with its burrowing habits, the Water-mole. It delights to haunt the broad and tranquil ponds that are formed by the expansion of a stream,

BURROW OF ORNITHORHYNCHUS.

in which it swims and dives with great facility. Its burrow is formed in the bank, and runs to a great distance under ground, sometimes extending even fifty feet. A nest of grass and weeds is formed at the extremity, where the parent rears its young.

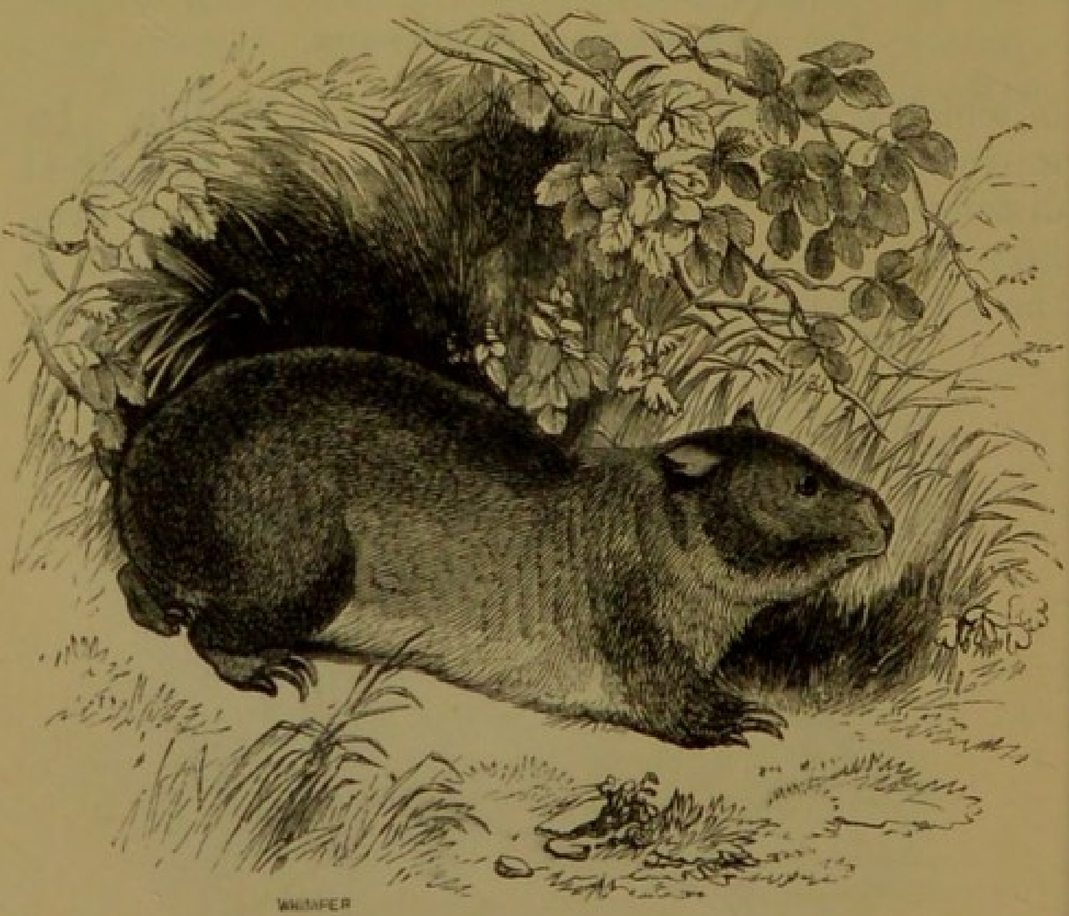
THE PORCUPINE ANT-EATER.

The Order contains another Australian animal, the muzzle of which forms a beak, but less developed than in the Duck-bill. It is clothed with bristly black hair, among which are many strong sharp spines. The tongue is long, capable of being thrust out, and covered with a glutinous secretion, by means of which it captures ants, on which it feeds. From these peculiarities it is called the Porcupine Ant-eater (*Echidna aculeata*).

ORDER II. MARSUPIATA.

(*Pouched Quadrupeds*).

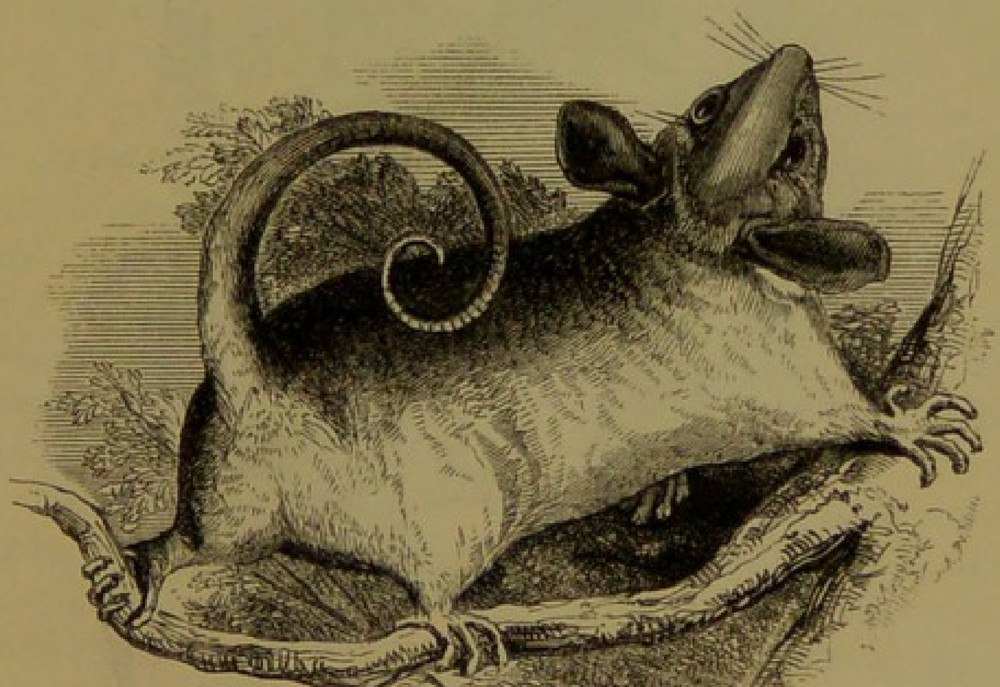
We have already alluded to the analogies presented by the MARSUPIALIA to the different Orders



WOMBAT.

of the PLACENTALIA. In the first Family which we shall mention, *Phascolomyidæ*, the Wombat, the teeth agree in their structure and arrangement with those of the RODENTIA. The form of the animal, also, as will be perceived from the figure, might easily be mistaken for that of a Cavy. It is about three feet in length, somewhat dull and inactive; it burrows by day, but during the night feeds on grass: its flesh is excellent meat.

Others of the RODENTIA, as the Squirrels and the Dormice, seem to be represented by the Phalangers (*Phalangistadæ*). As among the former there are some which can sustain themselves in the air for awhile, by means of an expansion of the skin between the legs, which are hence called Flying Squirrels, so are there Flying Phalangers, with exactly the same structure, beautiful little soft-



DORMOUSE PHALANGER.

furred animals, one species of which is called by the colonists the Sugar Squirrel (*Petaurus sciureus*). The skins of these pretty animals are exported as an article of commerce. The figure and habits of the Dormouse are exhibited by a smaller species, called the Dormouse Phalanger (*Phalangista gliriformis*): the lively and interesting manners of which have been agreeably narrated by Professor Bell.

The largest and most valuable of the Marsupial animals are the Kangaroos, constituting the Family *Macropodidæ*. The elegant forms and erect attitudes of these gentle creatures, and the disproportion between the taper foreparts and the broadly developed

COMMON KANGAROO.

hinder parts, especially between the short and feeble fore limbs, and the long stout and muscular hinder pair, are well known, as the animals are frequently brought alive to this country. The Kangaroos, of which there are many species, are exclusively herbivorous; they associate in herds, grazing on the herbage of large open plains. They are hunted with dogs, for the sake of the sport, as also for the flesh, which is much esteemed. In their course they proceed, not by running, but by enormous bounds or flying leaps, with the head and fore parts nearly erect.

There is one circumstance connected with the nutrition of the young, in the Kangaroo, which we cannot pass over without observation, exhibiting as it does, the hand of God, engaged for the special comfort of His creatures. When the helpless progeny is first presented to the nipple, it is utterly incapable of the muscular effort of sucking; the mother is therefore furnished with a muscle which presses the nipple, and causes the milk to flow. The act of swallowing, however, might not always take place at the same instant as the injection, and the throwing of the fluid into the windpipe might be fatal. This danger is provided for, and obviated by an express contrivance; the air-passage is completely separated from the throat, and the milk passes down in a double stream on each side of the larynx into the stomach; furnishing, as Professor Owen justly observes, "a most irrefragable evidence of creative foresight." A structure analogous to this is found in the Whale.

In the little Bandicoots (*Peramelidæ*) we are reminded of the Shrews and other small insect-eating quadrupeds. They are said to live on insects, for which diet their teeth seem suited; but some of the species are also reputed to feed on roots and bulbs. Thus Gunn's Bandicoot (*Perameles Gunnii*), a pretty creature about as large as a Rabbit, which is marked across the loins with alternate black and white bands on a yellowish ground, is accused of devouring bulbs in gardens; and thus of inflicting great injury. They are said also to devour corn in granaries, as rats and mice do in Europe.

More decidedly insectivorous is another little banded creature, the *Myrmecobius*, the single known species of which constitutes a Family named *Myrmecobiadæ*. It is about the size of a Squirrel,

GUNN'S BANDICOOT.

nearly black behind, and bright brown in front, the whole body elegantly crossed by cream-coloured bands. It has a greater number of teeth than are found in any other of the MAMMALIA, except some of the Dolphins and of the Armadillos. They are thus arranged :—

$$\text{I. } \tfrac{8}{6}\text{; C. } \tfrac{1-1}{1-1}\text{; F. M } \tfrac{4-4}{5-5}\text{; M. } \tfrac{4-4}{4-4} = 52.$$

This beautiful little creature was discovered at Swan River, but little is known of its history.

We now come to the carnivorous MARSUPALIA, some of which are formidable for their size, strength, and ferocity. They have been named as a Family, *Dasyuridæ*, or Hairy-tails, by way of distinction from the Opossums, in which the tail is rat-like and scaly, and naked and prehensile at the end. The Zebra-wolf or Native Tiger of the colonists (*Thylacinus cynocephalus*), equals a large dog in size and strength, specimens having been found four feet in length, besides the tail, which is two more. It is nocturnal, like most beasts of prey, feeds on

MYRMECOBIUS.

Kangaroos and other inoffensive animals; and is hated by the settlers for its depredations among the sheep that pasture upon the plains. The colour of this animal is yellowish-brown, marked with the same sort of transverse bands that we have seen in the last two species.

Finally, the Opossums (*Didelphidæ*) are the most highly organized of the Sub-class, and approach nearest in structure to ordinary quadrupeds. They comprise nearly thirty species, which are almost confined to South America, one or two species only extending into the Northern portion of that continent. They are analogous to the Monkeys, for they possess a well-developed opposible thumb on the hind feet, and the tail is naked and sensitive, able to coil around the branch of a tree, and to support the weight of the animal when swinging from it.

The Virginian Opossum (*Didelphys Virginianus*) was the earliest known of the MARSUPIALIA, and is one of the largest of the Family. It is about the size of a cat, covered with grey fur, thick and soft, but of no value; lives in trees throughout the whole United States; and is proverbial for its singular

MOUSE-OPOSSUM AND YOUNG.

habit of counterfeiting death when alarmed. Another species found in South America (*D. murina*) has the marsupial pouch imperfectly developed; to compensate for which, the parent carries her young upon her back; where they better maintain their position, amidst the climbing and leaping movements of the mother, by entwining their long, slender, and prehensile tails around hers.

SUB-CLASS II. PLACENTALIA.

(*Placental Quadrupeds.*)

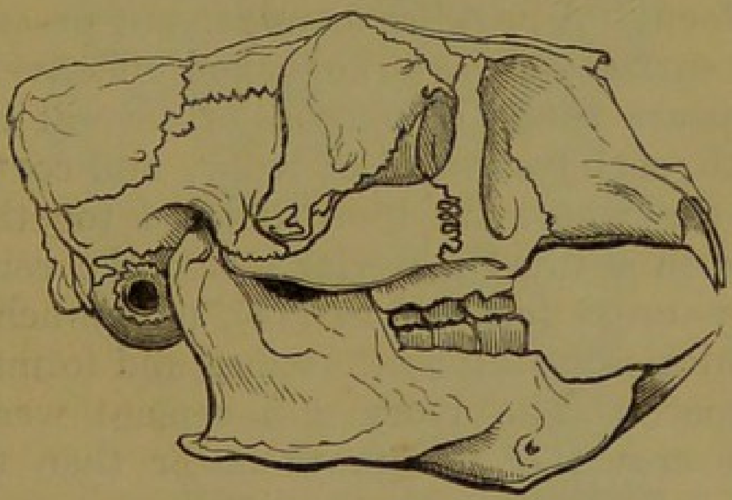
All the animals which compose this great division, and with which we close the series of organized existences that have occupied this volume, bring forth their young with all their organs perfectly formed, and more or less capable of being used in their several functions. A considerable portion of the development, which in the MARSUPIALIA is attained after birth and within the maternal pouch, is in these acquired before birth, the requisite nourishment being supplied through a peculiar network of blood-vessels in the body of the parent, which is named the *placenta*. After birth, however, the young are still dependent for a while on the care of the mother, and are nourished by her milk. There is still considerable diversity in the degrees in which the animal powers are developed at birth in the different Orders; the PACHYDERMATA and RUMINANTIA, herbivorous animals, are the most advanced, and the least dependent on parental care; the RODENTIA are more feeble, and the CARNIVORA are at their birth peculiarly helpless, immature, and even blind. The lively, vigorous and intelligent movements of a Pig, as it scampers after its mother on the day after its birth, contrast strongly with the feeble, ineffective, almost pitiable efforts made by a Kitten of the same age, as it languidly but vainly strives to lift up its body upon its feeble limbs, or tumbles about among the straw on which it is lying.

