ZOOLOGY FOR SCHOOLS.

PART I.

INVERTEBRATE ANIMALS.

INTRODUCTION

TO

ZOOLOGY,

FOR THE

USE OF SCHOOLS.

BY

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PART I.

INVERTEBRATE ANIMALS.

WITH UPWARDS OF 170 ILLUSTRATIONS.

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PREFACE.

I HAVE for years been anxious that NATURAL HISTORY should be made a regular Branch of Education, because it exercises both the observant and the reflective powers; furnishes enjoyment pure and exhaustless; and tends to make devotional feelings habitual. The present little Work has been undertaken in the hope that it might conduce to such a result.

In its preparation, I have aimed at conveying correct ideas of the peculiarities of structure by which the principal divisions of the animal kingdom are distinguished; and of the habits, economy, and uses of one or more of the most common native species belonging to each of these groups. Foreign species are occasionally mentioned in connexion with their respective classes, but the "home produce" forms the "staple commodity."

The exercise of memory involved in the repetition of scientific names, or in the recital of anecdotes respecting the animals of the arctic or tropical regions, is, comparatively, of little importance. The great object should be to bring natural-history knowledge home to the personal experience of the pupil. To teach him to observe, to classify his observations, and to reason upon them, and thus to invest with interest the COMMON OBJECTS which he sees around him. Small collections of natural objects, made by the pupils themselves, would, under the guidance of a judicious teacher, be of great value in this species of mental culture, and would form the much-prized ornaments of the school-room.

The present volume has been prepared amid the scanty leisure incidental to the life of a man of business. It will, therefore, I hope, be regarded with indulgence, both by the Naturalist and by him who is practically engaged in the important duties of the school-room.

R. PATTERSON.

Belfast, 3, College Square North,
September 5th, 1846.

NOTE.—The illustrations, for the most part, are those employed in the "*Cours Elémentaire de Zoologie*" of M. Milne Edwards; a work adopted by the Council of Public Instruction in France.

PREFACE TO THE SECOND EDITION OF PART I.

In presenting this Second Edition to the public, the Author wishes to state, that it differs from the preceding chiefly in the correction of some typographical errors and verbal inaccuracies, and in the substitution of some woodcuts for illustrations of an inferior kind.

R. P.

Belfast, 3, *College Square North*,
June 1*st*, 1848.

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INTRODUCTION TO ZOOLOGY

FOR THE

USE OF SCHOOLS.

"These are thy glorious works, Parent of good—
Almighty! Thine this universal frame,
Thus wondrous fair: Thyself how wondrous then,
Unspeakable! who sit'st above the heavens—
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine."—MILTON.

THE word "Zoology" is derived from two Greek words, and signifies a knowledge of animals. The science which teaches the structure, habits, and classification of animals is *Zoology:* the person by whom such knowledge has been acquired is a *Zoologist.*

When we regard man as the head of the animal creation, and trace the various gradations of structure and intelligence between him and some of the humblest organized tribes of being; or when we think of the countless multitudes of animals scattered over the earth, and diffused throughout its waters, it might seem that any attempt to form them into groups, to distinguish the several species, and bestow on them appropriate names, would be altogether unavailing.

But what the labour of an individual would be insufficient to effect, the combined exertions of many are, in the course of time, able to accomplish; and as man possesses the power of transmitting by writing the knowledge he has acquired, we are enabled to benefit by the toil and exertion of those

who have gone before us, and take advantage of the materials which their industry has collected.

The first and most obvious thing to be done is, to fix upon some good distinguishing marks by which the principal groups of animals may be separated from each other. This would, at first sight, appear an easy matter. Thus, birds might be distinguished by the power of flight, and fishes by that of living and swimming in the water. But a little attention would show, that such characteristics would, in both cases, lead to erroneous results. The Bat flies in the air, yet it brings forth its young alive and suckles them as the domestic cat would do. The Whale lives in the sea; but, while in the fish the heart has only two compartments, the blood is cold, and respiration is effected by gills, the Whale has a heart furnished, like that of the Ox, with four compartments, the blood is warm, and breathing is carried on by lungs. The fish deposits its spawn, and the young, when liberated from the eggs, provide for themselves according to their several instincts. The young of the Whale, on the contrary, are brought forth alive, are objects of maternal solicitude, and are suckled with affectionate assidnity. The Bat, though flying in the air, is not therefore a bird; the Whale, though swimming in the sea, is not therefore a fish. They both belong to the same division as our large domestic quadrupeds, which, from the circumstance of their suckling their young, are grouped together by the expressive term "Mammalia."

It is obvious, therefore, that *structure* must form the basis of classification. And in the present state of our knowledge, it is no less obvious that arrangements, based on the structure of one particular organ, or one series of organs, to the exclusion of others, would be incomplete, and would lead to error. All organs must be considered, and internal as well as external structure must be examined, before any true systematic arrangement can be attained; and this will be complete, exactly in proportion to the extent and the accuracy of our knowledge. The great object is, to arrange animals in such a way as to exhibit their true affinities to each other, and to embody, with regard to each group, the most comprehensive truths regarding them which the conjoined labours of eminent men have as yet elicited.

Lamarck, a distinguished French naturalist, proposed arranging all animals according to the presence or absence of a

skull and a backbone or vertebral column; and this division is so convenient and so obvious that it is still retained. But Baron Cuvier pointed out, that great and important differences exist among the invertebrate animals, or those which are destitute of a skull and vertebral column—differences so great as to justify a further subdivision; and that, according to the modifications of the nervous system, the entire animal kingdom might be divided into four primary groups,—one of them consisting of the vertebrated animals, and three of those which are invertebrated. Adopting these views, we follow the illustrious Cuvier in dividing the whole animal kingdom into four great groups, or sub-kingdoms; namely,—

I. Vertebrated animals, or *Vertebrata;*

[INVERTEBRATA.]

II. Soft-bodied animals, or *Mollusca;*
III. Articulated animals, or *Articulata;*
IV. Radiated animals, or *Radiata.*

To begin with those at the foot of the scale and gradually ascend, is the best mode of preparing to enter with advantage on the consideration of the higher ranks of organized beings. Our attention should, therefore, be directed, in the first place, to the Radiated animals.

RADIATED ANIMALS.

"O Lord, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches: so is this great and wide sea, wherein are things creeping innumerable, both small and great beasts."—PSALMS.

IF we pick up a common star-fish, which has been left upon the beach by the retiring tide, we notice that the limbs or arms of the animal are like radii, diverging from a common centre, or like rays surrounding a central disc. From this circumstance it is termed a "rayed" or "radiated" animal.

In other species belonging to the same great class, the radiated structure is not at first sight so obvious. It will, however, be easily detected in the sea-urchin (*echinus*), although

the outline of the animal is so different. In others, it will be found, not in the general aspect of the body, but in the radiated arrangement of the parts surrounding the mouth. Wherever, throughout this division of the animal kingdom, we are able to trace in the body the existence of a nervous system, it partakes of that radiated appearance which, in some species, is presented by the external figure. Some creatures, in which no nervous system has as yet been discovered, are included in this division; and as our knowledge of their structure and habits is increased, our present classification must be revised, and perhaps amended.

The Radiated animals may be treated of under four* primary divisions or "classes," in each of which there are found animals of a higher and a lower grade of organization, *viz.*:—

Infusoria, or Infusory Animalcules;
Entozoa, or Internal Parasites;
Zoophyta, or Polypes;
Radiaria, or Rayed Animals.

Class INFUSORIA, or INFUSORY ANIMALCULES.

"Where the pool
Stands mantled o'er with green, invisible
Amid the floating verdure millions stray."—Thomson.

If any vegetable substance be allowed to remain for about ten days in a glass of water, exposed in a window to the rays of the sun, the water will appear to the naked eye to have undergone little change. But if a drop be taken from the surface and placed under the microscope, it will exhibit such a multitude of living beings swimming about, that the spectacle cannot be looked upon for the first time without surprise, and even astonishment. Nor is the feeling of wonder diminished when we endeavour to calculate their size, and form some estimate of their numbers. If a drop of the water

* The sponges (*Porifera*) are omitted, as naturalists are not yet agreed as to their true nature.

containing them be placed between two pieces of glass, they will be seen swimming about with perfect ease in that little film of liquid, and passing and repassing without even coming

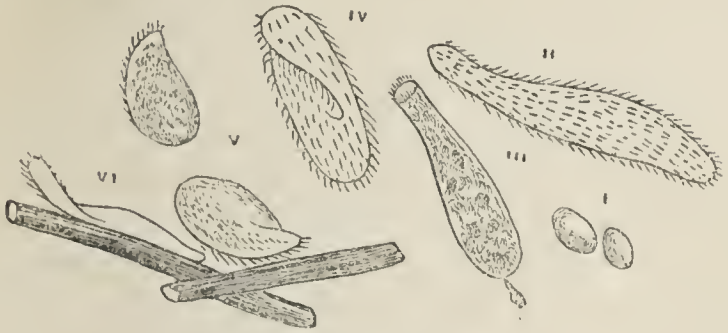

Fig. 1.—INFUSORIA.

into contact. The globules of blood in the human body are variously estimated in regard to size, but when magnified 180,000 times do not exhibit an image larger than the accompanying figure. Many of the infusory animalcules are, however, still more minute, so that 180,000 of them, if formed into a ball and laid upon the paper, would cover even a smaller surface.

Professor Ehrenberg, of Berlin, has calculated, that 2,000 of them placed together would measure but one line, or the twelfth part of an inch. According to this estimate, a single drop of water might contain 500 millions of these minute animals, a number nearly equalling that of the whole human species now existing on the earth!

But although these animalcules abound in infusions of animal or vegetable matter—whence their name *infusoria*—they are not restricted to such situations. They are numerous in all countries, and are found in all waters; not merely in those of the stagnant pool, but in lakes, in rivers, and in the sea itself. From materials furnished to him by the late antarctic expedition, Ehrenberg* has ascertained that they exist even in the ice and snow of the polar sea, and that they are abundant not only in inland seas, and in the vicinity of land, but that the clearest and purest water, taken from the open sea, and far from land, is crowded with microscopic life. These minute organisms have been found living at the depth of 270 fathoms

Fig. 1.—I. *Monads.* II. *Trachelius.* III. *Enchilis,* flask animalcule. IV. *Paramecium.* V. *Kolpoda.* VI. *Trachelius,* when moving upon microscopic vegetables.

* Ehrenberg on Microscopic Life in the Ocean at the South Pole, and at considerable depths.—Annals Nat. Hist. Sep. 1844, page 169.

(1,620 feet), and, consequently, subjected to a pressure equal to 50 atmospheres.* Nor are they bounded even by these localities, for they have been discovered in the cells of plants, and in other situations where, but a few years ago, their presence would not have been suspected.

As they are so widely diffused, and must, in such variety of circumstances, subsist on very different kinds of food, it may naturally be expected that they must present very considerable diversity of size, form, and structure. These differences furnish means by which species can be distinguished from each other; the agreement of several species in some one common character enables the naturalist to combine them into one genus; and, by a repetition of the same process, to unite several genera into one larger group, on which some common and characteristic name is bestowed. In this way, the whole of the Infusoria may be arranged in two great divisions. The distinguishing characteristic of the first of these is the presence in the body of the creature of a number of sacs, or stomachs, in which the food is received; and from this peculiarity the order is called *Polygastrica*, or "many-stomached" (*Fig.* 2). In the second order, instead of this peculiarity, there is another not less remarkable. About the head there are rounded lobes, which, when looked at under the microscope, seem like wheels in rapid motion; and hence the creatures in which this was observed were called "wheel-animalcules," and the order itself *Rotifera*, or "wheel-bearing." The parts do not in reality move like wheels, but the movements of the delicate hair-like organs with which they are fringed make them seem to do so.

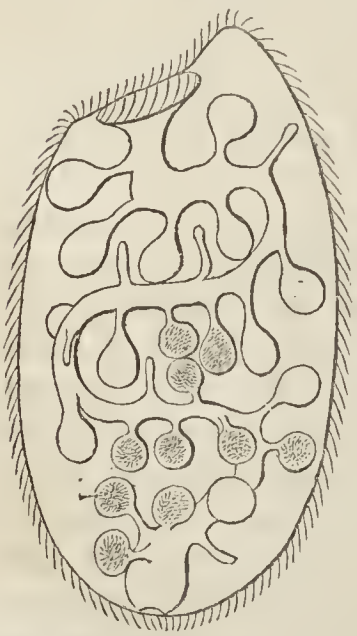

Fig. 2.—Leucophrys.

The use of scientific terms has something in it very repulsive to the young naturalist. But this often arises from the terms being used without any precise idea of their meaning being conveyed to the mind of the learner. When any term is thoroughly understood, there is an end of the

* About 750 lbs. on each square inch of surface.

difficulty; and the word once known, it is not readily forgotten. In the preceding instance, we have explained the meaning of the words Polygastrica and Rotifera, so that we hope there will not be anything difficult or obscure in their use hereafter. We shall endeavour to do the same with such other scientific terms as we may have occasion to employ. Their number is few, and they are of such great utility that the acquisition of them is worthy of a little effort. By such means we can indicate to a person in a remote country, and speaking a foreign language, the very animal regarding which we have any fact to communicate; and, in like manner, we can know with certainty of what animal observations made in other parts of the world are recorded. The terms of science are common to the men of science in all countries; and, if the terms be correctly applied, no doubt or ambiguity can arise. They furnish us with the means of expressing the ideas we wish to convey, with a precision otherwise unattainable; and the habitual use of them assists in giving precision to the ideas themselves, and thus forms a help in that mental process which the mind of the naturalist must undergo in the acquisition of knowledge.

It may naturally be asked how, in beings so inconceivably minute as the Polygastrica, the existence of a number of stomachs could be discovered. The plan adopted by Ehrenberg for this purpose was ingenious:—The professor removed some of them from the water in which they were found, and placed them in water of the purest and most transparent description, and, after having subjected them to a fast for some time, he put into it an infusion of indigo or carmine which tinged the water. When they began to feed, he found, as the stomachs filled, they became visible by the blue or red particles shining through their transparent skins. The bodies of the Polygastrica are furnished with fine hair-like appendages, termed *cilia;** these are scattered over the surface, and by their continual movement propel the little animals through the water, and bring within their reach the particles of decaying vegetable matter on which they live. There is reason to believe that these singular organs of locomotion are not put into activity by the will of the animal; and hence that their movement, like that of the human heart, might continue for any length of time without inducing a feeling of fatigue. This

* The Latin word for eyelashes.

idea receives confirmation from the fact, that by day or night, at whatever period the Polygastrica may be examined, the observer will never find them in a state of repose, or witness them roused to activity by the light.

The Rotifera present a higher organization than the Polygastrica. In them we can trace a nervous system; and we observe muscular bands running over the body, both longitudinally and transversely, by means of which they can expand or contract their bodies in any direction (*Fig.* 3). The cilia, already mentioned as fringing the lobes on the upper portion of their bodies, by their ceaseless action cause currents in the water, and thus furnish a supply of food, while, at the same time, they act as instruments of progression. The Rotifera feed on the Polygastrica; and they are furnished with an instrument by which they can attach themselves to one spot, and thus, when not inclined to swim about, they can moor themselves at pleasure, and feed at their ease on the nutriment which the currents caused by the action of the cilia bring within their reach. The Rotifera are remarkable for their tenacity of life. Fontana, an Italian naturalist, kept a number of them for two years and a half in dried sand; yet, in two hours after the application of rain water, the greater part recovered life and motion. Spallanzani repeated the experiments with similar results, after having kept the creatures for four years in the torpid state. He further proved their power of revival after apparent death, by alternately drying and moistening the same individuals. He tried this fifteen times; at each exhumation some of the animalcules did not recover—after the sixteenth time, none of them revived.

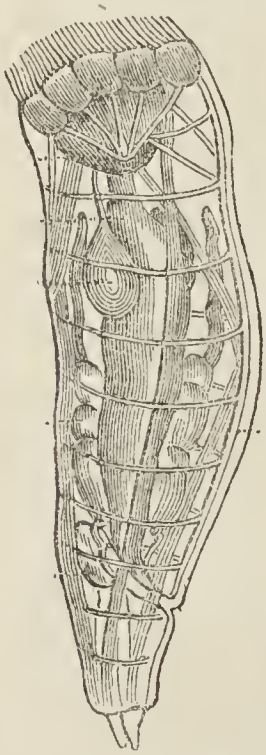

Fig. 3.—Hydatina.