The teeth, as the instruments by which the food is prepared for digestion, are among the most important organs in MAMMALIA; and as their form, structure, and arrangement depend on the nature of the food, they form an unfailing index to the characteristic habits of the animal, and are consequently made to furnish the ground of systematic distribution into Orders, Families, and Genera.

The most simple kind of tooth is found in the Dolphins, in which these organs are simple cones of ivory, without any distinction of form or function. Each tooth is hollow, and its cavity contains a pulpy matter furnished with blood-vessels. From the surface of this pulp or core, fresh layers of ivory or calcareous matter are being continually secreted and deposited on the inner surface of the tooth, which thus increases in substance. These animals do not renew their teeth; but new ones are continually forming at the back of the jaws, while those in front drop off in succession, and their sockets are absorbed. Thus the number of the teeth is irregular, and their size keeps pace with the growth of the jaws.

The single projecting tooth of the Narwhal, and the curved tusks of the Elephant, consist also of ivory, without any harder coating, and are formed in the same manner. In most quadrupeds, however, there is a layer of harder substance deposited around the proper substance of the tooth analogous to ivory. It is called *enamel*, is crystalline in its texture, very hard and dense, so as to act for a succession of years on various substances used as food without wearing away.

In the incisors of the RODENTIA, of which a ready example for investigation may be found in a Rat, or a Rabbit, the enamel is deposited only on one side of the tooth, that which is external. The tooth may be considered as a tusk, formed for the most part of solid ivory, growing in a socket which is curved in the arc of a circle. In the above figure of the skull of a Rodent, the extremities only are seen, but the sockets must be understood to extend to a point behind the molars. These teeth are constantly growing from the pulpy core at their base; but as those of the upper jaw meet those of the lower at their tips, they are perpetually worn away by their action upon each other, and upon the hard food which they are formed for scraping away. They would be, however, but dull and ineffective instruments if they were composed of ivory alone; but the outer surface being coated with a substance of extreme hardness, this resists the wearing action while the softer ivory yields to it; thus the points of these teeth constantly present a slanting edge, like that of a chisel, always sharp and effective. The wearing away of the extremities, and the growth from the bases balance each other with exact precision, but "when by accident an opposing incisor is lost, or when by the distorted union of a broken jaw, the lower incisors no longer meet the upper ones, as sometimes happens to a wounded Hare, the incisors continue to grow until they project like the tusks of the Elephant, and the extremities, in the poor animal's abortive attempts to acquire food also become pointed like tusks; following the curve prescribed to their growth by the



SKULL OF PORCUPINE.

form of their socket, their points often return against some part of the head, are pressed through the skin, then cause absorption of the jaw-bone, and again enter the mouth; rendering mastication impracticable, and causing death by starvation."*

The molar teeth have the ivory surrounded by a layer of enamel, which, however, forms irregular transverse folds running deeply into the body of the tooth. By the principle already described, the edges of these layers stand higher than the other parts, and thus the crowns of the teeth are marked with ridges running in and out, in a sinuous or zigzag pattern.

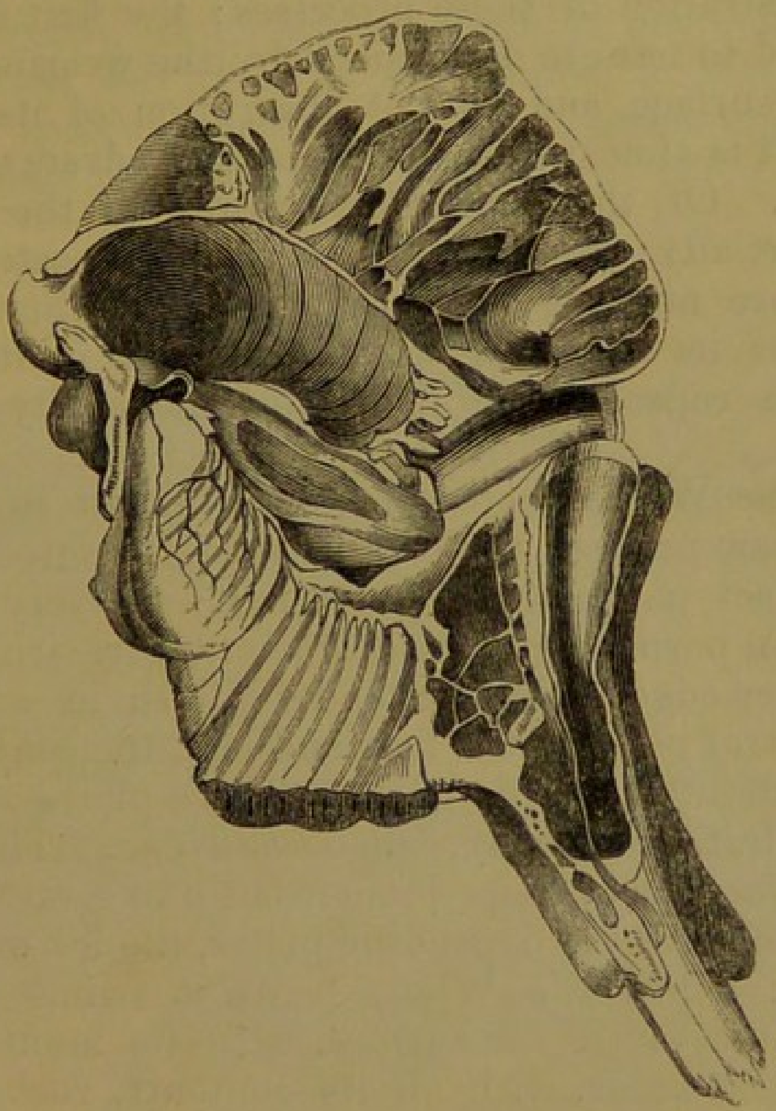
In the Beasts of Prey, as well as in the Monkeys and Man, the body of the tooth is composed of ivory, and the entire crown or projecting portion is

* Owen's Odontography, 411.

coated with the crystalline enamel; deposited before it issues from the jaw, by the interior surface of the vascular capsule in which it was formed.

The molars of herbivorous animals, such as the Elephant, the Horse, and the Ox, are in much more constant and more wearing employment than the teeth of other quadrupeds. Like the upper and nether millstones, these teeth perpetually work upon each other with great muscular force, grinding to a pulp the leaves and stalks on which these animals feed. A peculiar arrangement preserves the grinding surfaces always rough and effective. Each tooth appears to be composed of several independent teeth, each composed of ivory, and coated with enamel, the whole are then soldered together, and imbedded in a third material called the cement, or the stony crust (*crusta petrosa*), not much unlike ivory, which fills all the interstices, and forms a compound tooth. The ivory and cement wear away from the crown of the tooth faster than the hard enamel, and thus the latter is always prominent, forming irregular transverse ridges across the grinding surface.

To allow for the increasing size of the jaw in the growth of the animal, the teeth, which are not capable of growth, are replaced by others. Every one knows that this happens to children when about seven years old. The new tooth is formed below the one which it is to replace; and as it grows the roots of the latter are gradually absorbed, and the crown falls out to make way for its successor. This is the mode in which the process is effected in most animals; but in the Elephant there is another provision, which answers a similar purpose. As the molars wear away by use, their fangs are absorbed, and they disappear, while their place is constantly supplied by others growing up from behind. Thus the Elephant's teeth are constantly renewing as long as life continues. Each molar is composed of more constituent simple teeth than its predecessor; thus the first or milk teeth consist of four *laminæ* each, the next of eight or nine, until the eighth set are each composed of upwards of twenty of these laminæ of enamel.



SECTION OF ELEPHANT'S SKULL.

As each tooth advances, only a small portion pierces the gum at once; one of twelve or fourteen *laminæ*, for instance, shows only two or three of these through the gum, the remainder being as yet imbedded in the jaw; and in fact the tooth is complete at its fore part, where it is required for mastication, while behind it is very incomplete. The *laminæ* are successively perfected as they advance. The molar of an Elephant can never, therefore, be seen in a perfect state; for if it is not worn in front, the back part is not fully formed, and is without fangs; and when the structure of the hinder portion is perfected, the front part is already gone.

If the reader will glance at the section of an Elephant's skull, represented in p. 405, he will see an illustration of these processes: the first molar is reduced to minute dimensions by the wearing down of its surface, and by the absorption of its fangs, while it is almost pushed out by the advance of the second. Of this, about two-thirds of the surface are partially ground away, while the posterior *laminæ* are not yet perfected. Behind this is the germ of its successor, as yet inclosed in its membranous capsule, and lodged in the cavity of the jaw.

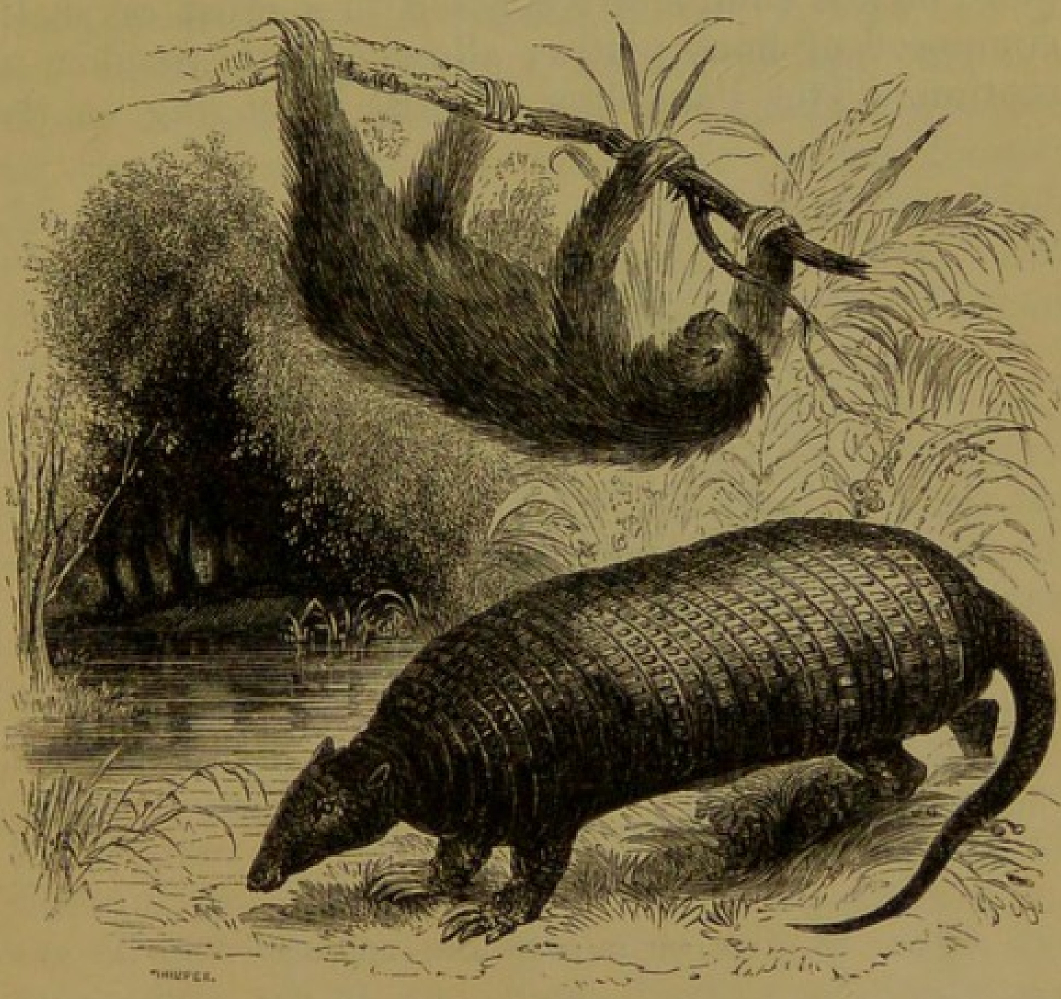
In the Whale there are no teeth, but from each upper jaw proceed more than three hundred horny plates, set parallel to each other, and very close; they run perpendicularly downwards, are fringed on the inner edge with hair, and diminish in size from the central plate to the first and last, the central one being about twelve feet long. These plates are commonly, but erroneously, called *whalebone*. The lower jaw is very deep, shaped somewhat like a vast spoon, and receives these depending plates, the use of which is this: when the Whale feeds, it swims rapidly just under or at the surface, with its mouth wide open: the water, with all its contents, rushes into the immense cavity, and filters out at the sides between the plates of the whalebone, which are so close, and so finely fringed, that every particle of solid matter is retained.

We now proceed to give some brief account of each of the nine Orders into which the PLACENTALIA are divided. They are named EDENTATA, RODENTIA, RUMINANTIA, PACHYDERMATA, CETACEA, CARNIVORA, INSECTIVORA, CHEIROPTERA, and QUADRUMANA.

ORDER I. EDENTATA.

(*Toothless Quadrupeds.*)

The term *toothless* applies strictly only to the incisive teeth, which are not found in any species of this Order, but there is one family in which the term is absolutely correct, the Ant-eaters being entirely destitute of teeth. The nails of the feet are

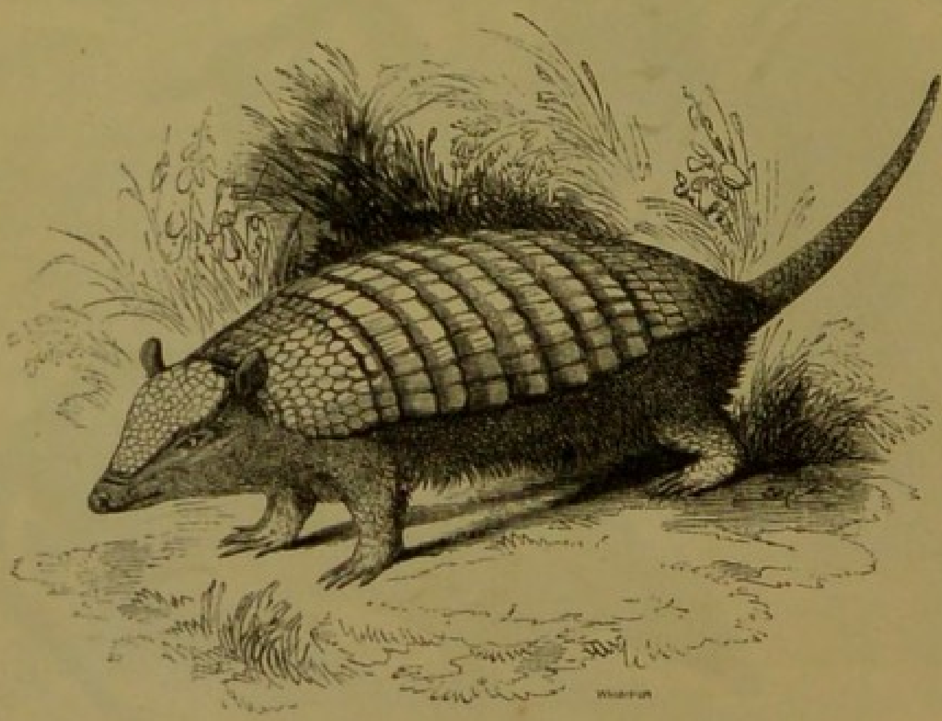


THREE TOED SLOTH, AND GIANT ARMADILLO.

enormously developed, forming large hoof-like claws commonly curved downwards. They are used either for digging in the ground, tearing to pieces the earthy dwellings of *termites*, &c., or for hooking the animal to the branches of trees.

The last named use is peculiar to the Sloths (*Bradypodidæ*), singular animals of South America, the economy and habits of which were for a long time misunderstood. It is now ascertained that they habitually dwell in trees, suspended from the branches by their strongly hooked claws, in the manner represented in the accompanying engravings. They feed upon the foliage, for the mastication of which their molars are of singular structure, each consisting of merely a cylinder of ivory, the sides of which are covered with enamel.

The Armadillos (*Dasypodidæ*) have their bodies more or less completely encased in a crust or shell, composed of bony plates; allowing little freedom of motion. The Pangolins (Manis) belonging to the



WEASEL-HEADED ARMADILLO.

Family of the Ant-eaters (*Myrmecophagadæ*) have another kind of armour composed of large sharp bony scales somewhat resembling those of a fish, with projecting edges. They inhabit Africa and India. The Ant-bears (*Myrmecophaga*) are clothed with coarse flattened hair resembling withered grass, as are also the Sloths. They are entirely destitute of teeth. All these feed on insects, chiefly Ants and Termites, which abound in South America, where most of them reside.

ORDER II. RODENTIA.

(Gnawing Quadrupeds.)

The incisor teeth which we have found to be entirely absent from the animals of the preceding Order are found developed in an unusual degree in these. As we have already, however, explained the peculiarities of their form and structure, we need not say anything more about them. About half of the Placental MAMMALIA known belong to this Order, which contains above six hundred species. Of these three hundred and six are of the Family *Muridæ*, the Rats and Mice, while the Squirrels (*Sciuridæ*) contain exactly half that number. Fifteen species are enumerated by Professor Bell as belonging to the British Isles.

"The structural organization of the Rodents," observes Mr. Martin, "as evidenced by the characters of the skull, the bird-like condition of the brain, and by other points, is at a low par, and the ratio of their intelligence is in a parallel degree. We may tame them, but we cannot educate them. They are all timid and feeble, and trust for self-protection to flight or concealment. The prey of ferocious beasts, and birds, and reptiles, their fertility, by a wise provision, counterbalances their annual diminution. Spread over the earth, from the equator to the coldest latitudes, they tenant rocks and mountains, plains and woods, feeding on grain and vegetables, and often devastating the cultivated domains of man . . . . Most are nocturnal, or crepuscular in their habits, many dwell in burrows; some conceal themselves amidst herbage, some amongst the foliage of trees, and some build for themselves habitations, which have excited the interest and admiration of man."*

So extensive an Order of small, often minute, animals are, as may be supposed, widely scattered.

* Pict. Mus. i. 54.

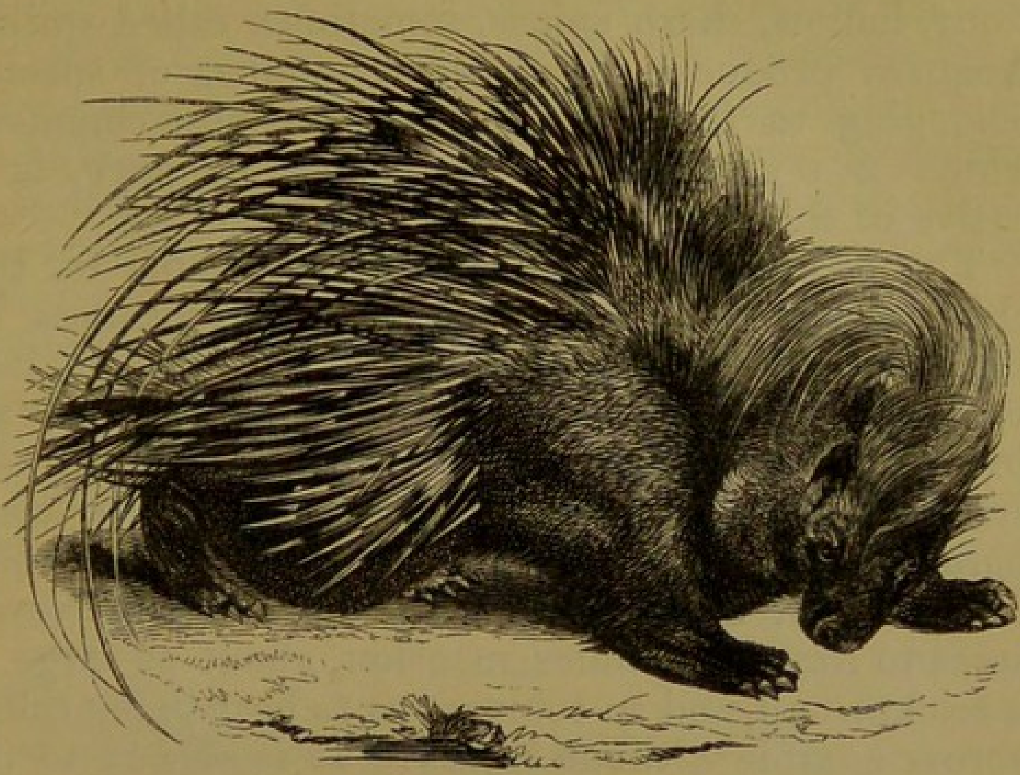
North and South America contain nearly as many as all the rest of the world together; in Australia, the Order is almost unknown, its place being supplied by the analogous forms of the MARSUPIALIA.

In most animals of this Order the hinder parts are more developed than the fore; so that they leap rather than walk; in some this disproportion is as

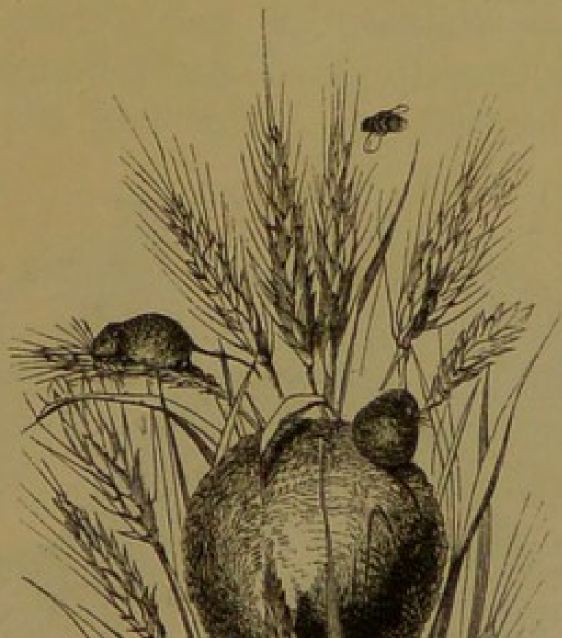
JERBOA.

great as in the Kangaroos; this structure is strongly seen in the Jerboas of Asia and Africa, belonging to the *Muridæ*, and in the Deer-mice (*Gerbillus*) of North America.

In most of the Rats (*Muridæ*) the hairs of the body have a tendency to become spinous; but in none is this so fully developed as in the Porcupines (*Hystricidæ*) which are covered with strong,



AFRICAN PORCUPINE.



NEST OF HARVEST-MOUSE.

stout, hollow, sharp spines, sometimes called quills. America produces the greatest number of species belonging to this Family, but the most common, which is represented in the preceding page, is a native of the South of Europe and of Africa.

The Squirrels (*Sciuridæ*) are remarkable for the elegance of their forms, and the sprightliness of their motions. The prettiest of our native RODENTIA is the Common Squirrel, as the Harvest-Mouse is the smallest. The nest of the latter is a structure which might without detriment be compared with the productions of birds. It is usually composed of blades of grass, artificially interwoven so as to form a globular mansion, about as large as a cricket-ball, and so compact as to bear being rolled across a table without injury. It is affixed to the stems of weeds, or, as in the engraving, to the stalks of growing corn.

BEAVER.

Still more famed for architectural skill is the Beaver (*Castor fiber*) which with the Voles forms the

Family *Castoridæ*. They are very mouse-like in appearance, and the Beaver might be mistaken for a huge overgrown Rat, but for its broad and flat tail. It builds, in association with its fellows, capacious huts of the branches of trees, intermixed with stones and mud; and so strong as to resist the force both of water and ice. They are built in a stream or lake, projecting from the bank, with the entrance beneath the surface. The Beaver was in ancient times an inhabitant of England.

The Hares and Rabbits (*Leporidæ*) form another Family of the Rodentia; no less than four species are mentioned as British Quadrupeds.

ORDER III. RUMINANTIA.

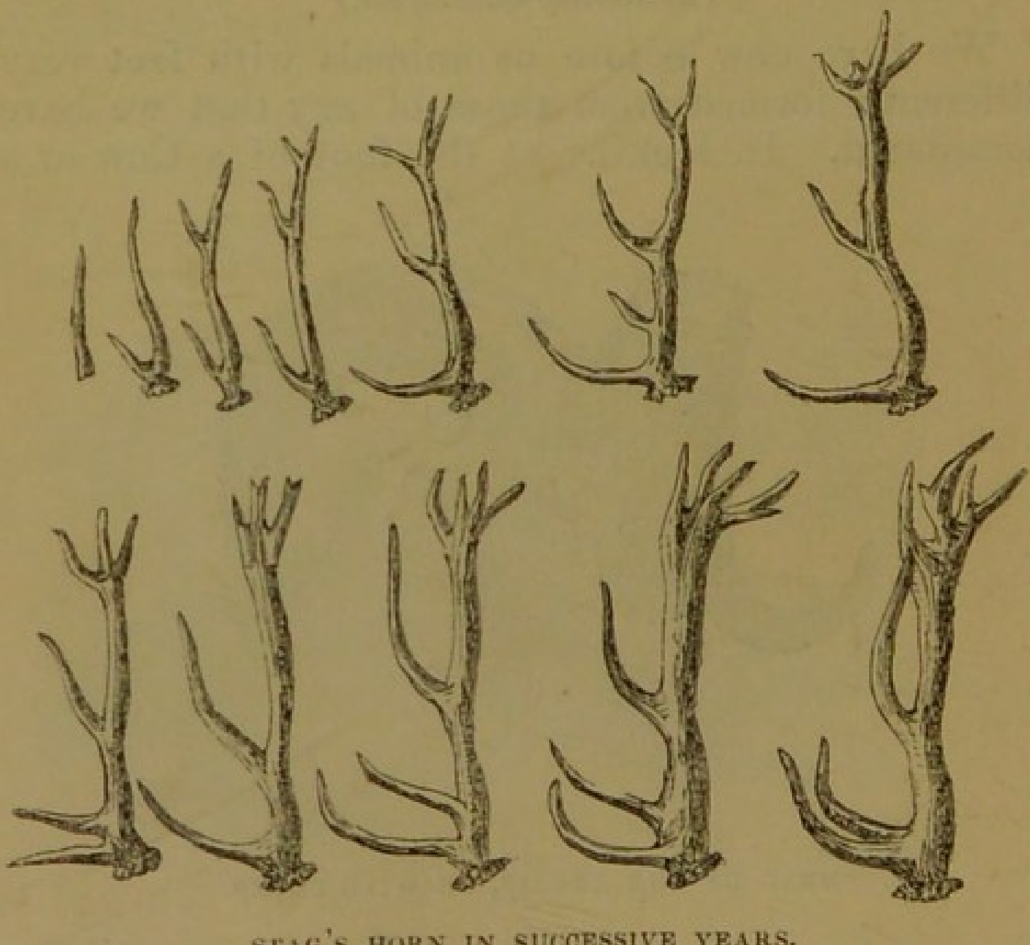
(*Ruminating Quadrupeds.*)

We have now before us animals with feet very differently formed from those of any that we have considered. In looking at the foot of a Cow or a

HEAD OF THE ARGALI, OR WILD SHEEP.