The different modes of reproduction among the Infusoria are very remarkable. Some are produced from gems or buds. These appear like little tubercles on the body of the parent—increase in size—assume the form proper to the species—drop off, and become perfect and distinct animals. This mode is

called *gemmiparous*. Another, which may seem more wonderful, is by the division of the body of the parent into parts, each part becoming a distinct animal, and, by a like process, giving life to numerous others. This mode, which has been termed the *fissiparous*,* "is amazingly productive, and indeed far surpasses in fertility any other with which we are acquainted, not excepting the most prolific insects, or even fishes. Thus, the *Paramecium aurelia*, if well supplied with food, has been observed to divide every twenty-four hours; so that, in a fortnight, allowing the product of each division to multiply at the same rate, 16,384 animalcules would be produced from the same stock, and in four weeks the astonishing number of 268,435,456 new beings would result from a continued repetition of the process. We shall feel but little surprised, therefore, that, with such powers of increase, these minute creatures soon become diffused in countless myriads through the waters adapted to their habits."†

There is yet another mode of propagation among the Infusoria, the *oviparous*, or that from *ova* or eggs. As the ditches in which they live dry up in Summer, the animalcules perish; but, prior to this, the mature ova burst through the skin of the parent, and thus the last act of the creature's life is to provide for the continuance of the species, by depositing thousands of fertile germs. These are lifted up by the winds, are dispersed through the atmosphere, and float in the air, ready to assume the functions of active life, so soon as they are placed in circumstances favourable for its development.

When we reflect upon the singular structure "of these miniature existences, small almost to invisibility,"‡ and on the providential care evinced in maintaining, by such varied means, the continuance of the species, we see "that greatness and littleness make no difference to God in his creation or his providence." They reveal to us that "magnitude is nothing in His sight; that He is pleased to frame and to regard the small and weak as benignly and as attentively as the mighty and the massive." On further investigation, it would be no less obvious that these minute and insignificant creatures are made the humble instruments of great benefits to man, and of important physical changes on the surface of the globe.

* Latin, *fissus*, divided; *pario*, I produce.
† Jones' Outlines of the Animal Kingdom.
‡ Sharon Turner's Sacred History of the World.

Existing, as they do, everywhere in countless multitudes, and endowed with appetites so voracious, it is clear that they are well adapted to be the unseen scavengers of nature, and that one of their uses in creation is to remove those decaying matters which would become offensive to our senses and dangerous to human life. Having removed those dead and decaying substances, and made them a part of their own organization, they in their turn become food for other animalcules, which again serve as nourishment for fishes. They form, therefore, one of the means by which the salubrity of our atmosphere is preserved, and putrefaction and decay rendered conducive, through their instrumentality, to the support of higher animals, and thus to the sustenance of man himself.

Some species of the Polygastric animalcules, notwithstanding their minuteness, are furnished with shells of various forms and sizes. These are generally formed of silex; and, though not displaying the rich colours of the shells of the mollusca, are no less beautiful, for the place of colour is supplied by the most varied and exquisite patterns of natural sculpture (*Fig.* 4).

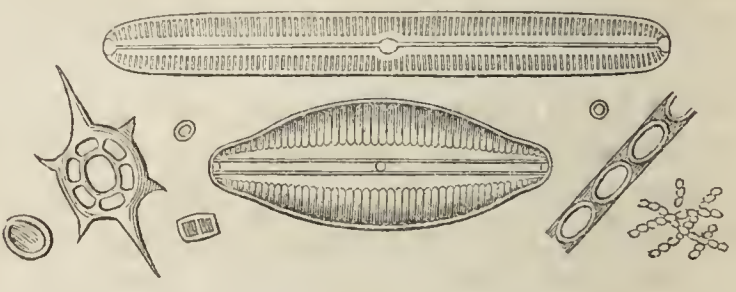

Fig. 4.—Shells of Infusoria.

The large aggregation of them in different parts of the world is perhaps the most surprising circumstance in their history, especially when we call to mind the fact, that each of these minute and scarcely visible shells is the production of an animal which has passed away, and left behind but this tiny memorial of its existence.

Ehrenberg found that a hill in Bohemia, composed chiefly of the polishing substance known in the arts as "tripoli," was one mass of the siliceous fossil shells of these creatures; and that in a stratum fourteen feet in thickness, a cubic inch contained the remains of 41,000,000,000 of individuals.* On

* Taylor's Scientific Memoirs, vol. i. p. 407.

the shores of a lake near Urania, in Sweden, is found a deposit of a similar kind, called by the peasants "mountain-meal," and which they use mixed up with flour as an article of food. Deposits of fossil Infusoria are not, however, confined to foreign countries. A few years since, the Bann Reservoir Company were deepening a small lake a few miles from Newcastle, in the County of Down, and the workmen found a white deposit at the bottom of the excavation. It proved to be an excellent material for cleaning and polishing plate; and, on subsequent examination, under the microscope of an Irish naturalist, was discovered to consist of fossil Infusoria.* The accumulation of similar deposits is at present producing important changes in the bed of the Nile, at Dongola in Nubia, and in the Elbe at Cuxhaven; it is even choking up some of the harbours in the Baltic sea.†

When we consider the diminutive size of these creatures, the stupendous monuments which they leave behind, and the mighty changes which their unseen labours are silently effecting, we must admit the justice of Ehrenberg's remark: "Truly indeed the microscopic organisms are very inferior, in individual energy, to lions and elephants; but, in their united influences, they are far more important than all these animals."

Class ENTOZOA, or INTERNAL PARASITES.

"Verily, for mine owne part, the more I looke into Nature's workes, the sooner am I induced to beleeve of her, even those things that seem incredible."—Holland's Pliny.

The body of every vertebrate animal forms the abode of many other animals that live within it. These creatures constitute the class *Entozoa*, a word which simply means "within an animal," and is very appropriate to the internal parasites, which constitute the present group.

With this class we are as yet imperfectly acquainted; but some idea of its numbers may be formed from the fact, that no species of animal is supposed to be exempt from their attacks, and that the human body is infested with no less than eighteen species. It is stated that every animal has one

* Drummond in Mag. Nat. Hist. 1839.

† Ehrenberg in Edinburgh Phil. Journal, vol. xxxi. p. 386.

or more species peculiar to itself. If so, the number of species among the Entozoa must exceed that of all other animals existing in the world.

These singular beings differ widely in their structure. Some, resembling delicate transparent membranes filled with water (*Fig.* 5), appear more simple than any of the Infusoria; others are so complex, that, in some respects, they seem allied to animals of a much higher rank in organization. Many details pertaining to their abode, their nutriment, and their means of increase, though interesting to the naturalist, and important to the physician, would here be out of place. But as the Entozoa constitute one class of the animal kingdom, and cannot, therefore, be passed over in silence, a brief notice of some of their peculiarities may be inserted.

Fig. 5.—Cystic Entozoon.

They are found in the stomach, in the intestines, in the bronchial tubes, in the biliary ducts, and even in the humours of the eye. The farmer is well acquainted with two kinds, one of which exists in the brain and the other in the liver of the sheep. One species, which infests the human body, is the common Tape-worm (*Tænia solium*, *Fig.* 6), which is occasionally found several yards in length. Its head is furnished with four suckers and two rows of recurved bristles, by means of which it is enabled to fix itself securely to any spot it selects. The most singular trait in the structure of the creature is the multitude of its joints, and the power which each of these joints possesses of producing thousands of fertile ova. When these ova come to maturity, the lower segment of its body breaks off from the upper: the Tape-worm may, from this peculiarity, be compared to trees or plants which fling off their seeds when they come to maturity. When the lower segment of the worm separates from the upper portion, the

Fig. 5.—*a*, *Cysticercus cellulosæ*, magnified.—*b*, the head, still further enlarged.

Note.—It is this species which is found in the cellular tissue of the Pig, and which, when abundant, gives to the flesh of the animal the appearance which has been termed *measles*, or *measly*.—*Vide* Dr. Bellingham on Irish Entozoa, in Annals of Nat. History.

last joint of the upper gradually lengthens and becomes two joints. The then lowermost joint in the same manner becomes elongated, and divides into two; and by a repetition of the same process the animal in a short time regains its original length. In *Ascaris lumbricoïdes*, the most common intestinal parasite of the human body, Dr. Eschright had estimated the number of ova which one mature female contained at 64,000,000. When creatures of structure and habits so singular were first found in the bodies of birds, fishes, quadrupeds, and other animals, it was naturally a subject of wonder how they got there, and some naturalists imagined that they were produced by the tissues of the animal body—in fact, by equivocal generation. When, however, it was discovered how elaborate was their construction, and that each animal contained millions of fertile ova, the truth of this theory was disproved, and the naturalist was taught to attribute their production, through the regular laws of generation, to Him who created the highest as well as the lowest order of beings.

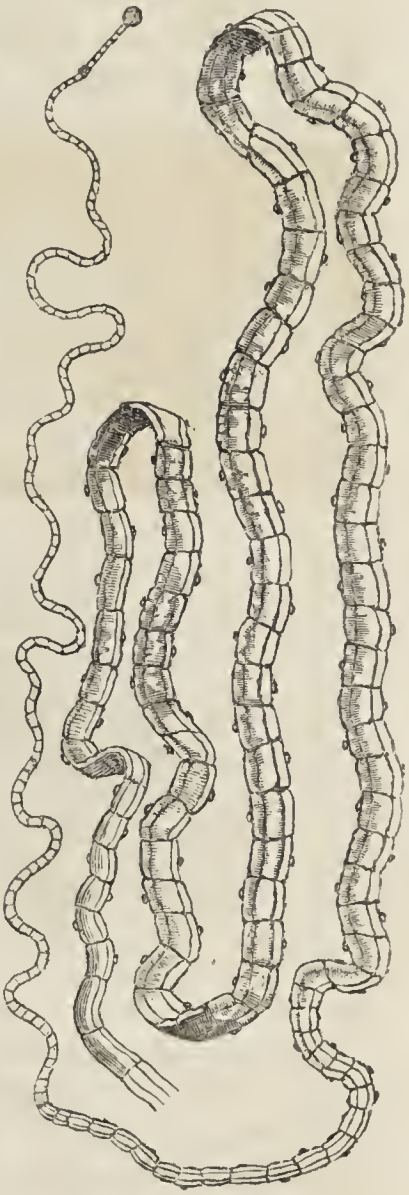

Fig. 6.—Tapeworm.

If we turn to any works in which the Entozoa are figured, it is impossible not to be struck with their great diversity, and with the elaborate delicacy of some of the organs with which they are furnished. Such examination, even when not followed up by that aid which the microscope affords, will convince the most unthinking of the accuracy of the following very beautiful passage from Professor Owen's "Lectures on the Invertebrate Animals:"—"In creatures surrounded by, and having every part of their absorbent surface in contact with, the secreted and vitalised juices of higher animals, one might have antici-

pated little complexity and less variety of organization. Yet the workmanship of the Divine Artificer is sufficiently complicated and marvellous in these outcasts, as they may be termed, of the Animal Kingdom, to exhaust the utmost skill and patience of the anatomist in unravelling their structure, and the greatest acumen and judgment in the physiologist in determining the functions and analogies of the structures so discovered. What also is very remarkable, the gradations of organisation that are traceable in these internal parasites reach extremes as remote, and connect them by links as diversified, as in any of the other groups of Zoophyta, although these play their parts in the open and diversified field of Nature."

Class ZOOPHYTA, or POLYPES.

"Here, too, were living flowers,
Which, like a bud comparted,
Their purple cups contracted;
And now in open blossom spread,
Stretched like green anthers many a seeking head.
And arborets of jointed stone were there,
And plants of fibres, fine as silkworm's thread,
Yea, beautiful as mermaid's golden hair
Upon the waves dispread.
Others that, like the broad banana growing,
Raised their long wrinkled leaves of purple hue,
Like streamers wide o'erflowing."—Southey.

The animals belonging to this class were formerly regarded as vegetables. They were afterwards considered to be partly of an animal and partly of a vegetable nature, which idea is still conveyed in the term *Zoophyte*, a word derived from the Greek, and literally meaning "animal-plant." It is to the labours of John Ellis, a London merchant, who devoted much of his leisure to Natural History, and has shown that such studies are not incompatible with commercial pursuits, that science is indebted for the series of accurate observations which, about a century ago,* established the true position of these singular creatures as members of the animal kingdom.

In the two former classes, the Infusoria and the Entozoa,

* 1754, 1755.

no radiated structure was externally apparent. In the present class; it begins to be manifested, not in the form of the body, but in the arrangement of the parts surrounding the mouth. These organs, or *tentacula*, being capable of considerable distension, and being used for the capture of food, probably suggested to the Greek naturalists the application to the animals of the word "polypi," the same which they applied to the many-armed Cuttle-fishes, to which externally they bear some resemblance.

The Zoophytes or Polypes, for by both of these terms are they still designated, may be arranged in four great divisions, to each of which in turn our attention may be briefly directed.

Order I.—HYDROIDA.*

In the first family (*Hydraidæ*) of the present order, is found the common fresh-water Hydra (*Fig.* 7), a singular being, whose history is more strange than the strangest fairy tale. Two species are abundant in pools and ditches during warm weather; one (*H. fusca*), furnished with tentacula capable of being distended many times the length of its body; the other (*H. viridis*), with shorter tentacula, and of a greenish colour. Seen in its contracted state, on the lower side of a leaf or a twig, floating on the water, it appears a little piece of jelly, not larger than the half of a pea. By extending and contracting its body, it can move along, and change its place at pleasure, executing a variety of movements not unlike those of the Caterpillars hereafter mentioned as the "geometric." When it is engaged in taking food, its favourite position seems to be the vertical, which is maintained by a singular proceeding. The tail, or

Fig. 7.—Hydras.

* The term means "Hydra-like."

terminal sucker, is exposed to the air until perfectly dry, in which state it repels the water, and thus becomes an instrument for sustaining the body of the little animal in a perpendicular position. In this attitude, the tail being at the surface of the water, the head underneath, it stretches out its tentacula, like so many fishing-lines, for the capture of its prey. These tentacula, there is reason to believe, possess the power of communicating some electric shock, or otherwise stunning the minute inhabitants of the water with which they come in contact (*Fig.* 8).

Fig. 8.—HYDRA.

The most common mode of reproduction in the Hydra is that by gemmation or buds. Little tubercles are observed to arise on the surface of the animal, which ere long assume the appearance of the parent, and then separate; but not unfrequently, even while attached to the body of the parent, the young Hydras throw out buds themselves. In this way, three or four young may be seen at the same time depending from the sides of the mother, and in different stages of growth—

> "Where some are in the bud,
> Some green, and rip'ning some, while others fall."

For our principal knowledge of the habits of the Hydra we are indebted to Trembley, of Geneva, a naturalist who lived in the last century, and devoted much time and attention to the study of this class of animals. His discoveries were published in 1744; and some of the facts he elicited were so astounding that, at first, naturalists refused to give credit to them. He found, for instance, that if a Hydra were divided into two parts, each division became a perfect Hydra, and that the same thing occurred if the creature were cut into forty pieces. Further, he found that if one Hydra were taken, and, by careful management, pulled into the inside of another, the two became incorporated in one body; and that the only

apparent difference, after the change had been effected, was in the increased number of tentacula which the animal exhibited about the mouth. The metamorphoses of which the Hydra was susceptible did not, however, end here. It might be turned inside out, as if it were the finger of a glove, so that what was the skin would become the stomach, and what had been the lining of the stomach would be converted into the skin. Trembley relates the following circumstance. On one occasion two Hydræ—one stronger than the other—had seized a worm. Neither would let go its hold of the prey, and each went on devouring it. At length, however, the stronger Hydra made short work of it with his rival; for he not only swallowed the small worm, but his opponent also. It might be supposed that this tragic occurrence put an end to, at least, one of the combatants, but such was not the fact; for, after an hour or so, the smaller Hydra came forth unhurt. The Hydra is perfectly naked, having no kind of shell nor cover whatever, differing in this respect from the animals of the next family (*Tubulariadæ*).

Two species of Tubularia, taken off the Irish coast, present the appearance of a number of convoluted tubes, each surmounted by a head of scarlet flowers, which the polype has not the power of withdrawing into the tube. It is difficult to convey an idea of the beauty of these sea-born blossoms, when suddenly drawn up by the dredge from a depth of several fathoms, each seeming petal indued with life, and possessing a distinct power of motion.