Sheep, we see but two principal divisions, each of which is encased in a horny shoe or *hoof;* these two hoofs present a flattened face to each other, as if a single hoof had been cut in two; hence these animals are called cloven-footed.

Another peculiarity is the lengthened and complicated process of digestion; their food consists entirely of herbage, which contains a small amount of nutritive matter in proportion to that which is indigestible; hence it is needful that it should be subjected to elaborate action, that all the nutriment be extracted. For this purpose there are four stomachs, as already mentioned, and the food, after having been swallowed, is brought up again into the mouth to be more completely chewed. This process is called ruminating, or chewing the cud. The grass is nipped off by incisor teeth in the lower jaw, acting on a callous pad in the upper, where there are no incisors. Most of the genera have no canines, but all have well developed molars.



STAG'S HORN IN SUCCESSIVE YEARS.

Many of the RUMINANTIA have horns for defence, which are bony excrescences growing out of the skull. Sometimes they are covered with horn, properly so called, and are permanent; as in the Oxen (*Bovidæ*); but in the Deer Family (*Cervidæ*), they are mere bones covered with skin, and grow every summer, attaining their full size in a few weeks. In the succeeding spring they fall off to be again renewed. They increase in size and in the number of the branches.

The flesh of all this Order is most nutritious, agreeable, and wholesome; and no species is superior in this respect to the domestic Ox. Many other qualities render this the most valuable of all the domesticated animals.

"If," as Professor Bell observes, "the qualities of the Dog are of a higher and more intellectual character, and bring it into closer communication with man as a social being; and if the Horse, as a beast of burden and of draught, serves more to his immediate personal assistance, the Ox surpasses these and all others in the devotion of its powers while living, and the appropriation of every part of the body when dead, to the wants, the comforts, and the luxuries of its owner."*

The Sheep and Goat constitute another Family (*Capradæ*) of great importance to man. The former we find in his possession from the very earliest times; for "Abel was a keeper of sheep." The flesh, the milk, and the wool of this animal are all valuable products.

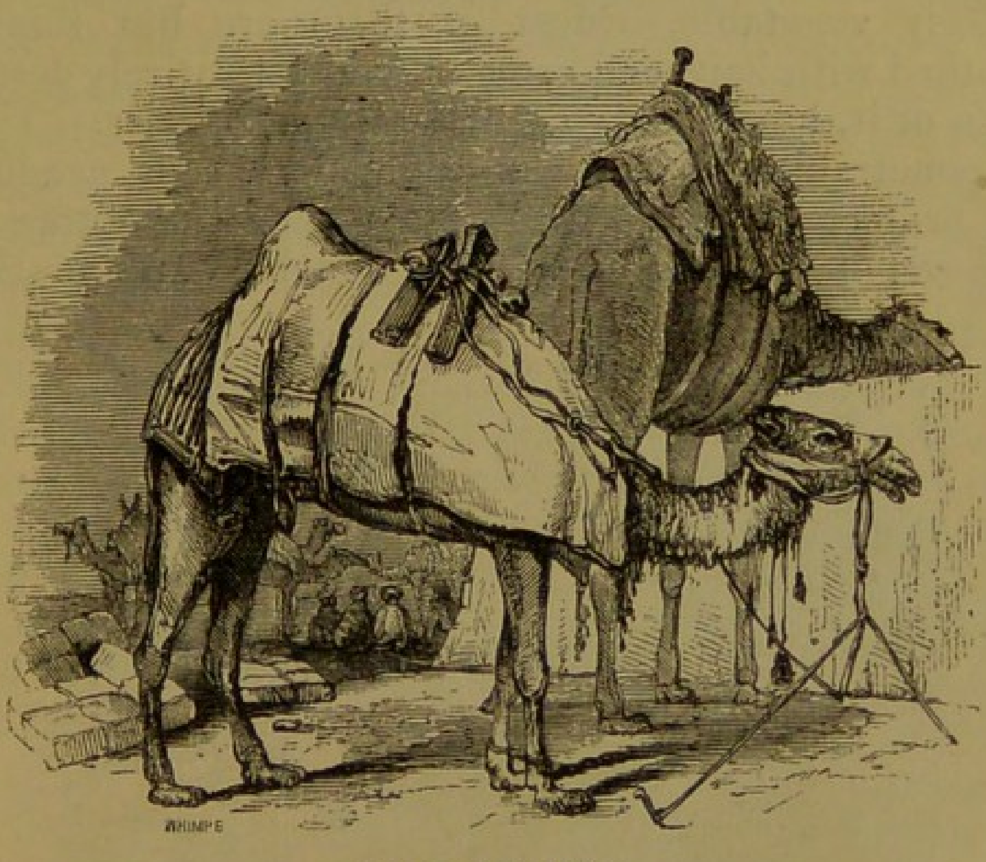
Passing by the Musks (*Moschidæ*), a group of elegant deer-like animals inhabiting Eastern Asia, and Africa, of which an idea may be formed from the annexed figure of the Kanchil (*Tragulus kanchil*),—we stop a moment to notice the Camels (*Camelidæ*), as valuable to the Arab of the desert as the Ox is to us. In structure they approach the PACHYDERMATA; they have no horns, but possess canine teeth, and incisors in both jaws; their toes, united beneath by a spongy pad, are free above, and

* Brit. Quad. 412.

SHEEP OF PALESTINE.

KANCHIL.

have their extremities encased in small round hoofs. By this formation, the broad foot rests on the shifting sand without sinking, a very important point in traversing the desert. The hump or humps on the back, though they give these animals a deformed appearance, are of great service to them. They are composed of granular fat, and form reservoirs of



HALT OF CAMELS.

nourishment, which supply the waste of the body during the long fasts to which these animals are often subject. Let us admire God's care for the comfort of His creatures, and the many ingenious contrivances by which they are better fitted for the service of man.

The number of species recognized as belonging to this Order is 148, which are thus distributed. *Bovidæ* (Oxen), 13; *Capradæ* (Sheep, Goats, Antelopes), 83; *Cervidæ* (Deer, Giraffes), 40; *Moschidæ* (Musks), 7; *Camelidæ* (Camels, Lamas), 5. They predominate in the Eastern hemisphere, less than one sixth of the whole belonging to America.

ORDER IV. PACHYDERMATA.

(Thick-skinned Quadrupeds.)

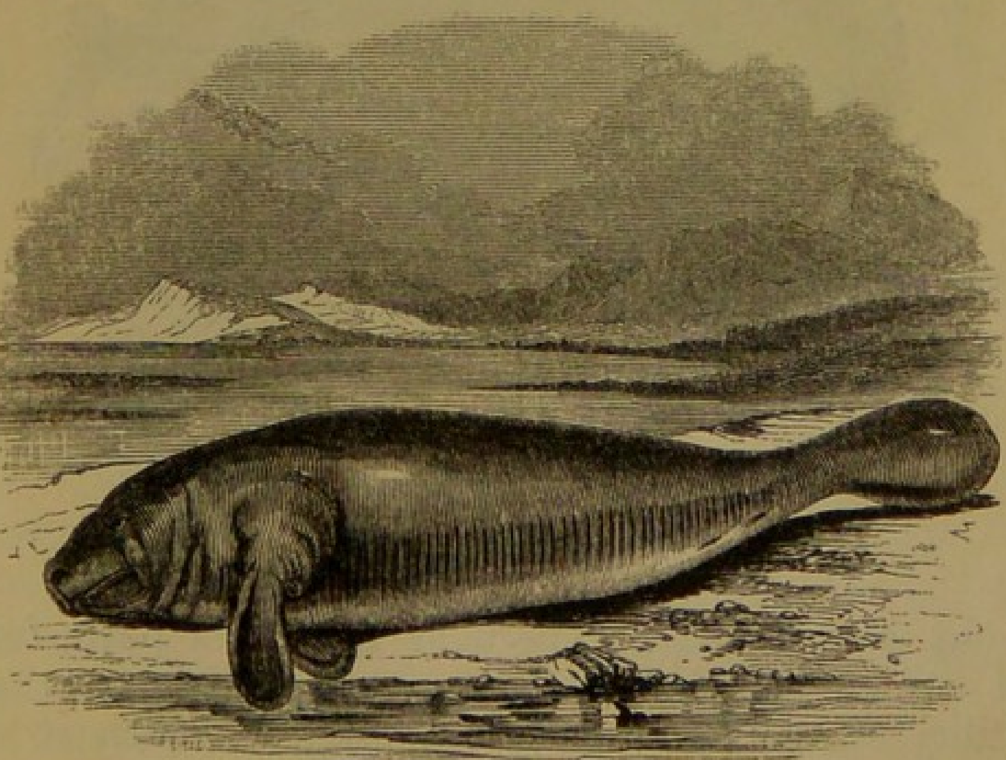
These are the largest of all the terrestrial creatures. They are characterized by the thickness of their tough and leathery skin, and the want of a ruminating stomach, though their natural food is wholly vegetable. Most of them are but thinly clothed with hair, and some are almost entirely destitute of it, having only a few scattered bristles. The impenetrable character of the hide is thus needful to protect them from the maddening punctures of the venomous ticks and flies, which swarm in the

WART-HOG, INDIAN RHINOCEROS, AND RIVER-HORSE.

sultry regions of the Tropics. For the same reason they seek refuge, during the burning heat of the day, in ponds and rivers, where, immersed to the neck, they enjoy the refreshing coolness, or, wallowing in the soft mud of the morasses, acquire an additional protection against these, their most formidable, though tiny foes. Conscious of their own massive strength, they fear no other enemies.

The torrid regions of the Old World produce the greatest number of PACHYDERMATA; the Hippopotamus, and the hideous Wart-hog (*Phacochœrus*), are exclusively African; of the Elephants, the Rhinoceroses, the Horses, and the little Damans (the Conies of the Scriptures) some species are peculiar to Africa, and others to Asia with its great islands; the Swine are principally Asiatic, while the Peccaries are South American, and the Tapirs are shared by South America with Eastern Asia. The Manatees, an aquatic Family, connecting this Order with the Whales, are found on the coasts of America, Africa, India, and Kamtschatka.

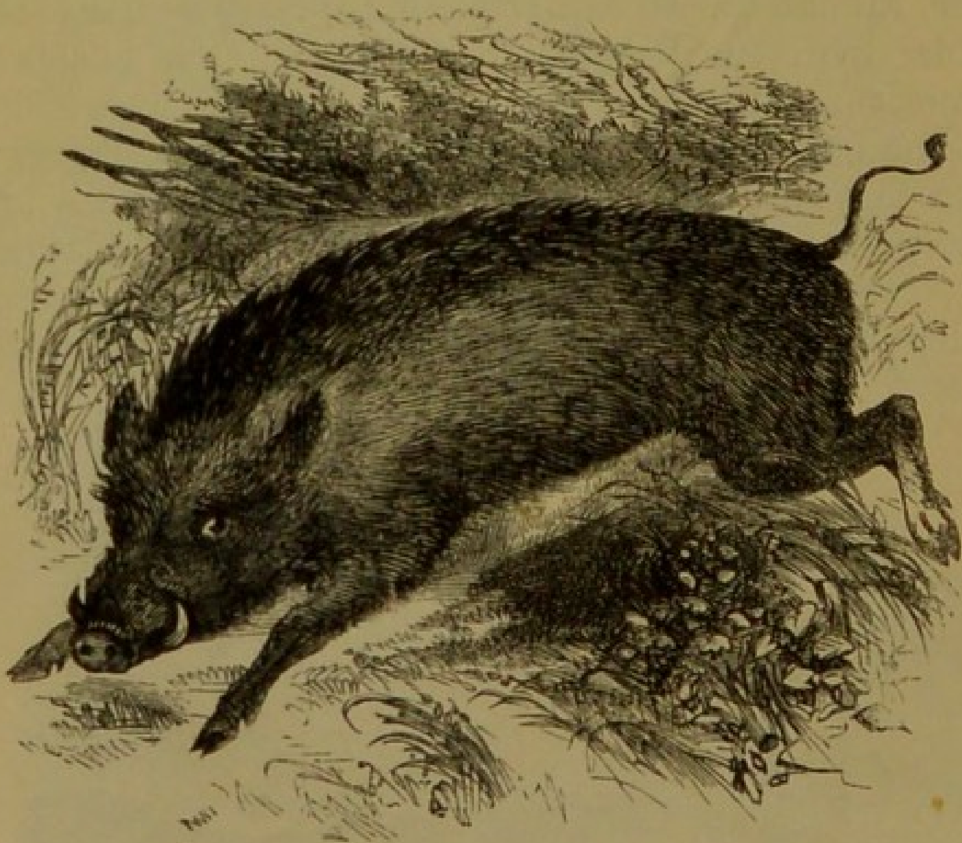
The Families with the number of species proper to each may be thus enumerated; *Equidæ* (Horses), 9; *Rhinocerotidæ* (Rhinoceroses, Damans, and Tapirs), 13; *Suidæ* (Hippopotamus, Swine), 16; *Elephantidæ* (Elephants), 2; *Manatidæ* (Manatees), 3; total 43.



MANATEE.

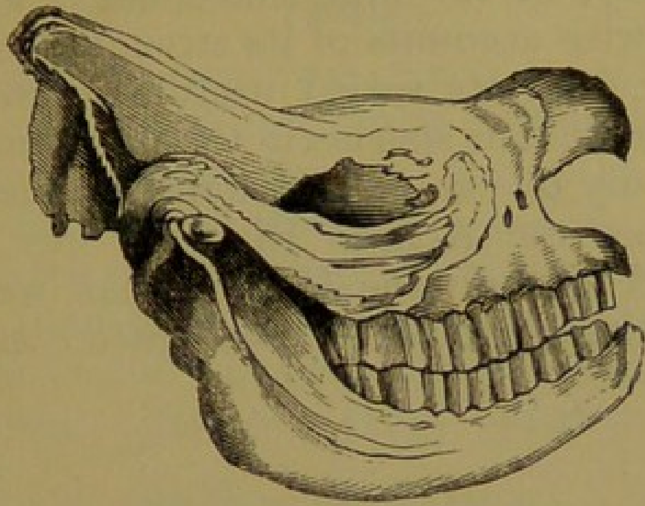
The noble and useful Horse (*Equus caballus*) with its fellows the humble Ass, and the beautiful Zebras and Quaggas of South Africa, connect the Order with the one we have just left, presenting some points of agreement with the Camels. The English Horse, in its various breeds, surpasses that of all other countries. Herds of wild horses are seen on the plains of Tartary, and of South America; but these are all probably descended from individuals escaped from domestication.

Though most of the Swine Family (*Suidæ*) belong to Africa and the Great Indian Archipelago, there is one species, *S. scrofa*, which is found throughout Europe in a wild state, and was formerly a tenant



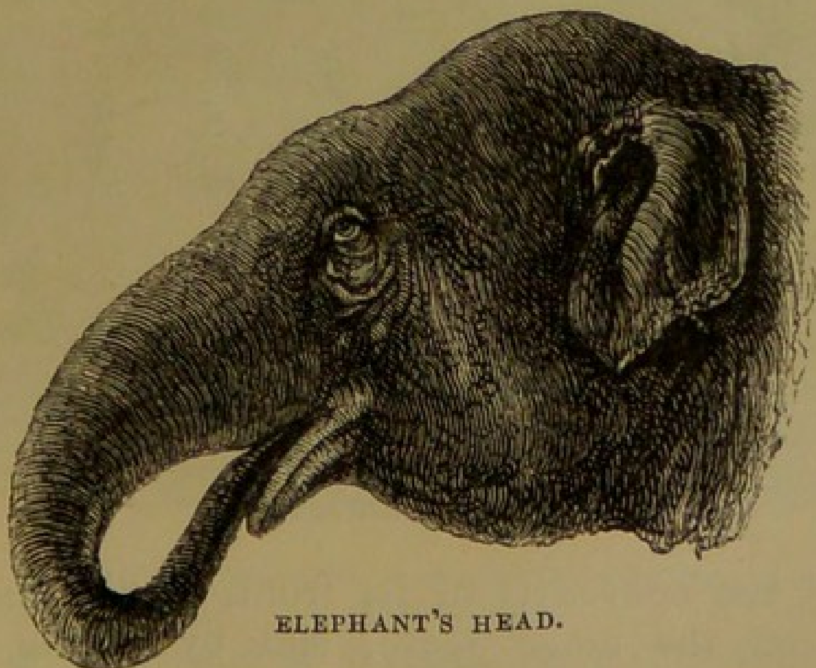
WILD BOAR.

of our own forests. The wild Boar is a powerful and savage animal. In a domesticated state, the fertility of the Hog, the readiness with which it is fattened, the wholesomeness and delicacy of its flesh, and the ease with which it is salted, render this one of our most valuable animals.



SKULL OF RHINOCEROS.

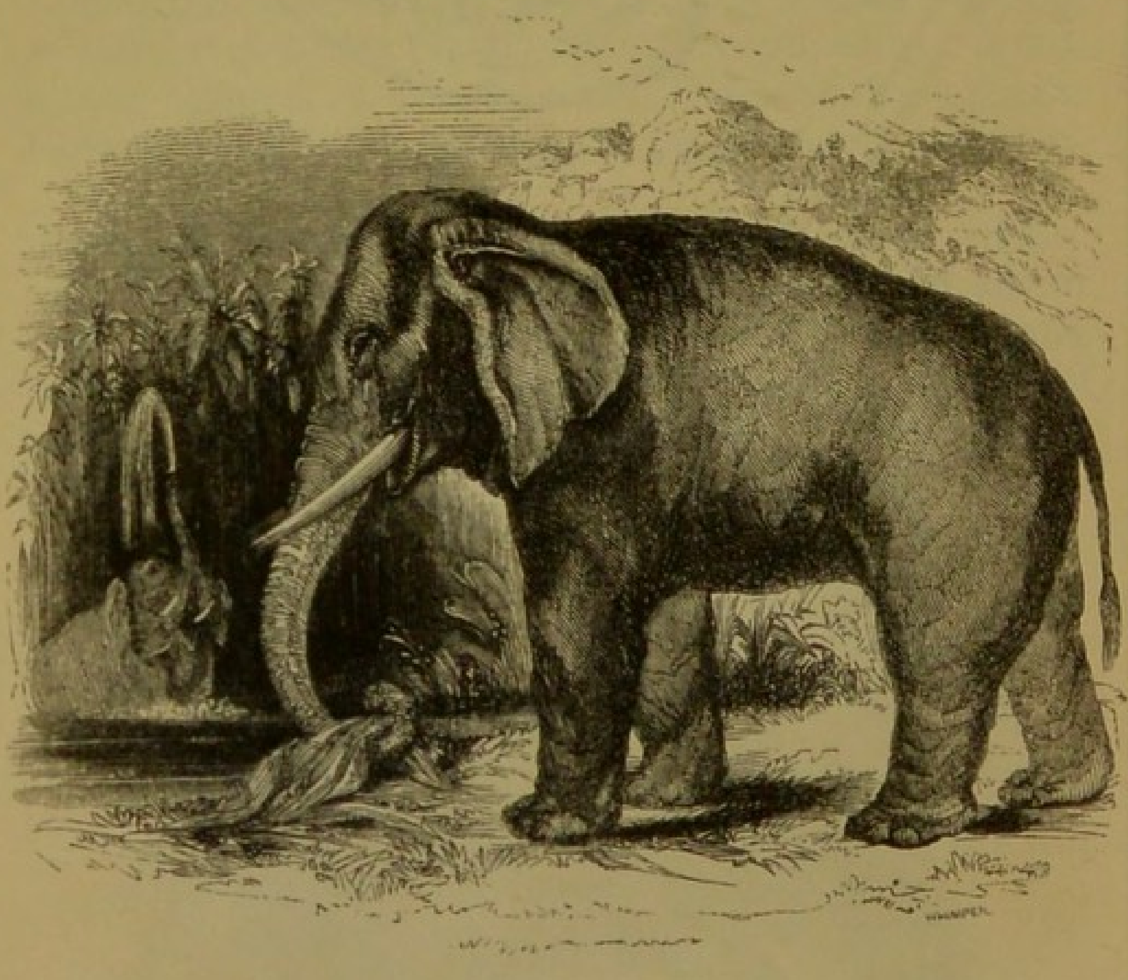
The above figure will give a notion of the skull in the Rhinoceros, as that on page 405 will of the Elephant. The protuberance of bone above the nose supports the solid horn, which is characteristic of this genus. This horn is of different structure



ELEPHANT'S HEAD.

from that of the Ox, and that of the Deer; it is composed of substance of the nature of hair, agglutinated into a dense mass.

Our limited space forbids us to dwell on the half-reasoning Elephant; a volume might be filled with descriptions of its flexible and versatile proboscis with its forty thousand muscles; of its curved tusks of solid ivory, of its huge naked body, and pillar-like limbs, with accounts of its strength, its docility, its sagacity, and its varied usefulness in war and peace. The Indian species is the best known to us, being the only one at present domesticated; but in ancient times the African Elephant was also subjugated and used in the Carthaginian wars. This species is distinguished by the greater size of its



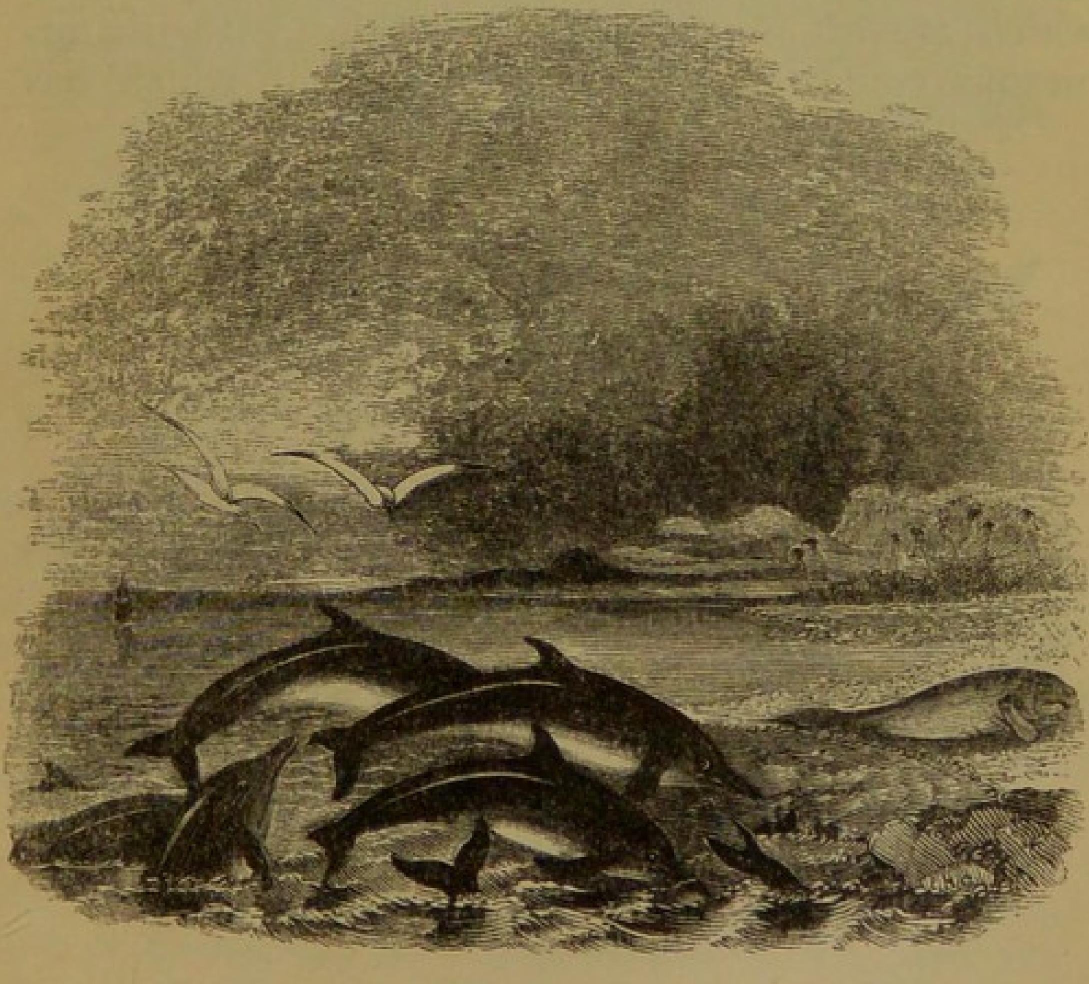
AFRICAN ELEPHANT.

ears, by the convexity of its front, by the lines of enamel on the molar teeth, and by having only three hoofs on each hind foot.

ORDER V. CETACEA.

(*Whales.*)

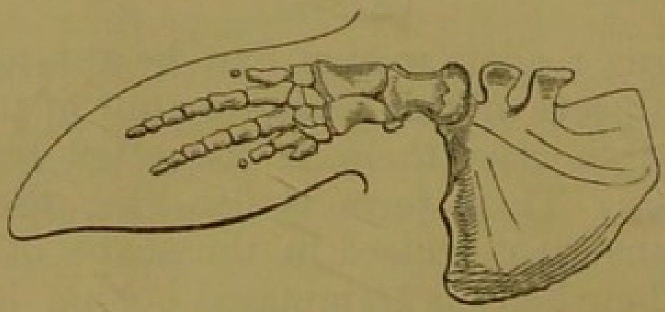
Our young readers may at first be apt to suppose that the subjects of this Order are out of place, and be inclined to class them, as has often been done, with Fishes. Their form is fish-like, their single pair of limbs are disguised in the shape of pectoral fins, and their body is terminated behind by a huge horizontal fin, of wide expansion and of great muscular power. Moreover they inhabit the ocean,



TROOP OF DOLPHINS, MANATEE IN THE DISTANCE.