It has been observed* that, when those animals were kept in the same water for a day or two, the heads dropped off; but, if the water was then changed, new heads appeared, so that a succession of heads might be produced from one stem, with this difference, however, that each new head would have a smaller number of tentacula than the original one. The young are produced by means of germs, and as soon as they are endued with life they are observed to have rudiments of tentacula, but they do not use them for the purpose for which they are employed by the mature animal. It is an object on which a great degree of providential care is bestowed, that the young of marine animals should be widely diffused through

* By Sir J. D. Dalyell. *Vide* Dr. Johnston's "History of British Zoophytes," from which valuable work most of our information has been derived.

the sea, at a distance from the places where the parents are fixed, and where they live and die. Were it not for this wise arrangement, the locality would, in time, cease to supply the conditions requisite for their existence, and the species must perish. The young Tubulariæ use the tentacula as feet, and, by their aid, remove themselves to a fitting distance from the locality of the parent.

The polypes of the third family (*Sertulariadæ**) resemble the Hydra in shape, and are retractile within their cells. Their common habitat or "polypidom"† assumes a tree-like aspect, reminding us, in some species, of miniature ferns and other vegetable productions. These are the corallines, whose feathery tufts decorate the exterior of the common Oyster or Mussel to which they are frequently attached.

Fig. 9.—Sertularian Zoophyte.

The cells, numerous as they are, are each inhabited by a polype, not as a mere occupant of the cell, and possessed of the power of leaving it at pleasure, but forming, with the cell, the stem, and the root, one living mass. Each polype is connected by a thread with the medullary matter in the centre of each branch, and thus all the parts are united into a compound animal, furnished with a multitude of mouths; for each individual polype contributes, by the food he takes, to the nutriment of all. This structure will be easily understood by the magnified representation of one of these animals given in *Fig.* 9. The repetition of any

* From *sertula*, a little nosegay, wreath, or chaplet of flowers.

† The term is applied to the horny sheath with which the soft body of the polypes is invested.

organ is indicative of a comparatively low grade of organization, and is found only in the lower divisions of the radiate group. An example of this occurs in the numerous stomachs of the Polygastrica, and in the ova-producing segments of the body of one of the Entozoa. The multitude of hungry mouths, each collecting food for the entire group, may be regarded as another instance of the same kind of structure. All the cells are not alike. Among them are some of a larger size and different form, which, from their containing the germs or ova, are termed "ovigerous vesicles."

The ova found in these vesicles are covered with hair-like cilia, which have the power of vibrating continually. By means of these, they are able to diffuse themselves over the bottom of the sea, and to swim about for a day or two, until they find a fitting place for their future habitation, and for the establishment of new and populous colonies. When the animal becomes fixed, it first spreads a little, so as to form a secure base; next, cells are observed; then branches teeming with their busy occupants are developed, and the coralline assumes the form characteristic of the species.

Some calculations have been made respecting the number of individual polypes contained in some of these structures. A single plume of a species found upon our shores has been estimated to contain 500. "A specimen of no unusual size has twelve plumes; thus giving 6,000 polypes as the tenantry of a single polypidom! Now, many such specimens, all united too by a common fibre, and all the offshoots of one common parent, are often located on one sea-weed; the site, then, of a population which nor London nor Pekin can rival!"* With regard to the growth of these corallines, it has been observed that the lower cells are developed soonest, and, after a season, drop off altogether. But "there are facts which appear to prove that the life of the individual polypes is even more transitory; that like a blossom they bud and blow, and fall off, or are absorbed, when another sprouts up from the medullary pulp to occupy the very cell of its predecessor, and, in its turn, to give way and be replaced by another."†

Many of these animals possess luminous properties. If some of them, on the frond or broad-spreading leaf of a sea-weed, are subjected to a sudden shock, they give out an

* *Plumularia cristata.* Johnston's Zoophytes, p. 144.

† Idem, p. 89.

instantaneous flash—a peculiarity alluded to by Crabbe, with his usual minute accuracy:—

> "See, as they float along, th' entangled weeds
> Slowly approach upborne on bladdery beads;
> Wait till they land, and you shall then behold
> The fiery sparks those tangled fronds unfold—
> Myriads of living points; th' unaided eye
> Can but the fire, and not the form, descry."

Order II.—ASTEROIDA.

> "We'll dive where the gardens of coral lie darkling,
> And plant all the rosiest stems at thy head."—Moore.

The animals of the present order are all marine. They are never found singly, but in a community, forming altogether a polype-mass, variable in form, strengthened in different ways, and having on its surface the cells in which the polypes live, and which open on the surface in a star-like figure, whence the order takes its name (*Fig.* 10).

Fig. 10.—Asteroid Polypes.

To this order belong the family of Pennatulidæ, or Sea-pens. One species, taken in abundance on some parts of the Irish coast, is the *Virgularia mirabilis*, a name which denotes the beauty and singularity of its appearance, for it literally means "wonderful little rod." It is dredged from a muddy bottom, in water a few fathoms deep, and comes up so perfectly clean, that fishermen suppose it stands erect at the bottom, with one extremity fixed in the mud. From the summit to the base of the Virgularia runs a long white, calcareous substance—an axis uniform in thickness throughout. This is the first instance which has as yet come before us of an animal possessing the power of secreting calcareous

matter; a power so remarkably developed in those polypes which are the builders of the coral reefs. If one of the wing-like expansions or "pinnæ" of the Virgularia is injured, the rest shrink as if all were hurt. The creature seems, however, to possess no motion beyond that of the pinnæ; nor, if put into a glass of water, does it change its position.

To the same order belongs the group under which the "Sea-fans" are included. The species most commonly exhibited in museums is the *Gorgonia flabellum*, which has occasionally been thrown ashore on different parts of the coast of England and Scotland. As usually seen, the surface consists of a hard calcareous material; but originally this was covered with an irritable living membrane, in the cells of which the polypes lived. If the Sea-fan were formed throughout of a hard, unyielding substance, it must be broken to pieces by the waves; this danger is obviated by the central axis being composed of concrete albumen, a substance resembling horn, which bends under the force of streams and currents, and is

Fig. 11.—Red Coral.

thus preserved. An American poet has referred to this with equal beauty and accuracy,—

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

In another species (*Isis hippuris*) may be observed an example of the varied but equally effective means by which the same security is attained. Here the stem is composed in part of a horny and in part of a calcareous substance, arranged in alternate joints, and thus uniting strength and flexibility. When recently taken, the stem is covered with one continuous living membrane, in which are the polype-cells. The common Red Coral resembles the Isis, in having a living rind in which the polypes find shelter (*Fig.* 11). Inside of this is found the calcareous substance known as the Red Coral of the Mediterranean. Its growth is slow, and its short, stunted stems require not, for their protection, the beautiful and effectual contrivances exhibited in the Gorgonia and the Isis.

Order III.—HELIANTHOIDA.*

> ——————"Seas have—
> As well as earth—vines, roses, nettles, melons,
> Mushrooms, pinks, gilliflowers, and many millions
> Of other plants, more rare, more strange, than these,
> As very fishes, living in the seas."—Du Bartas.

Fig. 12.—Sea-anemone.

The name of the present order denotes that the animals it includes bear a resemblance to such flowers as the daisy, the marigold, and others, which the botanist terms "compound" (*Fig.* 12, 14). The most common native species are single,—with a fleshy body, live only in the sea, and have the mouth encircled with tubular tentacula.

The common Sea-anemone, which is generally to be seen in the rock-pools round our shores (*Actinia mesembryanthemum*), may be taken as a

* Like the Sun-flower.

familiar example, and one which will illustrate some of the most striking structural peculiarities of the order.

Viewed when the tide has receded, and the rocks are left dry, the Actinias,* which adhere to them, appear as fleshy, inert, hemispherical bodies, of an olive tinge, or of a liver-coloured vermilion, the tint being variable. But when the advancing tide has again covered them, they are roused to more active life, unfold their tentacula, and present the appearance of expanded flowers, as described by the poet:—

> "Meantime, with fuller reach and stronger swell,
> Wave after wave advanced;
> Each following billow lifted the last foam
> That trembled on the sand with rainbow hues;
> The living flower that, rooted to the rock,
> Late from the thinner element
> Shrunk down within its purple stem to sleep,
> Now feels the water, and again
> Awakening, blossoms out
> All its green anther neeks."—SOUTHEY.

Though found attached to the rocks, they are not fixed there permanently, but can shift their place at pleasure. Some species are used as food for man, and, when boiled in sea-water, are said to have both the smell and taste of Lobster. They live upon small aquatic animals of every kind, including crustacea and shell-fish; the hard and indigestible parts being rejected by the mouth, about ten or twelve hours after being swallowed. By the mouth, also, we have seen the young Actinias expelled, as miniature representatives of the parent, and furnished even then with minute tentacula. By attention in changing the water and supplying the necessary food, they can be kept alive for a considerable period, under the observation of the naturalist. Sir John G. Dalyell, of Edinburgh, has had one living under his roof for a period of seventeen years.† They are said to exhibit, under such circumstances, great sensibility to atmospheric changes; so much so, indeed, that a French philosopher‡ asserts that they might be of use as sea-barometers; and he describes, in detail, the manifestations which indicate high winds and agitated waters, fair weather and a calm sea, and their intermediate states. Perhaps, however, no circumstance connected with these animals

* The word literally means "a ray."

† This was in August, 1845, and it was still in vigorous health.

‡ Dicquemare—quoted in "Johnston's Zoophytes," page 225.

is more remarkable than their power of bearing mutilation. If the tentacula be destroyed, others are soon after formed. If the animal be cut across into two distinct portions, the upper part continues to take food as usual, though for a time unable to retain it. If severed longitudinally, each half becomes perfect, so that two *actinias* are produced; nay, if it be so destroyed that not a fragment is left except a portion of the base, a fresh offspring is soon raised up to fill the place of the parent.

The following characteristic occurrence is related by Dr. Johnston:—"I had once brought to me a specimen of *Actinia gemmacea*, that might have been originally two inches in diameter, and that had somehow contrived to swallow a valve of *Pecten maximus** of the size of an ordinary saucer. The shell fixed within the stomach was so placed as to divide it completely into two halves, so that the body, stretched tensely over, had become thin and flattened like a pancake. All communication between the inferior portion of the stomach and the mouth was of course prevented; yet, instead of emaciating and dying of atrophy, the animal had availed itself of what had undoubtedly been a very untoward accident to increase its enjoyments and its chances of double fare. A new mouth, furnished with two rows of numerous tentacula, was opened up on what had been the base, and led to the under-stomach. The individual had, indeed, become a sort of Siamese twin, but with greater intimacy and extent in its unions!"

Fig. 13.—Caryophyllia.

Belonging to the same order, but to a different family from the Sea-anemones (*Actiniidæ*), are the Coral-building Polypes of tropical seas (*Madrephylliæa*), some of which have been taken in deep water off the British coast (*Fig.* 13). Their structures have been the wonder of the navigator and the theme of the poet; and while Science endeavours to reveal the process by which they are upreared, she but adduces another example that, under the dispensations of Providence, the mightiest of works can be executed by the weakest of agents.

* The common Scallop.

The great extent of some of the coral reefs is very remarkable. One on the east coast of New Holland is known to be nearly one thousand miles in length, and unbroken for a distance of 350 miles. Some groups in the Pacific are 1100 to 1200 in length, by 350 to 400 in breadth, and these are not formed in an expanse of deep and tranquil waters, but in the midst of an ocean which is ever breaking upon the barrier which the little architects are silently building in the midst of its uproar.

"The ocean," says Mr. Darwin, "throwing its breakers on these outer shores, appears an invincible enemy; yet we see it resisted, and even conquered, by means which seem at first most weak and inefficient. No periods of repose are granted, and the long swell caused by the steady action of the trade-wind never ceases. The breakers exceed in violence those of our temperate regions; and it is impossible to behold them without feeling a conviction that rocks of granite or quartz would ultimately yield and be demolished by such irresistible forces. Yet these low, insignificant coral islets stand, and are victorious; for here another power, as antagonist to the former, takes part in the contest. The organic forces separate the atoms of carbonate of lime one by one from the foaming breakers, and unite them into a symmetrical structure; myriads of architects are at work day and night, month after month, and we see their soft and gelatinous bodies, through the agency of the vital laws, conquering the great mechanical power of the waves of an ocean which neither the art of man nor the inanimate works of Nature could successfully resist."

It was formerly supposed that the coral-building polypes worked in unfathomable depths, and in the course of ages reared their pile to the surface of the water; and it was also conjectured that the oval or circular form of the Lagoon islands might be caused by their being based upon the craters of extinct submarine volcanoes. Both these hypotheses are now abandoned. Recent and widely-extended observations have led to the conclusion that all the phenomena attending the growth and structure of coral reefs may be explained by reference to the combined operation of three causes:—

1st,—That the species of polypes most efficient as coral-builders work only at limited depths, not exceeding twenty or thirty fathoms.*

* This may seem at variance with the fact, that in the immediate

2d,—That in the Pacific and Indian oceans are tracts where a gradual subsidence of the bottom of the sea is going on; and

3d,—That the Polypes work most efficiently at the outer edge of the reef, where the water is the purest and best aërated, and where their food is most abundant.

To enter into further details upon this subject would here be out of place. But this brief notice of the labours of Coral-building Polypes cannot receive a more appropriate close than that which has been furnished by the poet:—

"Millions of millions thus, from age to age,
With simplest skill and toil unweariable,
No moment and no movement unimproved,
Laid line on line, on terrace terrace spread,
To swell the heightening, brightening, gradual mound,
By marvellous structure climbing tow'rd the day.
Each wrought alone, yet all together wrought.
Unconscious, not unworthy instruments,
By which a hand invisible was rearing
A new creation in the secret deep.
Omnipotence wrought in them, with them, by them;
Hence what Omnipotence alone could do
Worms did. I saw the living pile ascend,
The mausoleum of its architects,
Still dying upwards as their labours closed:
Slime the material, but the slime was turn'd
To adamant by their petrific touch;
Frail were their frames, ephemeral their lives,
Their masonry imperishable."—MONTGOMERY'S PELICAN ISLAND.

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vicinity of some of the Coral islands, the sea is of great, and sometimes of unfathomable depth. But if, according to Mr. Darwin's theory, the polypes began originally to build at moderate depths, and the foundations of their structure were gradually carried downwards by the prolonged subsidence of the bottom of the sea, it is obvious, from his statements, that the ceaseless labours of the polypes are capable, in the lapse of time, of producing all the phenomena described. *Vide* Darwin's interesting work on "the Structure and Distribution of Coral Reefs," and an able analysis of his theory in Lyell's Principles of Geology, vol. iii.

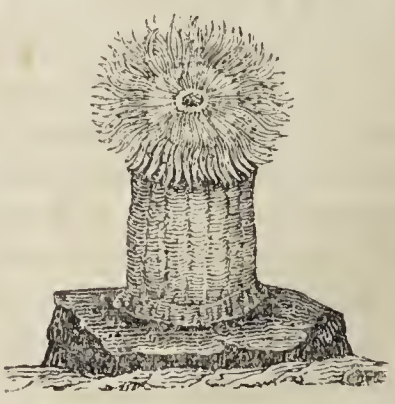


Fig. 14.—ACTINIA.

Order IV.—ASCIDIOIDA.

There is among the molluscous or soft-bodied animals, which in popular language are known as "shell-fish," a numerous order in which the animals are covered, not with calcareous shells, but with a soft membranous covering or tunic, and are hence called tunicated mollusca. Among them is a genus bearing the name of "Ascidia," one species of which is everywhere abundant round our coast. To this the Zoophytes of the present order bear, in some points, such a resemblance in structure, that the name "Ascidioida" is employed to denote the likeness.

b *a*

Fig. 15.—Plumatella.

These Polypes are not separated, but aggregated; their polypidoms are very variable, both in form and in material; sometimes enamelling with delicate net-work the frond of a seaweed or the exterior of a bivalve shell, at others rising into the aspect of miniature plants, or broad leaf-like expansions. They are furnished with distinct orifices for the reception of food, and for throwing off its undigested remains (*Fig.* 15). Round the mouth is a circle of retractile tentacula covered with

Fig 15.—*a*, natural size.—*b*, a group in various positions, magnified.

cilia, from which circumstance the order has been aptly termed "ciliobrachiata." These cilia are "contrived a double debt to pay," for they not only create currents which bring their food within the reach of the Polypes, but they are organs of respiration, and find in the aërated water which surrounds them the means of fulfilling their appointed functions.