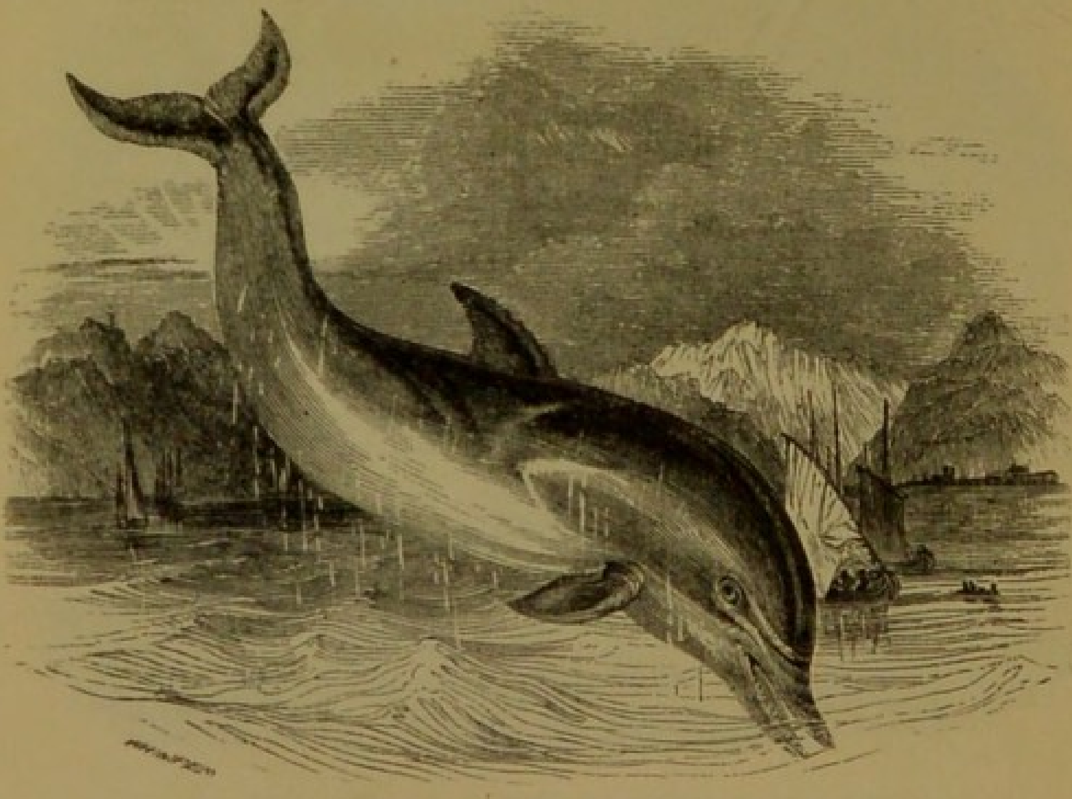
having no power of coming upon the shore. Yet they are as truly Mammalia as the Horse or the Dog: their blood is hot, their respiration is aerial, their circulation is double, they bring forth living young, which they suckle and nourish with their own milk.

The Dolphins and Porpoises of our own coasts and river mouths (*Delphinidæ*) are the smallest, but



FIN OF DOLPHIN.

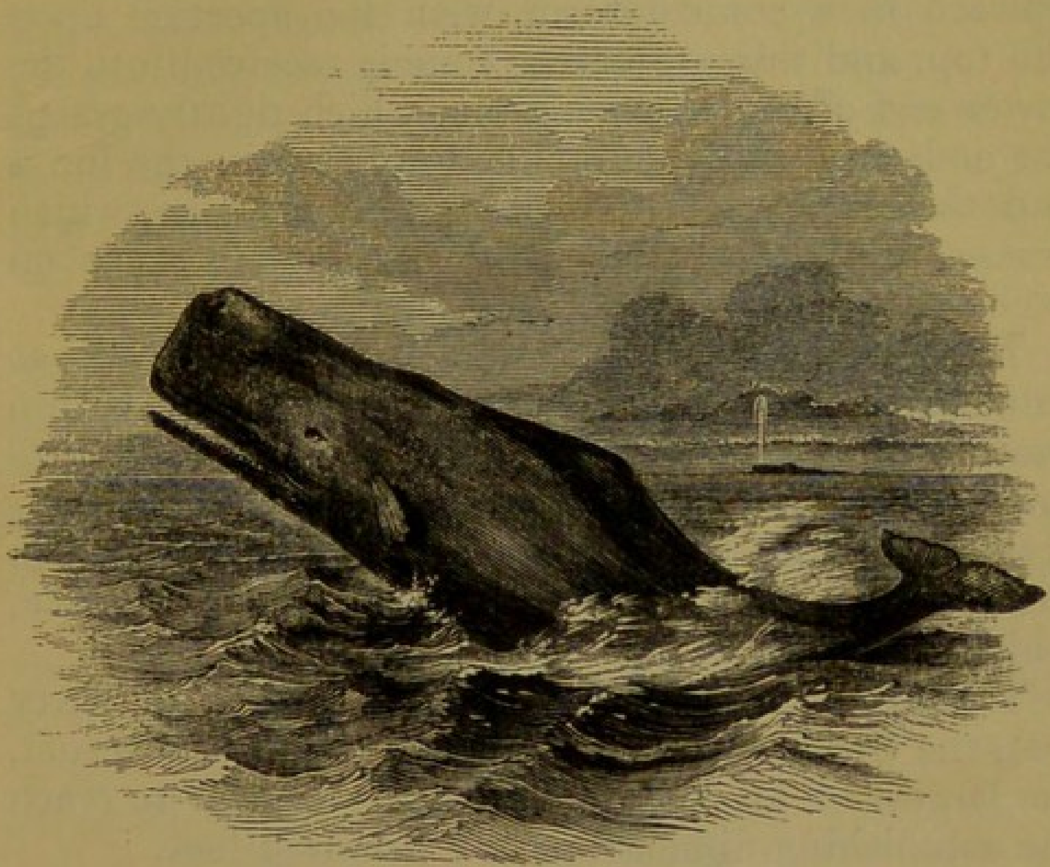
the most carnivorous of the Order. Their jaws which are often prominent, are furnished with numerous conical teeth, the structure of which has



DOLPHIN.

been already noticed. They are exceedingly playful and amusing animals. The beautiful Narwhal, or Sea-unicorn, belongs to this Family.

Spermaceti and sperm-oil, two substances of great value for the production of artificial light, are produced by the Sperm-whale, which represents the Family *Physeteridæ*. The fishery for this animal is chiefly carried on in the Pacific Ocean, and is



SPERM WHALE.

an enterprise full of privations and dangers. This animal has teeth in the lower jaw; but the Baleen-whales (*Balænadæ*) are entirely destitute of teeth, the whalebone plates already described supplying their place.

A beautiful contrivance prevents any ill results from the large quantities of water which the Whale is constantly taking into its mouth. In the MAMMALIA generally, the windpipe and the gullet open into a hollow at the back of the mouth, and the passage to the nostrils proceeds from it likewise. The windpipe runs up in front of the gullet, and the food which passes over the former is prevented from entering it by a lid or valve, which shuts down during the act of swallowing, but at other times is erect. But if such were the construction in the Whale, the force with which the water rushes into the mouth would inevitably carry a large portion of the fluid down upon the lungs, and the animal would be suffocated. The windpipe is therefore carried upward in a conical form, with the aperture upon the top, and this projecting cone is received into the lower end of the blowing-tube, which tightly grasps it; and thus the communication between the lungs and the air is effected by a continuous tube, which crosses the orifice of the gullet, leaving a space on each side for the passage of the food.

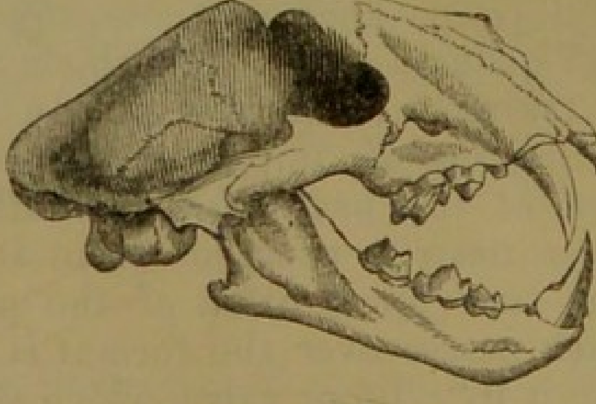
The fat or blubber of the Whale, which is so valuable an article of commerce, is contained within the substance of the skin, which is of loose texture interiorly, and enormously thickened. It thus invests the whole body like a blanket, and keeps in the animal heat, in those regions of cold and ice, which it inhabits.

The Greenland Whale attains a length of sixty feet, the Sperm-Whale of eighty; but the Rorqual, the largest of all known animals, is known to reach the astonishing dimensions of a hundred feet.

ORDER VI. CARNIVORA.

(*Flesh-eaters.*)

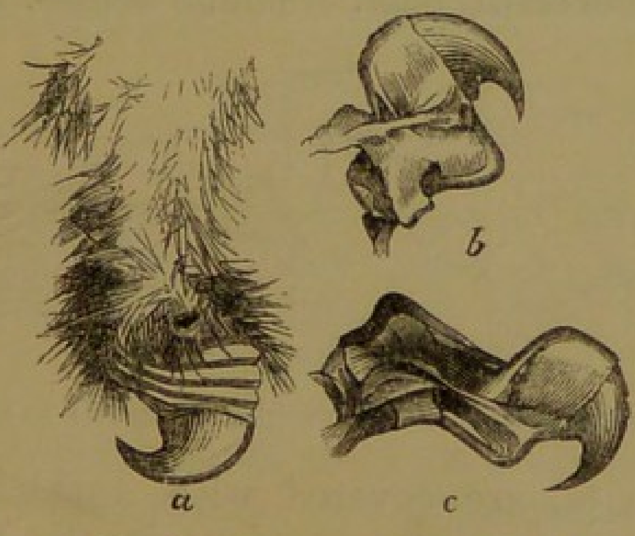
The four long and stout canines, separated from



SKULL OF TIGER.

the rest of the teeth, in this Order, reveal the appetite for flesh which has given it a name. In the most typical Family, that of the Cats (*Felidæ*), including the Lion, Tiger, Leopard, &c., the incisors are pointed, and the molars rise into sharp-edged lobes, fitted for cutting the flesh, or pointed cones for crushing the large bones of their victims. The feet of all are divided into toes, which are armed with claws; and in the Cats, where these organs play an important part in the disabling of the prey, the claws are long, curved, and very sharp.

In order to preserve them fit for use, it is necessary that the points should not come in contact with the ground; but if they were directed permanently upwards they would be useless. There is, therefore, a peculiar provision made, by which they are enclosed within sheaths formed by a fold of the skin at the tip of each toe, where they lie concealed in the hair, until a muscular action draws the base downwards, and the bristling talons stand out with

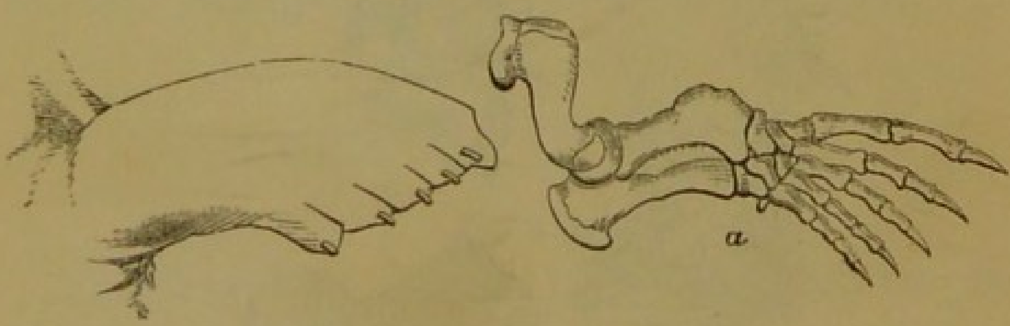


TOE OF LION. *a.* with the claw extended. *b. c.* without the skin, retracted and extended.

their sharp points and cutting edges ready for action. The silent tread of the Cats is partly owing to this structure, and partly to the elastic pads of granular fat with which the balls of the toes are furnished, and which likewise serve to break the shocks, to which their violent leaps would otherwise expose them.

All of the animals contained in this Order feed on flesh; in the Cats and Weasels (*Musteladæ*), in which the appetite for blood is the strongest, it is gratified by the destruction of living prey, partly by stratagem, partly by violence. In the Dogs (*Canidæ*), including the Wolf, Fox, and Hyena, the flowing blood is less desired, and carrion is often resorted to. In the Bears (*Ursidæ*), while some species are cruel and blood-thirsty, the majority feed largely on fruits, the carnivorous propensity and structure being feebly developed. Finally the Seals (*Phocadæ*) are marine, and feed chiefly on fish.

The last named Family connects the Order with the preceding; their general contour is fish-like, being plump in the middle and tapering to an extremity. The fore paws are webbed, and have much resemblance to fins; the hind limbs are set very far back, they are broadly webbed, fan-shaped, and form powerful oars. Their bodies, like those



FOOT OF THE SEAL. *a* SKELETON OF THE SAME.

of the Whales, are covered with a thick stratum of fat. They are most abundant in the Polar seas of both hemispheres.

The Cat and the Dog walk on tip-toe, the heel being raised from the ground, hence they are called *Digitigrade:* the Bears plant the whole sole on the earth, which gives them a peculiarly heavy gait; they are distinguished by the term *Plantigrade.* The Badger of our own country belongs to the Bear Family, as the Wild Cat of our northern woods represents the tiger, and other great Cats of the

HARP-SEAL AND WALRUS.