To this class of Zoophytes belong the "Sea-mats;" or, to use a more scientific term, the species of the genus "flustra," a word derived from the Saxon, and signifying to weave. Some of these encrust shells or seaweed, others present a foliated appearance of a determinate pattern. They furnish another example of the great abundance of animal life in some of the lower tribes. Though not thicker than common letter-paper, they exhibit, either on one or both sides, successive rows of cells, each of which has been occupied by its own inhabitant. In one species found on the Irish coast, and with cells upon one side only, Dr. Grant calculates "there are more than eighteen cells in a square line, or 1,800 in a square inch of surface, and the branches of an ordinary specimen present about ten square inches of surface; so that a common specimen of *Flustra carbasea* presents more than 18,000 polypi, 396,000 tentacula, and 39,600,000 cilia."

The spectacle presented by one of these polypidoms, when in a saucer containing sea-water, and placed under the microscope, is full of interest. Whether the animals lie in a state of repose, or with the tentacula expanded and in full activity, their aspect and motions are all indicative of happiness. This conviction enhances the pleasure with which we regard them; for truly has the poet said,—

> "The heart is hard in nature
> ——————— that is not pleased
> With sight of animals enjoying life,
> Nor feels their happiness augment his own."—COWPER.

To the scientific zoologist, it is highly instructive to contemplate the affinities which connect these Polypes with creatures so highly organised as the Mollusca. Many similar examples occur in his researches, linking together in close relationship beings which are widely severed in his classification, and showing that "the chain of beings" of which the poet has sung has no real existence in nature.

Class RADIARIA, or RAYED ANIMALS.

———"The firmament
Was thronged with constellations, and the sea
Strewn with their images."—James Montgomery.

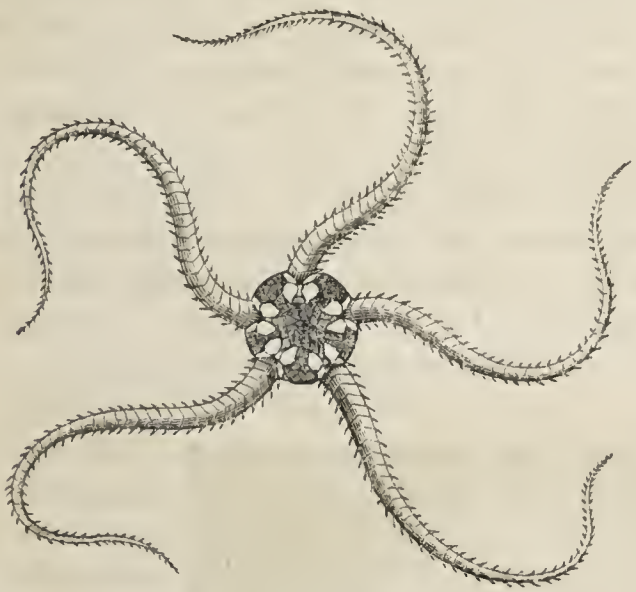


Fig. 16.—Star-fish.

We have now reached the fourth, or highest class of the radiated animals. In these the radiated structure is not confined to the nervous system, or to the arrangement of the parts surrounding the mouth: it extends to the form of the body, and is strikingly manifested in the common Jelly-fish, or in any one of the various Star-fishes (*Fig.* 16), so abundant on our coast. The two examples just mentioned point to an obvious and very natural division of the class. The soft and gelatinous tribes belong to a group of animals whose domain is the wide and open sea; the Star-fish and the Sea-urchin, to a community whose members feed upon garbage and shell-fish, at fathomable depths. The integument or covering of each of these groups of animals is suited to the situation which they are destined to occupy. That of the gelatinous Radiaria is soft and membranous; that of the other is hard, coriaceous, and prickly; thus furnishing a defence against the perils which those species must encounter whose habitat is on coasts exposed to the violence of the ocean. To the former of these two groups, distinguished, because of their stinging powers, by the term *Acalephæ*, a Greek word signifying nettles, our attention may in the first instance be directed.

Order Acalephæ, or Sea-Nettles.

"Awhile to wait upon the firm fair sand,
When all is calm at sea, all still at land;
And these the ocean's produce to explore,
As floating by, or rolling on the shore;
Those living jellies which the flesh inflame,
Fierce as a nettle and from that its name;
Some in huge masses, some that you may bring
In the small compass of a lady's ring;
Figured by hand Divine—there's not a gem
Wrought by man's art to be compared to them;
Soft, brilliant, tender, through the wave they glow,
And make the moonbeam brighter where they flow."—Crabbe.

There is much in the structure of these creatures to excite our surprise. Their frail and gelatinous bodies (*Fig.* 17) seem little else than a mass of vivified sea-water, or some analogous fluid; "For," says Professor Owen,* "let this fluid part of a large Medusa, which may weigh two pounds when recently removed from the sea, drain from the solid parts of the body, and these, when dried, will be represented by a thin film of membrane, not exceeding thirty grains in weight." They baffle the skill of the anatomist by the very simplicity of their structure. Feeble as they appear, fishes

Fig. 17.—Pelagia.

* Lectures on the Anatomy of the Invertebrate Animals, p. 102. It is to this work we refer in cases where we merely give the name of its distinguished author, without special mention of some one of his other numerous contributions to science.

and crustacea are quickly dissolved in their stomachs. The organism of their stinging power is yet but imperfectly understood, and the luminosity which many species possess equally demands investigation. They are found in all seas, and please the eye, both by their glassy transparency and by their brilliant hues.

To the different species of Acalephæ, as to those of other animals, whether inhabitants of the land or of the water, there is allotted a certain range of geographical distribution. They are known within certain boundaries, and beyond these they are rarely found. Now and then, indeed, the winds and the currents bring to our shores marine animals, the inhabitants of warmer climates; and such are, of course, objects of extreme interest to the naturalist.

Some of these may here be mentioned, because they exemplify the great variety of aspect which species belonging to the present division assume, and afford examples of some of its most remarkable families.

In 1838, an animal (*Diphya elongata**) not previously known as an inhabitant of European seas, was captured in Belfast Bay. Its length was about an inch and a half, and its transparency such that the eye could scarcely detect its presence, when the creature was swimming about in a vessel of sea-water. The most remarkable peculiarity in its structure seems to be the facility with which it divides into two parts, each of which continues to exercise powers of voluntary motion, leaving the spectator in doubt whether he is more correct in saying, that it is one animal which easily separates into two, or two animals usually found conjoined in one.

Another inhabitant of the seas of warmer latitudes is the Physalia, or Portuguese Man-of-war, fleets of which are sometimes wrecked upon our southern shores. It exhibits a crest which rises above the surface of the sea, and is enriched with tints of the richest blue and purple.

Sometimes it happens that the sea of our northern shores is enlivened by the mimic fleets of another navigator, the little Velella. On a bluish oval disc it exhibits a snowy, cartilaginous crest, fixed obliquely across, which has been compared to the lateen-sail of the Malay boatmen. Thus propelled, the

* Hyndman in Annals of Nat. Hist. vol. vii. page 164.

living squadrons of this little mariner (*Fig.* 18), have been observed while passing the picturesque headlands of the Giant's Causeway, or the basaltic bulwarks of the harbour of Ballycastle, on the coast of the County Antrim.

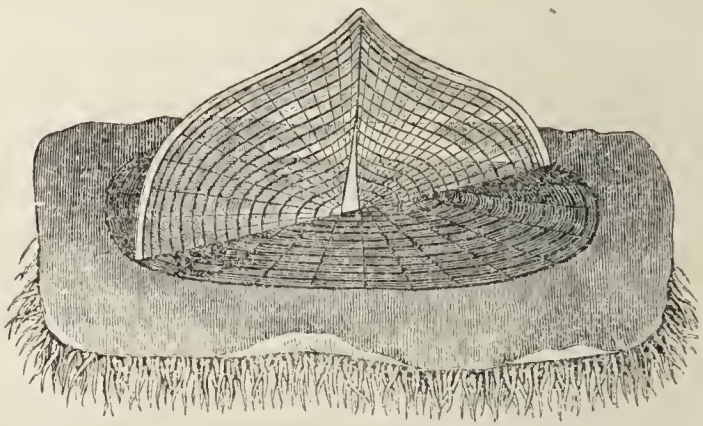


Fig. 18.—Velella.

Upon the southern shores it is, however, of more frequent occurrence. There the specimen was taken of which, by the kindness of Professor Allman, we are enabled to give a figure of the natural size. The original drawing by that gentleman was from a living Velella, respecting which he remarks:—"The individual who sat, or rather *floated*, for his likeness, was one of a fleet of countless multitudes, which, in the Autumn of 1836, was driven upon the coast of the County of Cork. On the subsidence of the gale, which had been blowing strongly from the south-west, the coast for miles round was strewn with the remains of the shipwrecked fleet."

The occurrence of species such as those mentioned is rare; and it is, therefore, desirable to convey some knowledge of the structure and habits of the Acalephæ, not by those which may seldom or perhaps never be observed by the generality of men, but by those which are abundant on our shores, and may be seen and studied by all.

If, during the fine weather of summer or autumn, a gauze towing-net be attached to a boat which is rowed gently along, it is probable that, if the net be examined after a short time, there will be found among its contents some transparent bodies, differing in size, but in general about as large as a boy's marble. Externally they exhibit ridges like those of a

melon, and are in form not unlike an orange or an apple, from which circumstance they take their specific name (*Cydippe pomiformis*, *Fig.* 19).* If gently lifted from the net, and placed in a glass of sea-water, the little animals will begin to move by means of eight bands of vibratile cilia, which extend

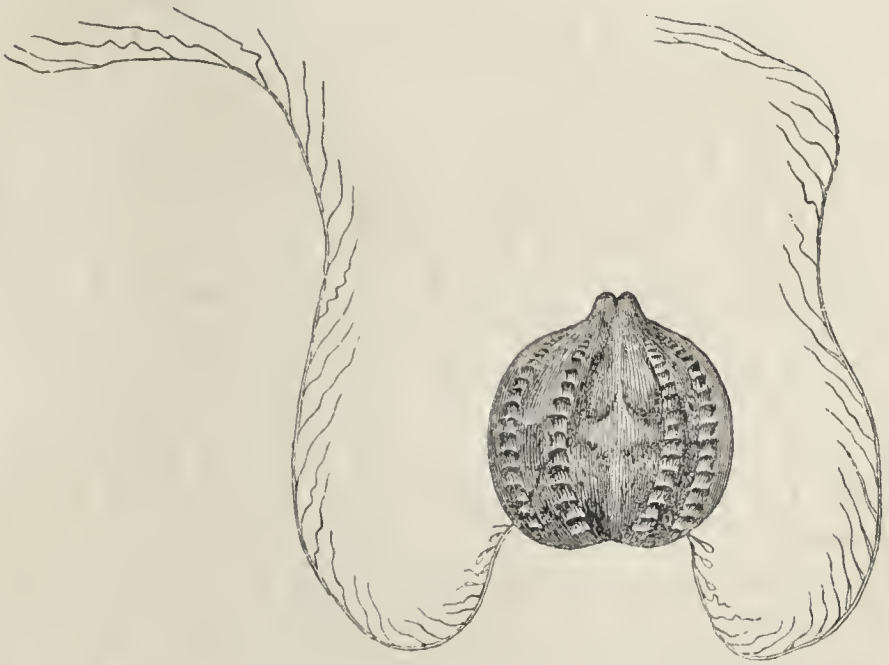


Fig. 19.—Cydippe.

from the upper to the lower extremity of its body. From this peculiar mode of locomotion, they are termed *ciliogrades*, and constitute a family which is distinguished by the classic appellation of Beroë, from one of the fabled sea-nymphs.

Specimens of the Cydippe, when recently taken, form most attractive objects, even to the unscientific. Their cilia, which act like so many little paddles on the water, produce a beautiful iridescence, and suggest, as not inapplicable, the language of the poet,—

> ———"Gay creatures of the element,
> That in the colours of the rainbow live."—Milton.

Their movements are incessant and ever-varying. The little animals can rise or fall at pleasure, executing, as they move up and down, a whole series of gyrations; or without actual

* Transactions of Royal Irish Academy, vol. xix. p. 91.

change of place, can perform with rapidity and ease a rotation which would put to shame the most finished pirouettes of the opera-dancer. During these movements the form of the body is not unfrequently altered, and the lobes of the mouth become more or less distended. These diversified aspects are further increased by the distension or the retraction of two tentacula, furnished on one side with cirri, which are sometimes spread out like delicate hairs, and, at others, are spirally convoluted. By these singular organs the little Beroë can attach itself to the sides or bottom of its glassy prison, and ride, as if at anchor, moored by these singular and delicate cables.

Its food appears to consist of small crustacea,* which may be seen in the transparent stomach for some time after being swallowed. Insensibility to pain, and a continuance of vitality for a long period in mutilated parts, seem to prevail in this, as in some of the other animals already mentioned. When, after a storm, Beroës are taken in a shattered condition, each fragment of their body continues the action of its cilia unimpaired. On one occasion, the author severed one of these fragments into portions so minute, that one piece of skin had but two cilia remaining attached to it; yet the vibration of these organs continued for nearly a couple of days afterwards. On another occasion, a species of Medusa or small jelly-fish, which was furnished with four arms, came in contact with a Cydippe confined in the same glass; the arms immediately closed, and the Cydippe was a prisoner. The diameter of the Medusa was not much greater than that of a sixpence; but it maintained its hold, though we endeavoured to liberate the captive by pushing its conqueror with the stick of a camel-hair pencil. When, at length, it had regained its liberty, the Medusa was found to have cut away a piece fully equal to the one-third of that side it had seized, or a sixth of the entire bulk of the body; yet the Beroë seemed quite unconscious of this mutilation, and did not evince any diminution of its activity or its enjoyment.

It is one of the advantages of natural history pursuits, that they furnish occupation and enjoyment when, from recent indisposition or other causes, either mind or body is unfit for

* We saw them, in May, 1835, feeding on two species then undescribed, but now named and figured by Templeton in the Trans. of the Entomological Society, vol. ii.

laborious exertion. At such a period, in a retired locality on the Antrim coast, the ever-graceful Beroës first attracted our attention, and made the summer day seem too short for the inquiries and researches which they suggested.

A species larger than the Cydippe, and different in form, is also generally diffused round our coast. Its occurrence is more rare, yet it sometimes appears in such abundance, that in Bangor Bay, County Down, we took, on one occasion, one hundred and thirty of them in twenty-five minutes. Its body is more fragile, its movements less active, and it is furnished with four ear-like appendages, which are ever changing in their form. When the water in which it is kept is shaken at night, or in a dark place, splendid coruscations, of a beautiful greenish light, are emitted, especially under the several bands of cilia. On one occasion we placed some specimens of this species (*Bolina Hibernica*)* in a jar on the chimney-piece, and so transparent were the bodies, 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.

The other great division of the Acalephæ is that to which the jelly-fish, which is so abundantly strewed upon the beach during the summer months, belongs. This group is divided into many genera, comprising about three hundred species. Some are furnished with a central peduncle, and resemble a mushroom with its stalk; others have its place supplied by prehensile arms; some have one simple central mouth, in others both its structure and position are different; in some the margin is furnished with long contractile tentacula, whence the well-known stinging secretion is supplied; in others, this formidable apparatus is altogether wanting. These differences, which are easily observable, enable the naturalist to classify the gelatinous Medusæ, for such is their collective appellation.

Their locomotion is effected by the contraction and expansion

* Trans. R. I. Academy, vol. xix. p. 156.

of the outer margin of the disc, the animal striking the water in the opposite direction to that in which it is moving. The motion is easy and graceful, admitting of progress in any direction. The lower surface of the disc is covered with a delicate network of vessels, in which the circulating fluids are exposed to the oxygen contained in the sea-water. Each contraction of the margin, therefore, not only impels the animal in its course, but assists in the process of respiration; and, as the moving and the breathing are thus dependent on the performance of the same act, the term *pulmonigrades** has been applied to these animals; a term no less descriptive than that of "ciliogrades," which, as already mentioned, has been bestowed upon the preceding group.

The Medusæ differ extremely in size. Some are occasionally thrown upon our coast, which are as large as a good-sized umbrella. While writing these pages, we have before us, in a jar of sea-water, several which are not larger than peas, and some which scarcely exceed in dimensions the head of a large sized-pin.

Some species are adorned with brilliant colours, and equal, in the richness of their hues, the brightest of our garden flowers. When from a small boat they are beheld rising and falling at pleasure, in a glassy and transparent sea, and occasionally turning over in the apparent exuberance of enjoyment, they form objects of contemplation so very attractive, as to excite the astonishment of the child, while they furnish matter for the contemplation of the naturalist.

Fig. 20.—Rhizostoma.

Considerable variety prevails in the organs for the reception and assimilation of the food. In the genus Rhizostoma (*Fig.* 20) the arms or peduncles which hang down from the lower surface of the umbrella-shaped disc, are furnished at their extremity with a multitude of pores. By these, the minute animalcules, or the juices of decaying

* *Pulmo*, a lung; and *gradior*, I walk or advance.

animal substances of larger dimensions, are imbibed, and form the nutriment of the animal. In the genus Cyanea, which is so extremely abundant on our coast, the food is taken by one four-lipped mouth, and is of a coarser kind, consisting principally of crustacea and small fishes. A provision for throwing off the undigested portions is therefore required, and we accordingly find that no less than eight canals lead from the centre of the disc to the outer margin, and are appropriated exclusively to this use; an apparatus which, in the other genus, was not wanted, and which, accordingly, had no existence.

To the minute and laborions researches of modern naturalists, we are indebted for a knowledge of the fact, that the sexes in these animals are separate, and that the ova, or eggs, undergo a singular and highly interesting series of transformations before assuming the likeness of the parent.

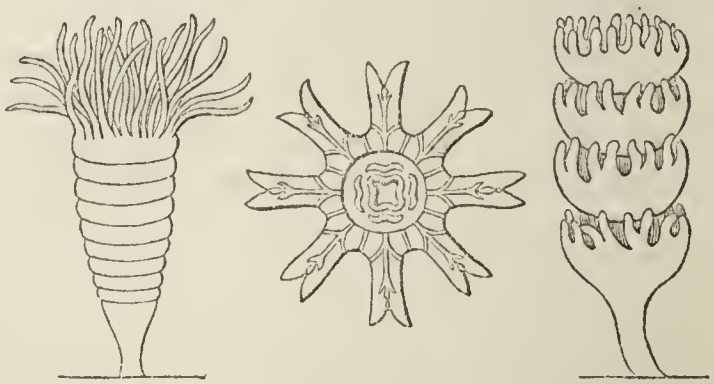
The species of Medusa most abundant on our coasts during the early part of the summer (*Cyanea aurita*) is well known by the four conspicuous lunar or heart-shaped figures which it exhibits. These are of a pinkish or purplish colour, and are, in fact, the ovaries. Four pouches are observed on the lower surface of the body. To these the young, at a certain period, are transferred from the ovaries, and undergo a species of development analogous to that of the young quadrupeds of Australia in the marsupial pouch of the mother. After changes in their size and colour, they exhibit a change of form, become clothed with vibratile cilia, and, leaving the maternal pouch, swim freely about, the larger extremity being always in advance (*Fig.* 21). The little creature soon at-

21. 22. 23. 24.

Development of the Medusæ.

taches itself to some fixed object (*Fig.* 22), and four arms appear, surrounding a central mouth (*Fig.* 23). The arms lengthen, four additional ones are developed, all are highly contractile, covered with cilia, and actively employed in the capture

of food. The number of these arms increases until it reaches twenty-four or thirty; and the body, originally about the size of a grain of sand, becomes a line, or the twelfth part of an inch in length. The animal, in its free state, swims about in the manner of the Polygastric animalcules; in its present condition, it presents an analogy to the habits of the Rotifera. During the winter months, it remains in security, "where the waves have no strife," and even throws out germs, or buds, which in time become perfect Medusæ (*Fig.* 24). But, with the approach of spring, the body becomes marked with transverse lines (*Fig.* 25), which gradually assume a wrinkled or furrowed appearance. These furrows become deeper, dividing the body into from ten to fifteen distinct portions, which, for a time, remain in contact, but without organic connexion, "like piled-up cups"* *Fig.* 26). After complete separation,



25. 27. 26.

Development of the Medusæ.

each part swims freely about, presenting an appearance so unique, that the young, in this state, has been figured and described as belonging to a new genus (*Fig.* 27).

The last change observable is its putting on the appearance of the perfect animal, and under the influence of the sun, the waves, and the currents, becoming a mature Medusa. "We thus see," says Professor Owen, "that a Medusa may actually be generated three successive times, and by as many distinct modes of generation—by fertile ova, by gemmation, and by spontaneous fission—before attaining its mature condition."

Our admiration of the various functions performed by the

* Such is the expression employed by Steenstrup in his Memoir "on the Alternation of Generations;" published by the Ray Society, 1845. The facts and illustrations we give on the authority of Steenstrup, Sars, and other distinguished naturalists.

Acalephæ is much increased when we reflect upon the extremely small quantity of solid matter which enters into their composition. This fact admits of easy illustration, both in the Beroës and in the Medusæ.

On one occasion we took a dead Cydippe, and placing it on a piece of glass, exposed it to the sun. As the moisture evaporated, the different parts appeared as if confusedly painted on the glass, and when it was become perfectly dry, a touch removed the only vestiges of what had been so lately a graceful and animated being.

With regard to the Medusæ, we may mention an anecdote which we learned from an eminent zoologist, now a professor in one of the English universities. He had, a few years ago, been delivering some zoological lectures in a seaport town in Scotland, in the course of which he had adverted to some of the most remarkable points in the economy of the Acalephæ. After the lecture, a farmer who had been present came forward, and inquired if he had understood him correctly, as having stated that the Medusæ contained so little of solid material, that they might be regarded as little else than a mass of animated sea-water? On being answered in the affirmative, he remarked that it would have saved him many a pound had he known that sooner, for he had been in the habit of employing his men and horses in carting away large quantities of jelly-fish from the shore, and using them as manure on his farm, and he now believed they could have been of little more real use than an equal weight of sea-water. Assuming that so much as one ton weight of Medusæ recently thrown on the beach had been carted away in one load, it will be found that, according to the experiments of Professor Owen already mentioned,* the entire quantity of solid material would be only about four pounds of avoirdupois weight, an amount of solid material which, if compressed, the farmer might, with ease, have carried home in one of his coat pockets!

Perhaps there is no circumstance connected with this class of animals more attractive or more remarkable than the power they possess of emitting a beautiful phosphorescent light; and, in some of the larger Medusæ, this is of such intensity, that they have been compared to balls of fire suspended in the water.

* *Vide ante*, page 30.

To those who delight in the contemplation of such phenomena, it affords high gratification to observe from a boat, on a calm night, the effulgence which these creatures shed over the depths below. We have always, at such times, been reminded of the wild and beautiful lines of Coleridge:—

"Beyond the shadow of the ship
I watched the water-snakes;
They moved in tracks of shining white,
And when they reared, the elfish light
Fell off in hoary flakes.

"Within the shadow of the ship
I watched their rich attire:
Blue, glossy green, and velvet black;
They coiled and swam, and every track
Was a flash of golden fire.

"O happy living things! no tongue
Their beauty might declare:
A spring of love gushed from my heart,
And I blessed them unaware."

Professor Rymer Jones, in speaking of the luminosity of the ocean, which is principally owing to the Acalephæ, remarks:—"We have more than once witnessed this phenomenon in the Mediterranean, and the contemplation of it is well calculated to impress the mind with a consciousness of the profusion of living beings existing around us. The light is not constant, but only emitted when agitation of any kind disturbs the microscopic Medusæ which crowd the surface of the ocean; a passing breeze, as it sweeps over the tranquil bosom of the sea, will call from the waves a flash of brilliancy which may be traced for miles; the wake of a ship is marked by a long track of splendour; the oars of your boat are raised dripping with living diamonds; and if a little of the water be taken up in the palm of the hand, and slightly agitated, luminous points are perceptibly diffused through it, which emanate from innumerable little Acalephæ, scarcely perceptible without the assistance of a microscope. All, however, are not equally minute; the Beroës, in which the cilia would seem to be most vividly phosphorescent, are of considerable size; the *Cestum Veneris*, as it glides rapidly along, has the appearance of an undulating ribbon of flame several feet in length; and many of the larger Pulmonigrade forms shine with such dazzling brightness, that they have been described

by navigators as resembling 'white-hot shot,' visible at some depth beneath the surface." *

The phenomenon is not, however, confined to warmer latitudes. Sir Walter Scott, in his "Lord of the Isles," has described it in our own seas:—

"Awaked before the rushing prow,
The mimic fires of ocean glow,
Those lightnings of the wave;
Wild sparkles crest the broken tides,
And, flashing round the vessel's sides,
With elfish lustre lave,
While, far behind, their livid light
To the dark billows of the night
A gloomy splendour gave."

The power of emitting light is possessed by several species of marine animals, among the Polypes, Annelids, Crustacea, and Mollusca. It was formerly a question, to what cause the luminosity of the sea was to be attributed? By some philosophers it was supposed to be owing to the decay of animal substances which it contained; while others conjectured that it arose from a kind of electricity peculiar to itself. These hypotheses are now abandoned, and it is universally admitted, that the phosphorescence of the sea is owing to that of its living inhabitants, more especially of those which belong to the present order; and it has been found, that the species of Medusæ most instrumental in producing the luminosity of the ocean, are those which are the most minute.

Perhaps no writer has succeeded in giving a clearer idea of the myriads of small Medusæ with which great tracts of the sea are peopled, than Scoresby. On examining a bucket of the olive-green water of the Greenland sea, he found its peculiar colour was owing to the multitude of minute Medusæ which it contained. "They were about the one-fourth of an inch asunder. In this proportion, a cubic inch of water must contain 64; a cubic foot, 110,592; a cubic fathom, 23,887,872; and a cubical mile, 23,888,000,000,000,000!" "Provided the depth to which they extend be but 250 fathoms, the above immense number of one species may occur in a space of two miles square. It may give a better conception of the amount of Medusæ in this extent, if we calculate the

* Outline of the Animal Kingdom, page 77.

length of time that would be requisite, with a certain number of persons, for counting this number. Allowing that one person could count a million in seven days, which is barely possible, it would have required that 80,000 persons could have started at the creation of the world, to complete the enumeration at the present time!"

"What a stupendous idea this fact gives of the immensity of creation, and of the bounty of Divine Providence in furnishing such a profusion of life, in a region so remote from the habitations of men! But if the number of animals in a space of two miles square be so great, what must be the amount requisite for the discolouration of the sea, through the extent of perhaps twenty or thirty thousand square miles?"* Even if the learned author, from whom this extract is taken, should prove to be incorrect in his supposition as to the depth to which the Medusæ extend, the spirit of his argument would remain unshaken. His observations prove, that they people, in countless multitudes, tracts of ocean which, without them, would be uninhabited, thus filling its vast expanse with life, and with the enjoyment by which life is accompanied; while, at the same time, they furnish an inexhaustible supply of food to whales and other cetacea, and many of the less bulky inhabitants of the deep. Thus, minute though they are, they indirectly contribute to the welfare of man, and exercise an influence on his social relations.

CLASS RADIARIA—CONTINUED.

Order Echinodermata, or Star-Fishes.

"As there are stars in the sky, so there are stars in the sea."—Link

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The second great division of the rayed animals comprises all those which have a hard coriaceous integument (*Fig.* 28), covered, in some species, with prickles like those of the hedgehog. The word "*Echinus*" means hedgehog; the word "*derma*," a coat or covering. Hence the compound word "*Echinodermata*" is an appropriate and characteristic

* Scoresby's Arctic Regions, vol. i. page 179.

term, as applied to all those creatures whose integument is coriaceous or prickly.

The Echinodermata exhibit, in many respects, an entire contrast to the Acalephæ. That of their covering is obvious to the most cursory observer; that of their internal structure is not less remarkable. The anatomist is baffled by the seeming simplicity and uniformity of texture in the gelatinous

Fig. 28.—Star-fish.

Radiaries; in the harder, or spine-clad species, the extreme complexity and diversity of their constituent parts is found to be no less perplexing.*

All the animals of this class are marine, and in their adult state move freely about. The sexes are distinct, and the young are produced from ova, which, in a certain stage of their development, become covered with minute cilia. They then come forth as ciliated gemmules, are diffused over the bottom of the sea, and undergo a series of transformations analagous to those described in the Medusæ. The observations of a Norwegian naturalist† have made us aware of an interest-

* Owen, page 112.

† Sars, *vide* Annals Nat. Hist. Oct. 1844, page 233, and plate III.

ing fact respecting the maternal solicitude evinced in a species of Star-fish, found upon our own shores (*Cribella oculata*, *Fig.* 29). The mother, by bending the arms and the lower surface of the body, forms a receptacle which, in its uses, may be compared to that of the marsupial animals, or to the pouches of the Medusæ. Here the ova are hatched; and for the space of eleven successive days, during which this process is going on, the female Star-fish has remained in the same recurved and contracted state, and without the possibility of taking nourishment during that period. We do not, at present, know any other example of an animal voluntarily forming a receptacle for the development of its young exterior to its own body, and enduring the privations consequent upon such a procedure.

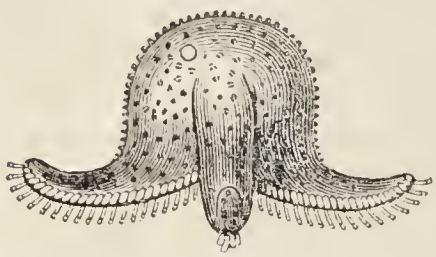

Fig. 29.—Eyed Cribella.

In this group, we find animals of extremely dissimilar appearance associated together. One species is attached for a certain period to a stem, and resembles a Polype with its waving and sensitive arms. In the common Star-fish, or "five-fingers," we have the arms radiating from a common centre. In the Sea-urchins, there are no arms, and the form of the body is globular, and, passing over some intermediate gradations of figure, we reach creatures which, in external aspect, resemble worms, and have even been classed as such. At one extremity of the range, the Echinodermata remind us of Polypes—creatures of inferior organization; at the other extremity, they approach the annulose* animals, whose structure is of a higher grade. Those occupying the centre of the group may be regarded, therefore, as the types or representatives of the class.

In Professor Forbes' "History of the British Star-fishes,"† the entire class is divided into six families. The first of these includes those animals which, in a fossil state, are known as

* A term derived from *annulus*, a ring, and applied to animals which like the Earth-worm are composed of a succession of rings.

† John Van Voorst: London. This is one of that beautiful series of Natural History works, for which we are indebted to that enterprising publisher. From it we have copied figures 31 and 32; the latter redueed.

"stone-lilies" (*Fig.* 30), and the term (*Crinoideæ*) applied to the family is one which simply means "lily-like." The abundance of these animals in former ages, and their present scarcity, have suggested the following paragraph, which we extract from the work just referred to. "One of the most remarkable phenomena displayed to us by the researches of the geologist, is the evidence of the existence, in primeval times, of animals and plants, the analogues of which are now rare or wanting on our lands and in our seas. Among those tribes which have become all but extinct, but which once presented numerous generic modifications of form and structure, the order of Crinoid Star-fishes is most prominent. Now scarcely a dozen kinds of these beautiful animals live in the seas of our globe, and individuals of these kinds are comparatively rarely to be met with: formerly they were among the most numerous of the ocean's inhabitants;—so numerous that the remains of their skeletons constitute great tracts of the dry land as it now appears. For miles and miles we may walk over the stony fragments of the *Crinoideæ;* fragments which were once built up in animated forms, encased in living flesh, and obeying the will of creatures among the loveliest of the inhabitants of the ocean. Even in their present disjointed and petrified state, they excite the admiration, not only of the naturalist, but of the common gazer; and the name of stone-lily, popularly applied to them, indicates a popular appreciation of their beauty."

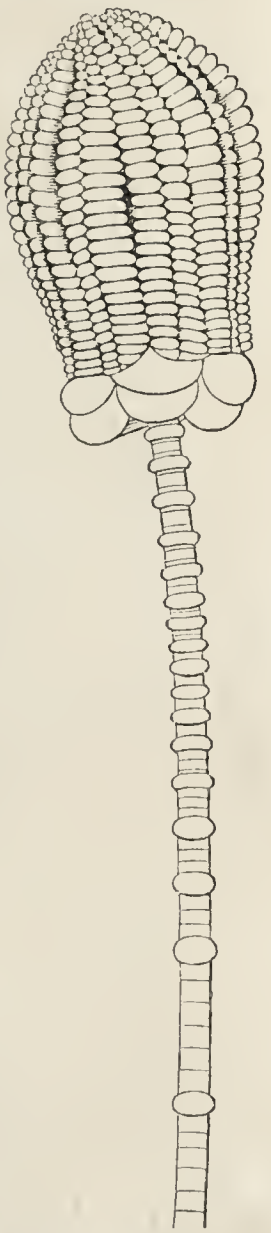

Fig. 30.—Encrinite.