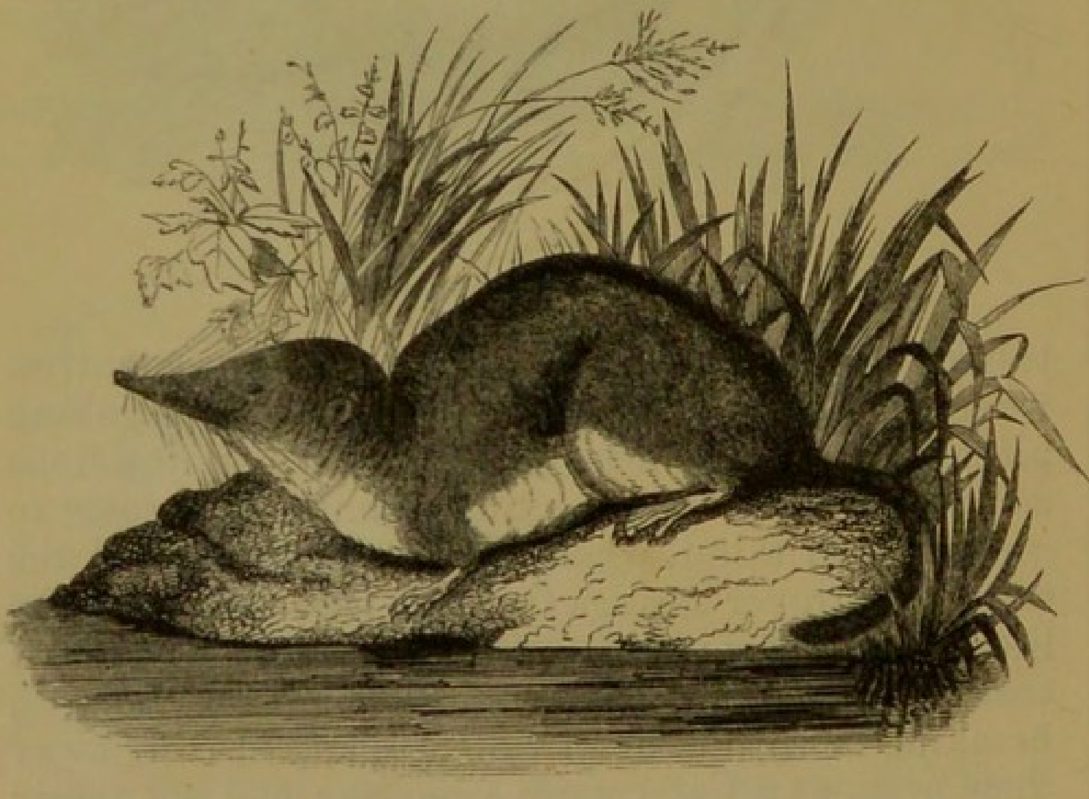
tropics. These are the scourges of the countries where they reside. They resort to the drinking places at the river margins, and watch in insidious ambush for the unsuspecting animals that come to quench their thirst, when with a sudden bound the terrific destroyer springs from his lair, and sucks the life-blood of his victim. Or frequently they prowl around the cattle-yards and folds of the villages, breaking in with sudden violence, and bearing away their prey, as a Cat carries a mouse ; and not rarely they pounce upon the benighted traveller, as he wends his lonely way through the darkening forest, or the tangled paths of the jungle.

ORDER VII. INSECTIVORA.

(*Insect-eaters*).

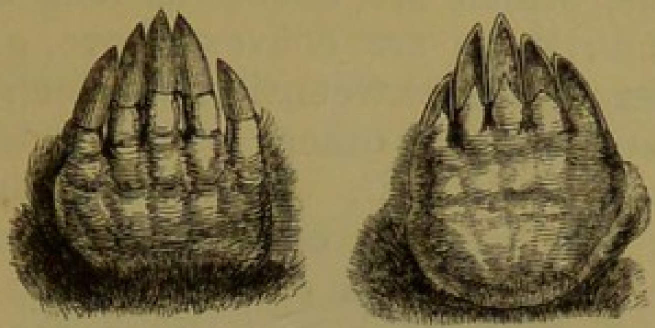
The Shrew (*Sorex*), the Hedgehog (*Erinaceus*), and the Mole (*Talpa*) are familiar British representatives of the Families that constitute this Order. They are all small animals, with short limbs, the whole sole of which is placed on the ground, the muzzle is more or less lengthened, and the molar teeth are furnished with small conical points, a structure that always indicates an insect diet.

The Shrews (*Soricidæ*) have their feet formed for walking or swimming, and are clothed with fur of delicate softness. They have a general resemblance



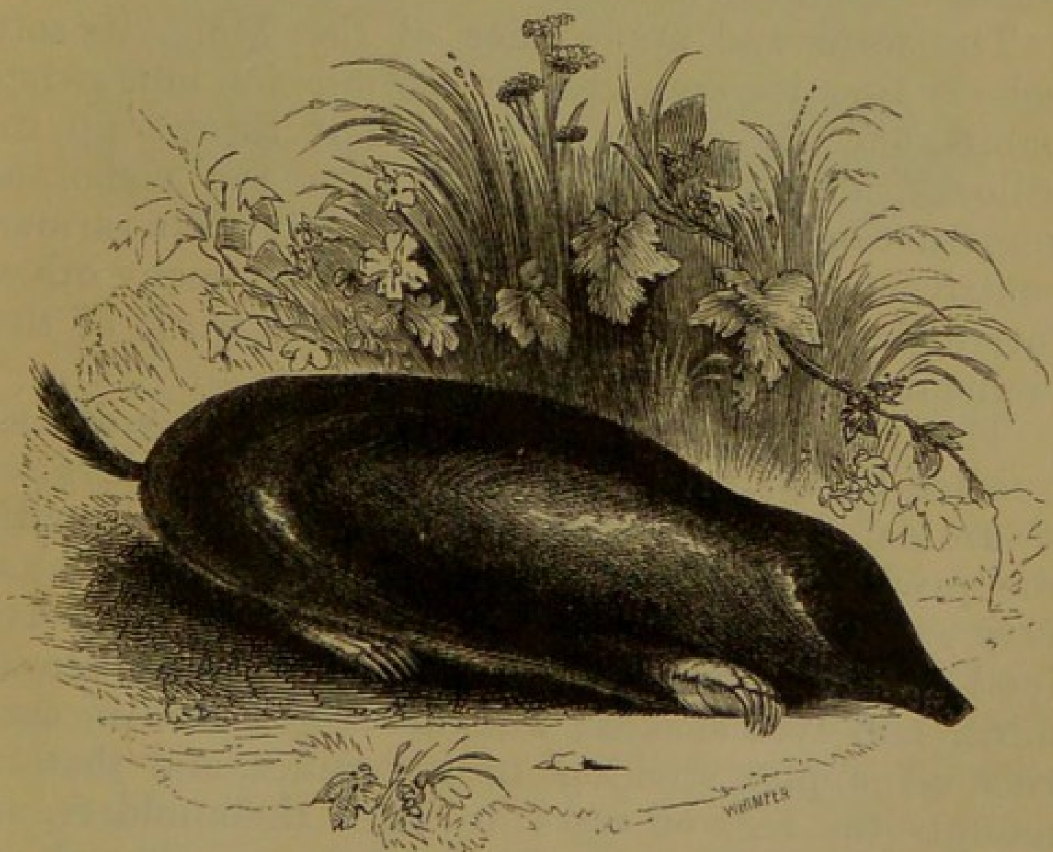
WATER-SHREW.

to mice, but the snout is greatly lengthened. They are fond of the vicinity of water, and one pretty little species, figured above, is eminently aquatic. It swims and dives with great rapidity and elegance, and its habits have been described in a very graphic manner, by Mr. Dovaston, in the Mag. of Nat. Hist. ii. 219.



HAND OF MOLE.

In the singular organ figured above, our readers would hardly recognise the fore-limb of a quadruped. But this is the foot (or *hand*, as it may well be called) of the Mole. Its structure and use are thus described by Professor Bell, the learned historian of our native MAMMALIA:—



MOLE.

"The strength and peculiar structure of the bones of the shoulder and of the fore-arm are in harmony with the remarkable form and direction of the hand. The joints of the fingers are extremely short, with the exception of the terminal ones, which are almost as long as the rest of the hand; these are convex above, grooved beneath, taper at the extremities, at which part they approximate to each other, and each is furnished with a long acute nail. The palms are directed outwards; the hand is only susceptible of being partially closed, which is effected by the inclination of the terminal joint, alone. When thus bent, the hand is formed of two portions; the one consisting of the palm turned outwards, and the other formed of the terminal joint of the fingers, the direction of which is backwards; a structure which at once explains the manner in which the earth and the smaller fibres of roots which are intermixed with it are, as it were, hoed away, and thrown directly backwards behind the animal."*

The form and appearance of the Mole, its soft velvety fur, its appetite for worms, its burrowing habits, and the manner in which it throws up its hillocks, are well known; but for the elaborate construction of its central fortress, and of its various contrivances for safety in danger, with many other interesting particulars, we refer to the work of the eminent zoologist just cited.

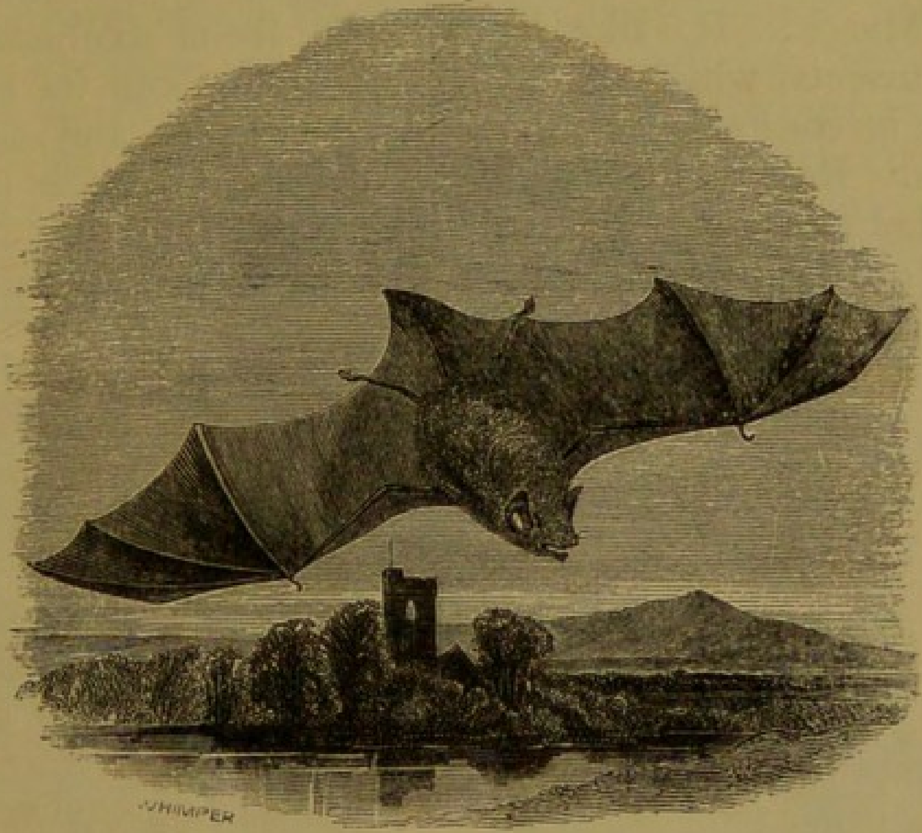
The Hedgehogs (*Erinaceadæ*) are readily distinguished by their dense coat of short sharp spines;—a sure defence, for, when rolled up into a ball, with the prickles projecting on every side, he must be a very game dog that will venture to attack one. Its food is not confined to insects, it eats snails, frogs, mice, and even snakes; but the notion that it carries off apples sticking to its spines, and that it mounts the legs of cows to suck their udders, is erroneous and absurd. Its habits are nocturnal, as are those of the Mole and Shrew. Of all these Families, there are many foreign species, but none in Australia nor in South America. The Hedgehogs are confined to the Old World.

* British Quadrupeds.

ORDER VIII. CHEIROPTERA. *

(*Bats*).

In the Mole we saw the fore-limbs shortened, flattened, and thickened into a shovel-like hand,



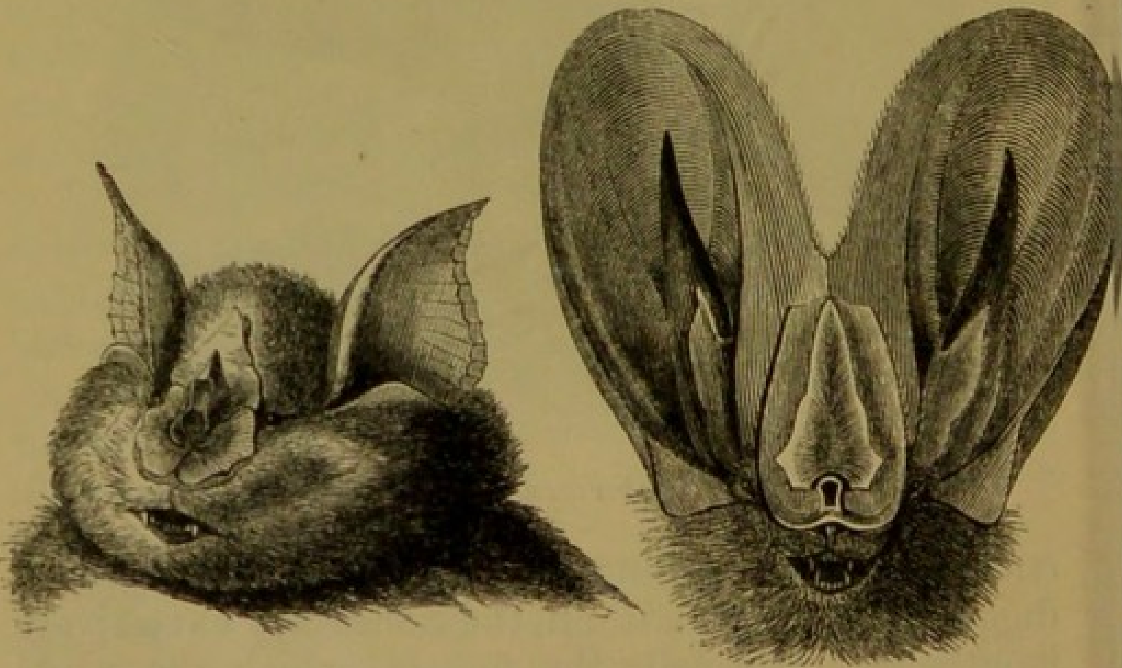
PIPISTRELLE.

endowed with amazing power, to be employed in digging. In the Bats all the bones are excessively lengthened, especially the fingers, which are made to diverge widely, and to support a delicate membrane stretched between them, forming a true wing. Both the one and the other would scarcely be recognized as modifications of the fore-foot of a quadruped; yet such they are, and all the essential bones can be found in each, and identified by the anatomist. The structure of the wing, independently of its anatomy, seems rather to agree with that of an insect than with that of a bird.