We have already seen, among the Zoophytes, instances of the secretion of calcareous matter within a living body. If we suppose a Polype on a long-jointed stalk, extending five pair of arms, composed of a vast number of pieces, all uniformly shaped and jointed together, we shall have some idea of what these animals were in their living state. The detached

vertebræ are well described by the common English name of "wheel-stones." "The perforations in the centre of these joints, affording a facility for stringing them as beads, has caused them, in ancient times, to be used as rosaries.* In the northern parts of England, they still retain the appellation of St. Cuthbert's beads." Sir Walter Scott has, with his usual felicity, referred to the circumstance in his poem of Marmion:—

> "But fain St. Hilda's nuns would learn
> If, on a rock by Lindisfarn,
> St. Cuthbert sits, and toils to frame
> The sea-born beads that bear his name."—CANTO II.

The race of Crinoid Star-fishes was believed to be altogether extinct in European seas, when, in 1823, Mr. J. V. Thompson announced the discovery, in the Cove of Cork, of a diminutive species measuring only three-quarters of an inch in length. In 1836, the same gentleman proclaimed that this was the young state of the Star-fish known as the Rosy-feather-star (*Comatula rosacea*, *Fig.* 31). The actual change of the animal, from its fixed and pedunculated state into its free condition, had not actually been seen by this intelligent observer. But at length the matter was placed beyond any possibility of doubt.

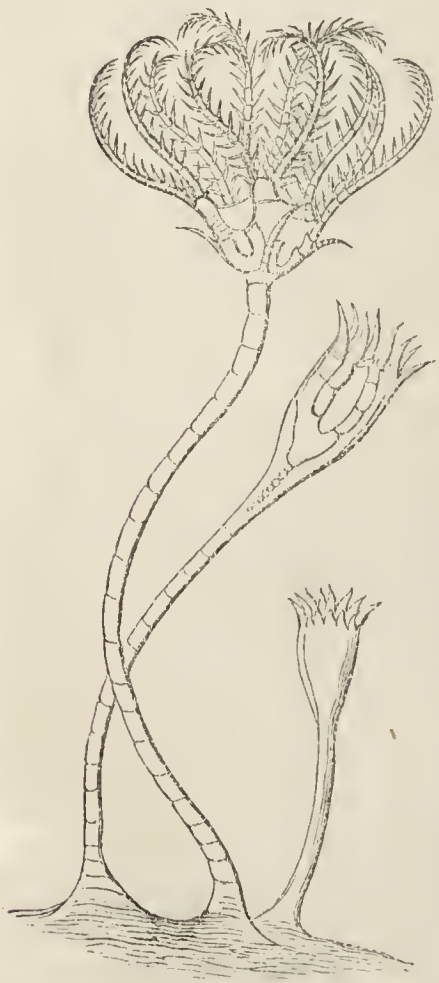

Fig. 31.—POLYPE STATE OF THE FEATHER-STAR (MAGNIFIED).

"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

* Buckland's Bridgewater Treatise, vol. i. page 424.

Comatula; nor could we find any difference between it and the perfect animal, when examining it under the microscope."

The species which formed the subject of these interesting observations has five pair 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.

The second family consists of those Star-fishes which have a roundish central body, furnished with five long arms, not unlike the tails of Serpents (*Fig.* 32); and as the word *ophiura* means a Serpent's tail, the term *Ophiuridæ* has been adopted as the family appellation. These arms are not furnished with suckers, like those of the next division, nor do they contain any prolongation of the digestive organs. They are merely arms external to the body, and easily separated from it at the pleasure of the animal; from which circumstance the English name of "Brittle-stars" has been bestowed upon the tribe. Its members differ very much in size and appearance. Some of them measure as much as sixteen inches in diameter; others are so small, that a score or two of them might be displayed on an ordinary visiting-card. Those who have looked upon such objects only in the dried and rigid aspect they present in our museums, can form no idea of the flexibility, variety, and beauty which they present in the living state. We have, on

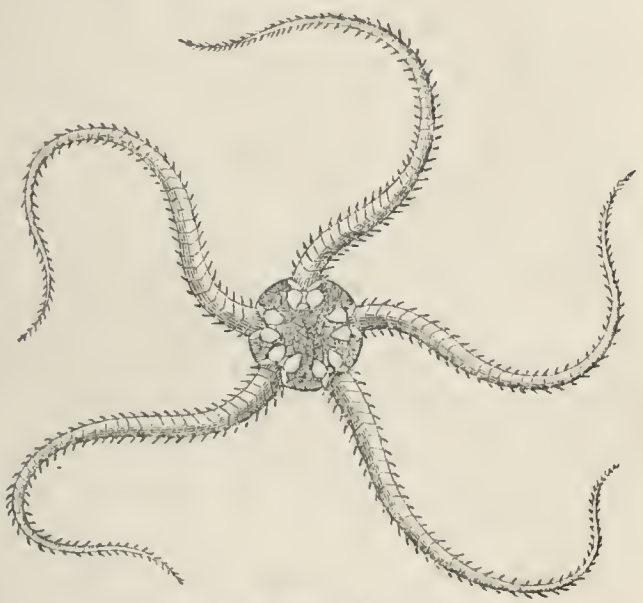

Fig. 32.—Common Sand-star.*

* *Ophiura texturata*. Forbes, p. 22.

many occasions, seen a dredge come up half filled with a spine-covered species (*Ophiura rosula*) everywhere abundant round the coast, and can bear testimony to the accuracy of Professor Forbes' description:—"Of all our native Brittle-stars, this is the most common and the most variable. It is also one of the handsomest, presenting every variety of variegation, and the most splendid displays of vivid hues arranged in beautiful patterns. Not often do we find two specimens coloured alike. It varies also in the length of the ray-spines, the spinousness of the disc, and the relative proportions of rays and disc; and in some places it grows to a much greater size than in others. It is the most brittle of all Brittle-stars, separating itself into pieces with wonderful quickness and ease. Touch it, and it flings away an arm; hold it, and in a moment not an arm remains attached to the body."

The word *aster* means a star, and the term *Asteriadæ* is applied to the third family; that to which the true Star-fishes, or those which are typical of the class, belong. If we take from our cabinets a dried specimen of the common Cross-fish, or "Five-fingers," we find the mouth on the lower surface of the central disc, and five rays, with deep grooves throughout their entire length. Each groove contains a multitude of small orifices, through each of which, when alive, the animal could protrude a tubular organ, capable of adhering to the surface of any body to which it was applied. By such means, its prey can with ease be overcome, dragged into the oral orifice in the centre of the rays, and devoured.

But these suckers, which render the Cross-fish so formidable an assailant, are not only organs of prehension—they are also organs of locomotion. To appreciate them aright, they must be seen in action; for words alone will not convey an adequate idea of the singularity and beauty of their mechanism. On this subject, we prefer the words of Professor Rymer Jones to any which we ourselves could employ*:—"Let any of our readers, when opportunity offers, pick up from the beach one of these animals, the common Star-fish of our coast, which, as it lies upon the sand, left by the retiring waves, appears so incapable of movement, so utterly helpless and inanimate; let him place it in a large glass jar, filled with its native element, and watch the admirable spectacle which it then

* Outline of the Animal Kingdom, p. 141.

presents; slowly he perceives its rays to expand to its full stretch, hundreds of feet are gradually protruded through the ambulacral* apertures, and each apparently possessed of independent action, fixes itself to the sides of the vessel as the animal begins to march. The numerous suckers are soon all employed, fixing and detaching themselves alternately, some remaining firmly adherent, while others change their position; and thus, by an equable, gliding movement, the Star-fish climbs the sides of the glass in which it is confined, or the perpendicular surface of the sub-marine rock."

It has been remarked, that the Star-fishes are furnished with five rays; and although individuals are met with which have four or six rays, the five-rayed predominate so much, that, among the problems proposed by Sir Thomas Browne, is one, "Why, among Sea-stars, Nature chiefly delighteth in five points?" Throughout all the animals of this class, five is the governing number, regulating even the plates of which the "shell" of the Sea-urchin is composed. In the Medusæ, the governing number is four; and each Jelly-fish, with but few exceptions, exhibits, in the arrangement of its parts, the number four, or some multiple of that number.†

Although the rays of the Crossfish, or "Five-fingers," are not mere arms, but true prolongations of the body, and, in many species, have an eye well defended by spines at the extremity, they are frequently broken off, and in such cases are reproduced. The oyster fishermen believe that it loses its rays in attempting to seize the oyster at a time when the shell is incautiously left open. That it is injurious to oyster-beds may be true, for it is known to feed upon different kinds of Mollusca; but it would appear to overpower its prey, by applying some poisonous secretion, and pouting out the lobes of the stomach, so as to convert them into a kind of proboscis, and thus suck the Molluscs from their shells.

A species which Mr. Ball has taken in great abundance about Youghal seems to emulate the Brittle-stars in the facility with which it can fling off its rays. It is appropriately named *Luidia fragilissima*, and has been so graphically delineated by Professor Ed. Forbes, that it would be doing

* A term derived from the Latin word *ambulacra*, from a fancied resemblance which the rows of apertures bear to the walks, alleys, or avenues of some of our old mansions.

† Forbes, Intr. page 15.

injustice to the reader not to present him with the portrait which that gentleman has furnished:—"It is the wonderful power which the *Luidia* possesses, not merely of casting away its arms entire, but of breaking them voluntarily into little pieces with great rapidity, which approximates it to the *Ophiuræ*. 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 disc and a discless 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 sank 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 his corporation, and 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."

The members of the fourth family, that of the Sea-urchins (*Fig.* 33) are furnished with spines, and, from the resemblance in this respect to the Hedgehog (*echinus*), the family bears the name *Echinidæ*. Here the arms have disappeared, and the form has become more or less rounded, according to the species. The spines do not grow from the "shell," or, to use a more correct term, the integument, as thorns do on the branches of the common hawthorn. They are attached to tubercles, and move upon them in the manner of so many ball-and-socket joints. The Sea-urchins are also furnished

with retractile suckers, similar to those described in the Star-fishes; and, by the joint action of their spines and suckers,

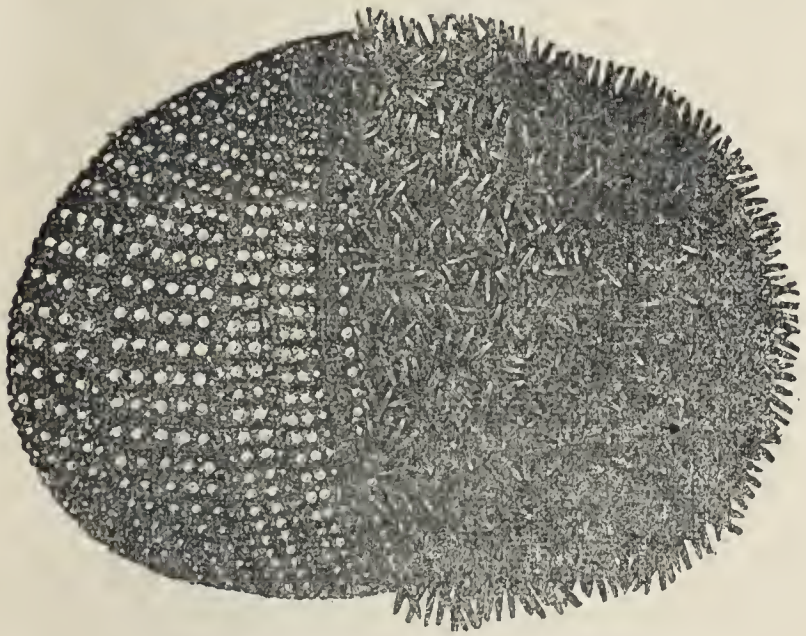

Fig. 33.—Sea-urchin (exterior).*

they can move in any direction they please, or can moor themselves to the surface of sub-marine rocks.

The calcareous covering of the Sea-urchin exhibits a singular and beautiful contrivance for the progressive growth of the animal. It is not one piece, as the word "shell," so commonly applied to it, would lead us to suppose. It is formed of a multitude of pentagonal pieces, accurately fitted together, some rows of them bearing the tubercles to which the spines are attached, and others pierced with hundreds of minute orifices, through which the tubular suckers are protruded. A living membrane, analogous to that found in some of the Polypes, covers the entire surface, and dips down between the several plates. It has the power of depositing a calcareous secretion, which, being added to the edges of the plates, augments all in an equal ratio; and thus, whatever may be the size of the Sea-urchin, the relative proportion of the several parts is uniformly maintained.

It is impossible to contemplate the admirable mechanism of the spines and suckers, and the elaborate structure of the shell, without at once feeling the conviction that in them we behold a portion of "the works of the Lord, and His wonders

* Fig. 33.—The spines have been removed from the left side for the purpose of exhibiting the arrangement of the pieces composing the "shell" underneath.

in the deep." And this feeling increases with the increased minuteness of our examination. "In a moderate-sized Urchin I reckoned," says Mr. Forbes, "sixty-two rows of pores in each of the ten avenues. Now, as there are three pairs of pores in each row, their number multiplied by six, and again by ten, would give the great number of 3,720 pores; but, as each sucker occupies a pair of pores, the number of suckers would be half that amount, or 1,860. The structure in the Egg-urchin is not less complicated in other parts. There are above 300 plates of one kind, and nearly as many of another, all dovetailing together with the greatest nicety and regularity, bearing on their surfaces above 4,000 spines, each spine perfect in itself, and of a complicated structure, and having a free movement on its socket. Truly the skill of the Great Architect of Nature is not less displayed in the construction of a Sea-urchin than in the building up of a world!"

Respiration is secured in these animals by the free admission of sea-water through the pores in the external covering, and by its propulsion, by means of cilia, over every portion of the body. A large portion of the interior of the shell is, at certain times, occupied by vessels filled with the ova, which, in the Mediterranean and elsewhere, are much prized as an article of food; but, at other times, the ordinary observer finds in the interior only a tube wound twice round the circumference, and containing the stomach and intestine (*Fig.* 34). In every step we make towards a knowledge of the structure and habits of these animals, we experience a feeling of surprise and pleasure at the peculiarities they exhibit. Thus, on one occasion, we had cut horizontally into two nearly equal parts a large Sea-urchin, for the purpose of examining the intestines and ovaries. These being removed, the shell was thrown on the deck of our little vessel, as being no longer of any service. It chanced, however, that we afterwards picked up the parts and placed them in a shallow vessel of sea-water. To our surprise, the suckers were soon extended, and the animal walked about, apparently as unconcerned as if the loss of intestine and ovaries had been an every-day occurrence.

At one extremity of the alimentary canal is a singular apparatus, which performs the functions of teeth and jaws, and which, in its detached state, is known as "the lanthorn of Aristotle." Any teeth, fixed in sockets as ours are, would speedily be worn away by their action on the shell-fish, &c.;

upon which the Sea-urchins feed. They are, therefore, constituted with a continual growth, as in the case of the gnawing animals, and the points have all the hardness of enamel. Five jaws, admirably adapted to act as grinders, are furnished with bony pieces, ligaments, and muscles, so contrived and arranged as to draw from Professor Rymer Jones the remark, "these jaws, from their great complexity and unique structure,

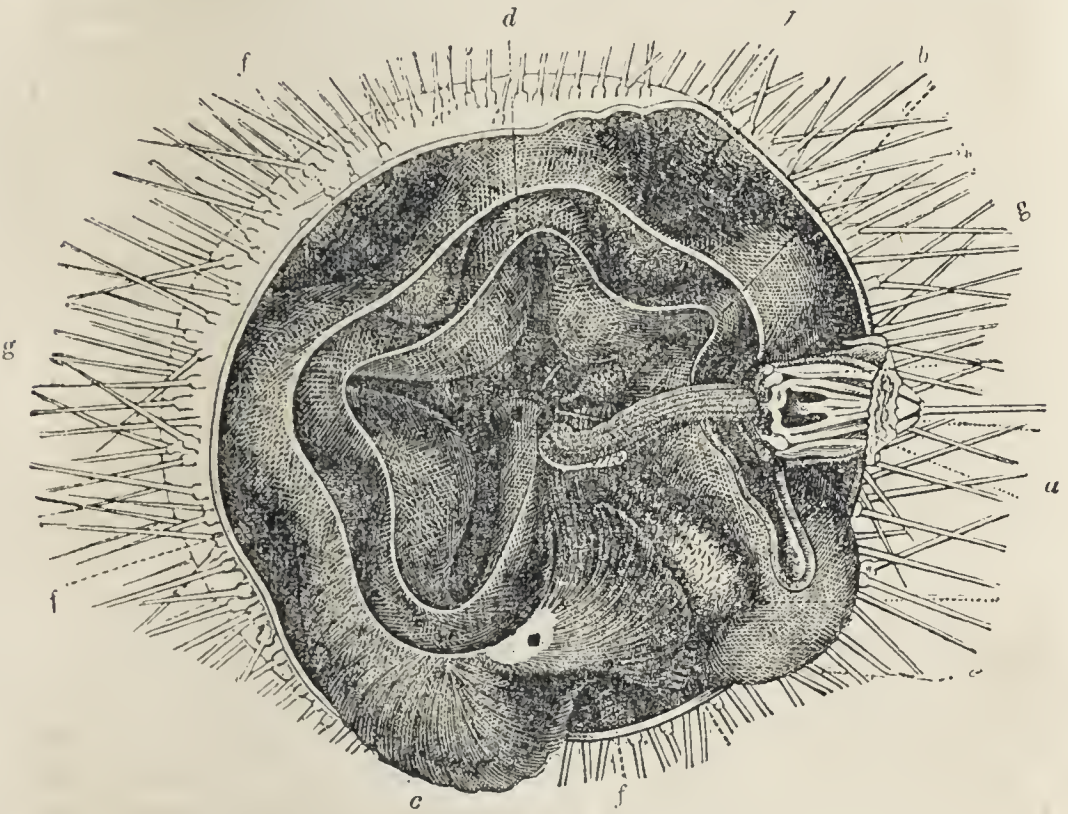

Fig. 34.—Sea-urchin (interior).

form perhaps the most admirable masticating apparatus met with in the whole animal kingdom" (*Fig.* 34).

One species of our native Sea-urchins is remarkable for its habit of boring, principally into limestone rocks, and living in the excavation thus formed. It is gregarious, and was found in abundance by Mr. Ball and Mr. Thompson, when visiting the south Isles of Arran, in 1834. "It is always stationary; the hole in which it is found being cup-like, yet fitting so as not to impede the spines. Every one lived in a hole fitted to its own size—the little ones in little holes, and the large

Fig. 34.—Anatomy of Sea-urchin (*Echinus*).

a, Mouth, with the teeth and jaws.—*b*, Œsophagus.—*c*, Stomach, or first portion of the intestine.—*d*, Intestine.—*e*, Ovary.—*f*, Ambulacral vesicles.—*g*, Shell with spines.

ones in large holes; and their purple spines and regular forms presented a most beautiful appearance studding the bottoms of the gray limestone rock-pools."

The individuals of the fifth family (*Holothuridæ*) are not likely to attract the notice of the casual observer, and are of comparatively rare occurrence even to the naturalist. The English term, Sea-cucumbers (*Fig.* 35), gives some idea of their general form. In them the spines have disappeared; but, as the covering of the body is soft, they can move by the

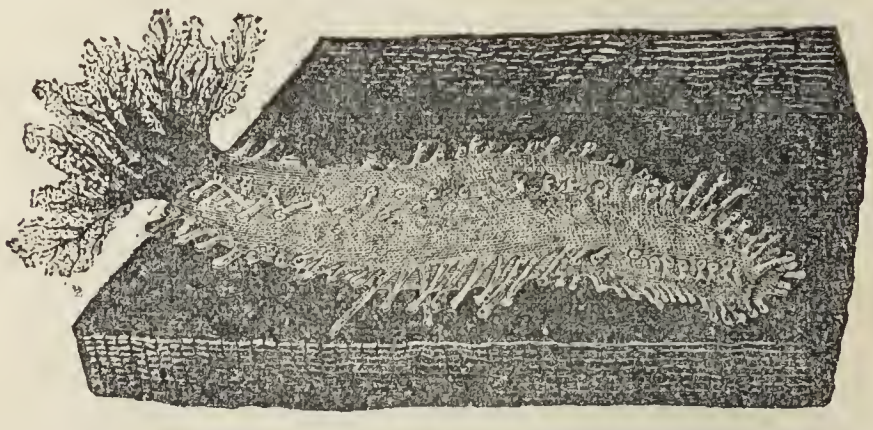

Fig. 35.—Holothuria.

extension or contraction of its parts, as worms do; and, like the Sea-urchins, they continue to employ the aid of suckers. They are remarkable for their power of casting off and of reproducing parts that would seem the most essential. Sir J. G. Dalyell* has known them to lose "the tentacula, with the cylinder (dental apparatus), mouth, œsophagus, lower intestinal parts, and the ovarium, separating from within, and leaving the body an empty sac behind. Yet in three or four months, all the lost parts are regenerated."

Mr. Forbes states,—"It is this animal which the Malays of the Oriental Isles seek so diligently for the supply of the China market, where it obtains a good price when well preserved. It is employed by the Chinese in the preparation of nutritious soups, in common with an esculent sea-weed, Sharks' fins, edible birds' nests, and other materials, affording much jelly. Jaeger says the intestines are extracted, the animal then boiled in sea-water, and dried in smoke."

A species found off the coast of Cornwall, and first described

* Paper read at Glasgow Meeting (1840) of British Association.

by Mr. Peach at the York Meeting of the British Association, in 1844, bears the singular name of "the nigger," from its dark colour, and the "cotton-spinner," from its long white threads.*

The members of the sixth family (*Sipunculidæ*) in external appearance resemble worms; but, from an examination of their internal structure, it is ascertained that they must, in reality, be classed among the Star-fishes. They are not furnished with suckers, nor do they exhibit any quinary arrangement of parts; and their movements are so entirely those of worms, that they are, with great propriety, termed "*Vermigrade Echinodermata.*" Some are found under stones, some burrow in sand, and some select as their mansion an empty univalve shell; their habits, however, are as yet imperfectly known.

We have now completed our proposed sketch of the radiate animals, commencing with the microscopic animalcules, and advancing to those in which the radiated structure attains its highest perfection. To all we may apply the remark with which Professor Forbes concludes the excellent work from which we have so largely quoted.

"Among the British Echinodermata we have seen some of the most extraordinary forms in the animal kingdom, some of the most wonderful structures and of the strangest habits. Much yet remains to be done towards their elucidation, and the investigation of them, both structurally and formally, presents a wide field of inquiry to the student of nature, as yet but imperfectly explored. The great naturalist of Denmark,

* Mr. C. W. Peach is one of those lovers of natural history whose ardour in the pursuit surmounts all difficulties. At the time we first made his acquaintance, in 1841, he held a very subordinate situation in the coast guard, and had a numerous family dependent on his scanty pay. He was the schoolmaster of his own children, and the superintendent of the Sunday school of the village of Goran Haven, Cornwall, where he then resided. Yet, notwithstanding his ceaseless avocations, and the laborious night and day duties of his situation, natural history was never neglected; and in his solitary rides along the beach, his eye, trained to observe, was ever on the alert. Thus he collected the materials for several communications on geology and natural history, made by him at successive meetings of the British Association. We are happy to add, that some of the influential members of that body, appreciating his exertions, represented them to government in such colours, that he has been promoted to a situation of comparative ease and comfort in the custom-house at Fowey.

Müller, long ago said that we need not resort to distant regions and foreign climes for rare or wonderful creatures;—that the fields, the woods, the streams, and the seas of our native lands, abounded in wondrous evidences of God's power and wisdom. The investigation of our native animals must ever be a chief source of sound zoological knowledge; for it is there only we can watch, under favourable circumstances, for the observation of their development, their habits, and their characters. The naturalist whose acquaintance is confined to preserved specimens in a cabinet, can form but a vague idea of the glorious variety of nature, of the wisdom displayed in the building up of the atoms of matter to be the houses of life and intellect; and, unless we study the creatures living around us, how can we gain that delightful knowledge? The passing note of an animal observed during travel is an addition to science not to be scorned; the briefly characterizing of a new species from a preserved specimen, if done with judgment, is of importance; but the real progress of natural history must ever depend on the detailed examination of the beings gathered around us by the laws of geographical distribution, living and multiplying in their destined homes and habitats."

ARTICULATA.

ARTICULATED, OR JOINTED ANIMALS.

———"Whatever creeps the ground,
Insect or worm; those waved their limber fans
For wings, and smallest lineaments exact
In all the liveries deck'd of summer's pride,
With spots of gold and purple, azure and green;
These, as a line, their long dimensions drew,
Streaking the ground with sinuous trace."—MILTON.

THE traveller who passes the line of demarcation which separates two adjacent kingdoms, does not at once perceive any obvious change in their physical features or their natural productions, nor see anything in the manners or customs of the inhabitants to tell him that he has entered a new realm. Such is the case with the naturalist who has been an observer of the radiate animals, and enters the dominions of the articulated. The Leeches and Worms, among which he has come, present very much the same aspect as the vermiform or worm-shaped Echinodermata, from which he has parted. "Why," he asks, "should they be thus divided?"

Fig. 36.—NERVOUS SYSTEM OF CARABUS.

The question is best answered by an examination of the internal structure. A difference in the nervous system is at once apparent. It is no longer arranged on the radiate type, but presents the brain in the form of a ring surrounding the throat (*Fig.* 36); a double nervous thread extends along the body at its lowest side, united at certain distances by

double "ganglions," as these nervous masses are termed, from which are given off the nerves that proceed to the extremities. From the symmetrical disposition of these nervous centres, Mr. Owen has given to this sub-kingdom the name Homogangliata.* The body in general presents a corresponding symmetrical form, and consists of a repetition of rings or segments, as in the Earth-worm, or the Millepede (*Julus*, *Fig.* 37).

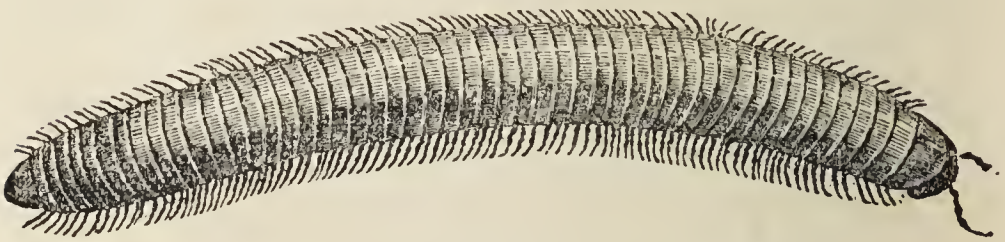

Fig. 37.—Julus.

The articulated animals are arranged in the following classes:—

Annellāta,	Leeches, Earth-worms, &c.
Cirripĕda,	Barnacles and Acorn-shells.
Crustacea,	Crabs, Lobsters, &c.
Insecta,	Beetles, Bees, Butterflies, &c.
Arachnĭda,	Spiders, Scorpions, and Mites.

* From two Greek words, one signifying "similar," the other "a ganglion," or knot, being the mass of nervous matter from which the nerves diverge.

CLASS I.—ANNELLATA.

Leeches, Earth-worms, etc.

"Her divine skill taught me this,
That from everything I saw
I could some instruction draw,
And raise pleasure to the height,
Through the meanest object's sight."—G. Wither.

The most obvious external character of the Leech or the Earth-worm is the number of little rings of which the body is composed; and hence the Latin word "annellus," a little ring, suggests an appropriate and descriptive term for animals of this class.

The medicinal Leech and the common Horse-leech of our ponds are so well known, that the most incurious cannot fail,

Fig. 38.—Leech.

at some period or other, to have noticed the singular disc with which these creatures are furnished at each extremity of the body, and which, at the will of the animal, can be used as a sucker, and thus converted into a support or point of attachment. Leeches are of many species; but these prehensile discs may be regarded as "the badge of all the tribe." They are destitute of external organs for locomotion, and move by the expansion and contraction of the segments of the body. In the water they can swim with ease and rapidity. Respiration is effected by a series of membranous sacs, which are analogous to internal gills, and to which water is freely admitted by minute orifices on the lower surface of the body.*

The medicinal Leech (*Hirudo medicinalis*) is not-indigenous to Ireland; it is found in some parts of Britain, but is now becoming very rare. It is still seen in the lakes of Cumber-

* Jones's Nat. Hist. of Animals.

land, but even there is rapidly disappearing. This fact is mentioned by Wordsworth's leech-gatherer in a stanza, which casually notices, at the same time, the manner in which they are collected.

> "He with a smile did then his words repeat;
> And said, that, gathering leeches, far and wide
> He travelled; stirring thus about his feet
> The waters of the pools where they abide.
> Once I could meet with them on every side,
> But they have dwindled long by slow decay;
> Yet still I persevere, and find them where I may."
> *Resolution and Independence.*

The supply of leeches used in these countries is derived from France, Sweden, Poland, Hungary, the frontiers of Russia, and Turkey, and the great extent of the trade thus carried on may be judged of from the fact, that "four only of the principal dealers in London import 7,200,000 annually."*

When we find that the medicinal Leech has been applied to the use of man from a remote antiquity, and now constitutes so important an article of commerce, we are naturally led to inquire, "to what peculiarity of structure is its utility owing?" The first and most obvious is that by which its wound is inflicted. Just within the margin of the mouth "are situated three beautiful little semicircular horny saws, arranged in a triradiate manner, so that their edges meet in the centre."† "No sooner is the sucker firmly fixed to the skin than the mouth becomes slightly everted, and the edges of the saws thus made to press upon the tense integument, a sawing movement being, at the same time, given to each," they cut their way to the sluices of blood beneath. Nearly the entire body of the animal consists of a series of chambers into which the blood thus taken is received. They are eleven in number, perfectly distinct, and in the first eight the blood may remain for months unchanged either in colour or fluidity, the creature merely allowing so much to pass into the alimentary canal as is necessary to preserve its existence.‡ Hence the repugnance of the animal to repeat the operation, until the store of food with which it is thus gorged has been consumed.

The term *Leech* (derived from the Anglo-Saxon verb

* Penny Cyclopedia, Article Leech.
† Jones's Natural History of Animals, vol. i. page 322.
‡ Owen, page 133.

læce, to cure, to heal) was applied by our old writers, not only to the animal, but also to persons, both male and female, who were skilful in the art of healing.

Thus, in the ancient Ballad of Sir Cauline, the king calls upon the princess to exercise her skill on behalf of the wounded knight:—

> "Come down, come down, my daughter deare,
> Thou art a leeche of skille;
> Farre lever had I lose half my landes,
> Than this good knight sholde spille."

The young of the leech are produced from cocoons* deposited by the mother towards the end of summer. The winter is passed by our common horse-leech (*Hæmopsis sanguisuga*) in a state of torpidity, in the mud at the bottom of the ponds or ditches where it resides. This habit gave origin, on one occasion, to a somewhat singular scene, which we chanced to witness. On the morning of the 27th March, 1838, a part of the footway on one of the most crowded thoroughfares adjoining the town of Belfast, was so covered with leeches, that it was scarcely possible to walk without trampling them under foot. So great was their abundance that some of the passers-by remarked, that it seemed as though a shower of leeches had fallen. They extended for about 100 paces in this profusion; on both sides of this space they were less numerous. The phenomenon continued for the two following mornings, but with diminished numbers. A slight examination served to explain its cause. The ditch on the side of the fence which separated the footway from the adjacent fields had been cleaned out the preceding day. The leeches had been buried in the slime, and on this being placed on the top of the fence, they had struggled out, and spread themselves over the adjoining footway.

The earth-worms represent another tribe of Annelids. In them suctorial discs, such as those of the leeches, do not exist; but a mechanical contrivance of a different kind may be observed. The rings, of which their body is composed, are no longer perfectly smooth; but are furnished with minute bristles, or recurved hooks. These, as the creature pushes its way, catch upon the soil, and form fixed points of support, by which the worm is enabled to maintain its place while drawing

* Owen, page 145.

forward the remaining parts of the body. Earth-worms move but little abroad during the day-time, except when disturbed. The young are produced from eggs, which, previous to their being deposited by the mother, have undergone a certain degree of development.* Their blood is red; but in some species it is yellow, and in one it is a pale green, so that the mere colour of the circulating fluid does not seem to be of the zoological importance attached to it by Aristotle.