About eighteen British species of this Order

* "Hand-winged" animals.

have been described; one of the prettiest and smallest of which is the little Pipistrelle (*Vespertilio pipistrellus*). All our Bats are summer-fliers, resorting in autumn to hollow trees, holes in walls, the eaves of houses, &c., to pass the winter in torpidity; but this species may be seen almost till the end of the year, and is active again by the middle of March. It, like its fellows, feeds exclusively on insects, which it catches in flight; and its activity is confined to the hours of twilight and darkness. Bats are awkward on the ground, their long folded wings being much in the way, so that they can only shuffle along in a slow and grotesque manner.



HEADS OF BATS. *Rhinolophus ferrum equinum* and *Megaderma frons*.

The ears are generally large, and sometimes enormous in these flying MAMMALIA; as may be seen in an almost equally common native species, the Long-eared Bat, (*Plecotus auritus*). That part which is called the *tragus*, which in the human ear is a slight projection from the front, partially concealing the orifice, is in Bats often greatly developed, so as to look like a second ear. Other genera have the margins of the nostrils dilated in various complicated leaf-like patterns; or have other singular enlargements of the skin of the face. Illustrations of these peculiarities will be seen in the accompanying figures of *Rhinolophus* and *Megaderma;* the former of which is a British genus. These expansions of naked and sensitive skin, in addition to the extensive membrane of the wings, thickly supplied with nerves, are doubtless intended to increase the peculiar capacity which these animals are known to possess, of receiving impressions from the impact of the air.

The species above noticed belong to the very extensive Family *Vespertilionidæ,* or Insect-eating Bats. These are all of small size; but there are others constituting the Family *Pteropodidæ,* which are much larger; some of them measuring five feet in spread of wing. These feed on fruits, and are found in the coasts surrounding the Indian Ocean, as well as in Japan.

ORDER IX. QUADRUMANA.*

(*Monkeys*).

Though the interval between a Bat and a Monkey at first sight seems immense, close observation will modify our impressions; for, notwithstanding their dissimilarity in appearance, the elongation of the arm and hand, the number, form, and position of the teeth, the situation of the *mammæ,* and other characters, indicate the affinity of these Orders. The connexion is assisted also by some singular animals of the Philippines (*Galeopithecus*), which have the form of the Lemurs, but are furnished with an expanded membrane on each side, including the limbs and reaching to the tail. By means of this structure, they can take long flying leaps from tree to tree.

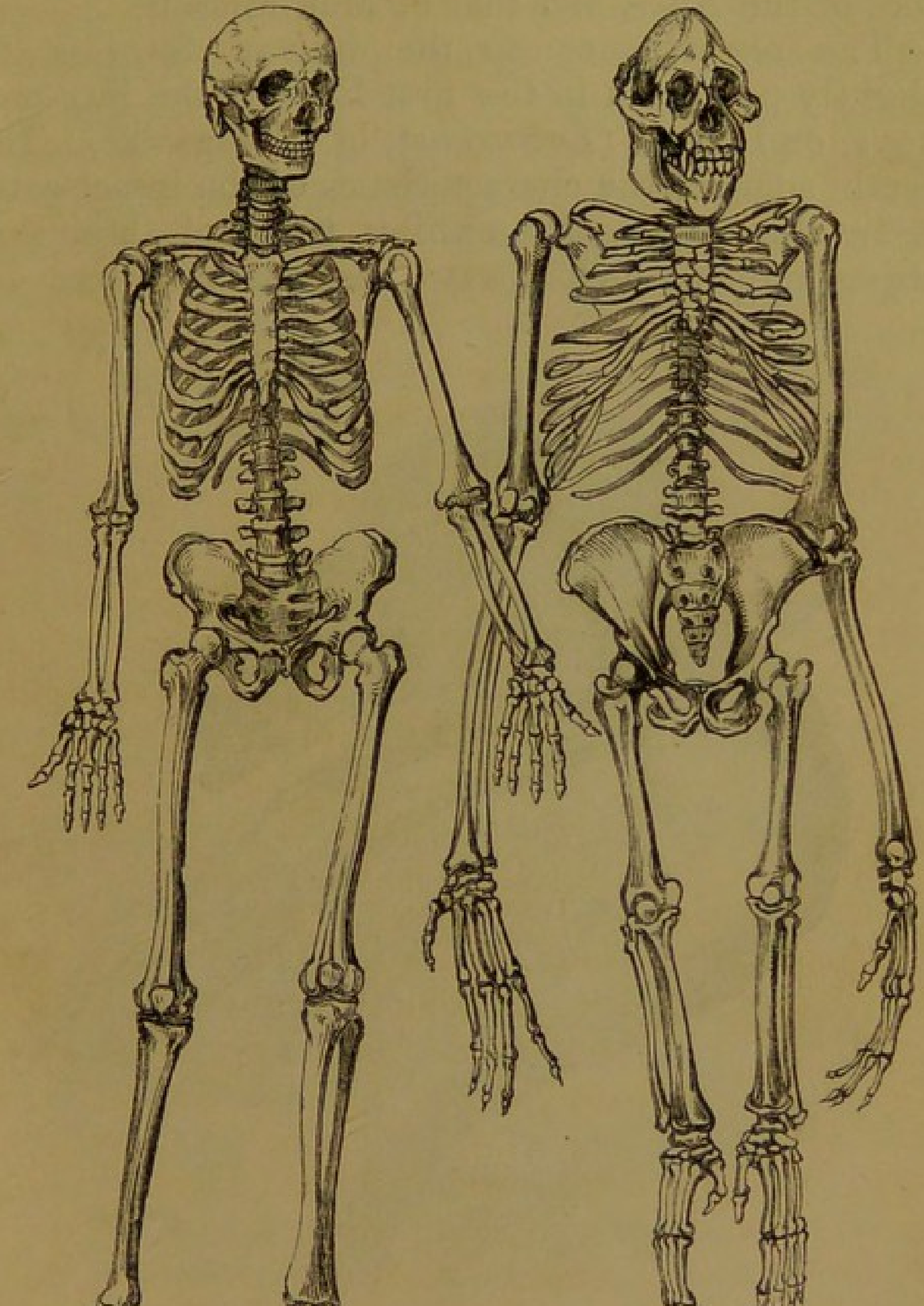
The principal characteristic of this, the highest

* "Four-handed" animals.

Order of the Brute creation, is that all the limbs are terminated by hands; each consisting of four long fingers, and a short thumb projecting at an angle from the wrist, and capable of being brought

ORANG-OUTANG, GIBBON, AND SPIDER MONKEY.

into opposition to the fingers. Thus the hand, moved by many muscles, becomes a powerful and yet delicate instrument of prehension. All the Monkeys are formed for an arboreal existence; they do not run on all fours, nor do they walk erect, like Man; but climb among the branches, taking hold with all their hands. For such a life, the great length of the arms, the shortness of the lower limbs, and the position of the feet (the soles of which cannot be brought flat on the ground, but partially face each other) are all suited, though they incapacitate



SKELETON OF MAN AND ORANG.

the animal for an erect position. The preceding engraving will show the points of resemblance and of diversity between the skeleton of the most man-like of the Apes, and that of Man himself.

The resemblance to the human form is but slightly perceived in the first Family, the Fox-monkeys, or Lemurs (*Lemuridæ*), of Madagascar. They retain some of the characteristics of the insect-eating tribes, for their molars exhibit traces of those sharp rising points, which always bespeak an insect diet.

WHITE-FRONTED LEMUR.

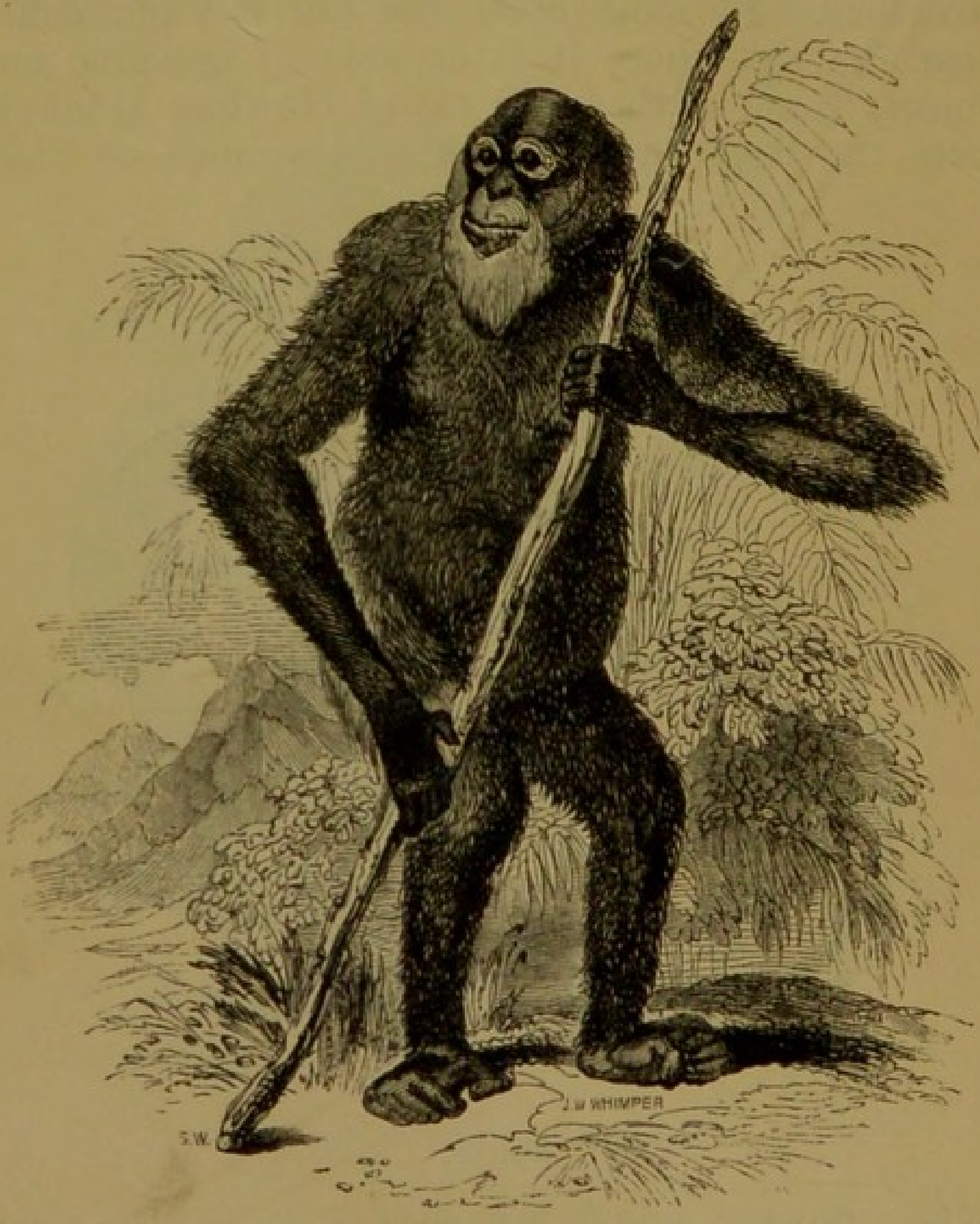
They are fox-like animals, with the limbs of a monkey; their fur is thick and soft, the tail long and bushy, rarely wanting. They are very nimble in their habits, but their activity is chiefly nocturnal. A curious peculiarity of them all is that the fore-finger of the hind hand is furnished with a narrow pointed claw, while all the rest have broad nails.

The Monkeys of the American continent differ so much from those of the Eastern hemisphere, as to constitute a separate family, named *Cebidæ*. The most important distinction is that the thumb of the fore-hands is either wanting, or is not at all opposible to the fingers; though in some genera it is placed farther back, and thus approaches the usual structure. In most cases the tail is long, naked near the tip, where it is capable of grasping any object. Some of these are called Howling Monkeys from the tremendous power and volume of their

KAHAU.

voice. Others, distinguished by their great length of limb, are called Spider-monkeys. The pretty little Marmozets, or Ring-tails, feed only on insects.

The last Family, *Simiadæ*, contains the Monkeys, Baboons, and Apes of the Old World. The most common Monkeys of our menageries are natives of Africa, where they live in great troops in the forests, enlivening the gloom with their incessant chatterings and fantastic tricks. Other genera inhabit India and the great contiguous islands, where many of them are held in reverence by the superstitious natives. The preceding figure represents one of the most remarkable forms. The Monkeys have long tails and cheek-pouches.



BORNEAN ORANG.

The Baboons have the muzzle greatly developed; their tail is short, their contour thick and muscular. The brutal ferocity of their nature is well indicated by a most repulsive aspect. They inhabit Africa, and feed largely on Scorpions.

Finally, the Gibbons of the Oriental Archipelago, and the true Apes, or Orangs, have no vestige of a tail, nor of cheek-pouches. They are the most man-like of all animals, but they are separated by an immense interval from him who was created in the image of God. Brutes they are, and brutes they must ever remain; but Man is endowed with an immortal soul, capable of everlasting happiness in the presence of God, or of everlasting misery with the devil and his angels. His soul has been redeemed, not with corruptible things, but with the precious blood of Christ, God manifested in human nature. Thus, though fallen from the high estate in which he was created, the way has been made clear for his reconciliation to God, for his participation "of a divine nature," and for his inheritance of a glory and a blessedness far exceeding that which was forfeited in Eden.

INDEX OF ENGLISH NAMES.

INDEX OF SYSTEMATIC NAMES.

THE END.

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