The mouth of our common earth-worm (*Lumbricus terrestris*) has a short proboscis, but is destitute of teeth. Its food consists of the decaying particles of animal and vegetable matter, "the crumbs that fall from nature's bounteous table."† By the ordinary process of chemical decomposition, these particles would be dissolved and lost. Swallowed by the earth-worm, they become converted into nutriment, are assimilated to the substance of its body, and in this state minister to the support of beings of higher organization—to that of birds and fishes.

On this subject, the Rev. Gilbert White, in his delightful "Natural History of Selborne," has long since made the following judicious observations;—

"The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of nature, than the incurious are aware of; and are mighty in their effect, from their minuteness, which renders them less an object of attention, and from their numbers and fecundity. Earth-worms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. For, to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and fibres of plants, by drawing straws and stalks of leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps of earth called worm-casts, which being their excrement, is a fine manure for grain and grass."

The correctness of these views has recently received a

* Owen, page 146.
† Rymer Jones, page 328.

curious confirmation, in a paper communicated by Mr. Darwin* to the Geological Society of London, in Nov. 1837. He observes that, in a pasture field which has long remained undisturbed, not a pebble will be seen, although, in an adjoining ploughed field, a large proportion of the soil may be composed of loose stones. This he attributes to the working of worms, and states his conviction, that every particle of earth in old pasture land has passed through the intestines of worms; and hence that, in some senses, the term "animal mould" would be more appropriate than "vegetable mould." It has been estimated that, in eighty years, the marl laid upon a field for manure, has been covered with soil to the depth of thirteen inches, by the operations of these creatures.

"It is commonly supposed," says Dr. Carpenter, "that the earth-worm may be multiplied by the division of its body into two pieces, of which each will continue to live. This, however, does not appear to be the case with regard to the common species. If it be divided across the middle, when in motion, each part will continue to move for a time; but only the piece which bears the head will be found alive after a few hours. This forms a new tail, and soon shows little sign of injury. But if the division be made near the head, the body will remain alive, and will renew the head; and the head, with its few attached segments, will die."†

The power of reproduction is enjoyed by many other Annelids to a much greater extent. A small worm (*Lumbricus variegatus*) was cut by Bonnet, a French naturalist, into twenty-six parts, and "almost all of them reproduced the head and tail, and became so many new and perfect individuals. It sometimes happened, that both ends of a segment reproduced a tail. Wishing to ascertain if the vegetative power was inexhaustible, Bonnet cut off the head of one of these worms, and, as soon as the new head was completed, he repeated the act; after the eighth decapitation, the unhappy subject was released by death."‡

In some species, the propagation reminds us of that of which we saw examples in the Infusoria. Thus, "in the *Nais*,§

* *Vide* Note to White's Selborne, edited by Rev. L. Jenyns, 1843, and Penny Cyclopedia, *Lumbricus*.

† Zoology, vol. ii. page 310.

‡ Owen, page 143.

§ Carpenter's Physiology, page 549.

one of the marine worms, the last joint of the body gradually extends, and increases to the size of the rest of the animal; and a separation is made by a narrowing of the preceding joint, which at last divides. Previously to its separation, however, the young one often shoots out a young one from its own last joint, in a similar manner, and three generations have thus been seen united." It is a curious circumstance, that the same tail serves as the tail of successive individuals, and seems thus to enjoy an exemption from the ordinary laws of mortality.

Fig. 39. ARENICOLA.

Respiration in the earth-worm is carried on by means of pores and internal sacs, similar to those of the leech. In the "lob-worm,"* or "lug of fishermen (*Fig.* 39), a portion of the body is furnished with little arborescent (tree-like) tufts, to which the blood is conveyed, and there purified, by coming into contact with the air diffused through the sea-water.

In the next tribe of Annelids, a new modification of the respiratory organs is exhibited, one admirably adapted to their peculiar habitats and modes of life. All the individuals of this assemblage dwell in tubes, consisting either of calcareous matter, secreted from their own bodies, or, as in the Terebella, of particles of sand and gravel agglutinated together to serve as a habitation. Under these altered circumstances, the only place to which the vivifying principle of the sea-water could freely have access, would be that adjacent to the exterior orifice of the tubes; and here, accordingly, we find the respiratory apparatus arranged, often extremely graceful in its form, and enriched with brilliant colouring. The small contorted tubes which encrust, in so fantastic a manner, the old bottles or dead shells dredged up from any of our bays, form an example of this class. They are the dwellings of one of these sedentary worms,

* This was formerly classed with the earth-worm, under the name of *Lumbricus marinus;* but, from its difference of structure, it is now referred to a different order (*Dorsibranchiata*), and bears the name *Arenicola piscatorum.*

bearing the name of *Serpula* (*Fig.* 40). "If, while the contained animals are alive, they be placed in a vessel of sea-water, few spectacles are more pleasing than that which they exhibit. The mouth of the tube is first seen to open by the raising of an exquisitely constructed door, and then the creature cautiously protrudes the anterior part of its body, spreading out, at the same time, two gorgeous fan-like expansions of a rich scarlet or purple colour, which float elegantly in the surrounding water, and serve as branchial or breathing organs."*

Fig. 40.—Group of Serpulæ.

The minute convoluted shells (*spirorbis*), which are seen like whitish specks upon almost every piece of sea-weed, exhibit an instance no less striking of the same exquisite design, the same admirable adaptation of means to the required end.

The fourth tribe present, in their habits, a complete contrast to the last. They are formed for locomotion, and some among them can swim with considerable swiftness (*Fig.* 41). The roving life they lead has induced

Fig. 41.—Nereis.

Milne Edwards, the eminent naturalist, whose classification we have followed, to bestow on them the characteristic appellation of *Errantes*.†

* Jones's Natural History of Animals, page 313.

† Recherches pour Servir à l'Histoire Naturelle du Littoral de la France. Paris, 1834.

They present considerable diversity in size. In one tribe (*Nemertina*) there are individuals not more than one or two inches long, while others, of the same fraternity, attain the enormous length of fifteen feet,* or, when artificially distended, of more than twenty yards.† The sea long-worm, for so this species is named (*Nemertes Borlasii*), contracts in spirits to one or two feet in length, and the thickness of an ordinary quill. One was taken by Captain Fayrer, "holding on to a bait on his long line, when he was fishing for cod off Portpatrick."‡

In contrast with the freebooter, thus made prisoner while on a predatory excursion, we may mention a species which is so much broader and thicker than other Annelids as to have lost its worm-like aspect. It is common around our coast, and is popularly known as the sea-mouse (*Aphrodita aculeata*). Besides being furnished with numerous fasciculi, or bunches of stiff, sharp-pointed bristles, employed both as organs of motion and weapons for defence, it is decorated with numerous soft, silky hairs, of the most brilliant metallic colours, and highly iridescent. Strange it may seem to us, that a worm, living in the midst of the slime at the bottom of the sea, should have a vesture which rivals, in the splendour of its hues, the wing of the butterfly, or the plumage of the humming-bird! But the beauty impressed on even the humblest of created beings seems boundless as the beneficence of Him who called them into being.

We have enumerated four tribes of Annellata:—

I. The Suctorial, comprising the Leeches;
II. The Terricolous, including the Earth-worms;
III. The Tubicolous, which inhabit tubes;
IV. The Errantes, which are the most highly organized, and the most locomotive.§

In respect to some worms, there are traditionary errors

* Dr. Johnston in Mag. of Zoology and Botany, 1837, page 536.

† This we state on the authority of Mr. R. Ball, who took one at Clifden, Co. Galway, which he ingeniously caused to distend itself, and was thus enabled to ascertain its measurement.

‡ W. Thompson in Mag. Nat. Hist. vol. ii. No. 13.

§ Their respiratory organs are placed upon the back; hence the term applied to them by Cuvier, *Dorsibranchiate*, from *Dorsum*, the back; and *branchiæ*, gills.

which are still current. Thus, there is a species, called the Hair-worm (*Gordius aquaticus*), which is abundant, during a part of the summer, in rivulets in the North of Ireland and elsewhere. Its length is about eight or ten inches, and the common superstition about it is, that horse-hairs placed in water become vivified, and are changed into these worms. This notion, with the addition that the Hair-worm was the young state of the serpent, was prevalent in the days of Queen Elizabeth, for we find it is thus recorded by Shakspeare,—

> ———"Much is breeding,
> Which, like the courser's hair, hath yet but life,
> And not a serpent's poison."

The writings of the same poet furnish us with examples of the comprehensive manner in which the word "worm" is used, and of its application to objects different from those to which it is restricted by the naturalist.*

Among these humble animals are some which possess luminous properties: one has been observed in Ireland on some of the extensive tracts of bog; and to Mr. R. Ball we are indebted for the following notice of a similar power in one of the marine species:—"The most beautiful instance 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 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 day-light, it is probable, their very existence would have been unnoticed, so little conspicuous were they. An idea of the size and

* "The *worms* were hallowed that did breed the silk."—Othello.
"A convocation of politic *worms*."—Hamlet.
"Hast thou the pretty *worm* of Nilus here, that kills and pains not?"
Antony and Cleopatra.
"Your *worm* is your only emperor for diet."—Hamlet.
"There the grown serpent lies; the *worm* that's fled
Hath nature that in time will venom breed."—Macbeth.
"Eyeless venom'd *worm*."—Timon of Athens.

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.*

Some among these creatures occasionally present themselves to our notice in situations where they would be least expected. Thus, Templeton describes one (*Spio calcarea*) "living in minute tubular cavities, in our limestone rocks, the tentacula alone projecting, and kept by the animal in constant motion."† We have noticed the same, or some allied species, in rock pools on the County Down coast, where there is no limestone. There the pinkish substance, now regarded as vegetable,‡ that lined the pools, formed the materials of its dwelling, and the minute waving tentacula gave animation and interest to the otherwise quiet little basins.

CLASS II.—CIRRIPEDA.

Barnacles and Acorn-shells.

"There are found in the north parts of Scotland and the islands adjacent, called Orchades, certain trees, whereon do grow certain shells of a white colour, tending to russet, wherein are contained little living creatures; which shells in time of maturity do open, and out of them grow those little living things, which, falling into the water, do become fowls which we call Barnacles."

The words which we have selected as the motto for the present chapter occur in Gerardes' "Herbal, or General History of Plants," a work published in 1597, and regarded for more than a century afterwards as one of the best sources of botanical information. Its author resided in Holborn, and established there a "physic garden" of his own, which was probably, at that period, the best of its kind in England for the number and variety of its productions. The transformation above mentioned he gives on the authority of others. "Thus

* As all our readers may not be familiar with the ornament to which our friend, Mr. Ball, has referred, we annex a wood-cut, which will render his illustration more perfectly understood.

† Mag. Nat. Hist. vol. ix. page 233.

‡ *Millepora polymorpha.*

much by the writings of others, and also from the mouths of people of those parts, which may very well accord with truth." He then proceeds in a strain which marks the downright sincerity of this honest and laborious old naturalist, who had mistaken the soft parts of the barnacle for a bird. "But what our eyes have seen and our hands have touched, we shall declare. There is a small island in Lancashire, called the Pile of Foulders, wherein are found the broken pieces of old and bruised ships, some whereof have been cast thither by shipwreck, and also the trunks and bodies, with the branches, of old and rotten trees cast up there likewise, whereon is found a certain spume or froth, that in time breedeth unto certain

BARNACLES.

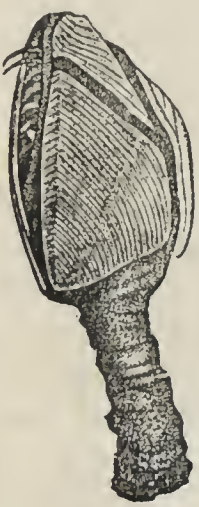

Fig. 42.—Shell of Lepas.

Fig. 43.—Body of Lepas.

shells in shape like those of a mussel, but sharper pointed and of a whitish colour; wherein is contained a thing in form like a lace of silk finely woven, as it were, together, of a whitish colour, one end whereof is fastened unto the inside of the shell, even as the fish of oysters and mussels are; the other end is made fast unto the belly of a rude mass or lump, which in time cometh to the shape and form of a bird: when it is perfectly formed, the shell gapeth open and the first thing that appeareth is the foresaid lace or string; next come the legs of the bird hanging out, and, as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill. In short space it cometh to full maturity, and falleth into the sea, where it gathereth feathers and groweth to a fowl bigger than a Mallard and lesser than a Goose."

The specific name, *Anatifera*, or goose-bearing, by which the most common kind of barnacle-shell (*Lepas*) is distinguished, commemorates this old traditionary error, which is still current. On more than one occasion, when we have been examining a sea-borne piece of timber, with its crowd of suspended Barnacles, some casual spectator has volunteered to point out to us the bill and feathers of the future bird!

We may smile at the extravagance of these ideas, and wonder how fancy could have devised such tales. But the wildest stretch of imagination could not venture upon anything more wonderful than the real and simple facts respecting the transformations of these animals.

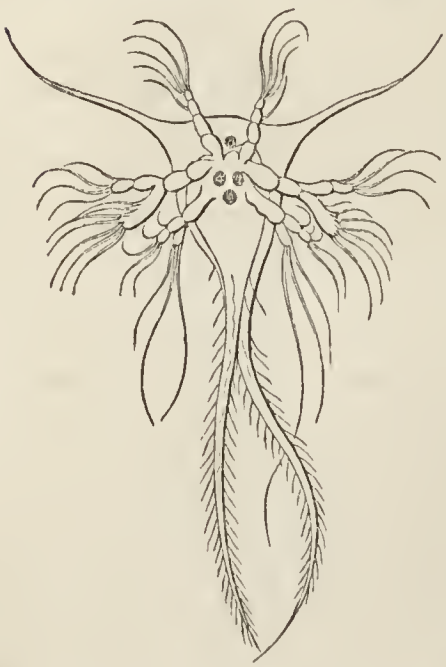

Fig. 44.—Young of Lepas.

Before the shelly covering of that Barnacle was secreted, the creature, not fastened as now by its fleshy pedicle, was free and locomotive, with members well adapted for swimming, and furnished, like the fabled Cyclops, with one central eye (*Fig.* 44). The animal of that acorn-shell, now fixed so immoveably upon the rock, had, at one time, an elliptic figure, two eyes mounted upon footstalks, and six pair of jointed legs, which, keeping stroke like so many oars, propelled it onwards (*Fig.* 45). At a certain period its erratic habits were laid aside, its future resting-place was selected, and then, attaching itself securely to the place thus chosen, its shelly covering was secreted, and as the process went on, the visual powers, no longer needful for the welfare of the animal, were extinguished for ever.

Fig. 45.—Young of Balanus.

To Mr. J. V. Thompson, whose name we have already had occasion to mention, we are indebted for the discovery of these metamorphoses, which the researches of other observers

have amply confirmed.* Mr. Thompson, in the spring of 1826, took, in a small towing-net, a number of minute translucent creatures about the tenth of an inch in length, and of a somewhat brownish tint.† They were taken on the first of May, and kept alive in a glass of sea-water. They appeared like small crustacea. On the night of the eighth, two of them had thrown off their outer skin, and were firmly attached to the bottom of the vessel, when they rapidly assumed the apparel of the sessile Barnacles or acorn-shells (*Balanus pusillus*).

The pedunculated barnacles, or those with the long pedicle, present, in their young state, an appearance very dissimilar; but, in all essential particulars, the change from their transitory swimming condition to their permanently adhesive state is precisely similar. In their perfect state (*Figs.* 42, 43) they are described by Mr. Owen as being "symmetrical animals, with a soft unarticulated body enveloped in a membrane. They are provided with six pair of rudimentary feet, obscurely divided into three joints, and terminated each by a pair of long and slender, many-jointed, ciliated tentacles, curled towards the mouth, and thence giving origin to the name of the class" (*Cirripeda*, curl-footed).‡

The acorn-shell is based on a deposit of calcareous matter, and has a shell composed of many pieces, and thus capable of enlargement according to the wants of the animal. It was formerly classed with the Barnacle among the Multivalve shells, the contained animals being regarded as Mollusca, or, to use a more common phrase, as "shell-fish." Their structure and their changes being now better understood, they constitute, of themselves, a small but interesting class, allied to that of the crustaceous animals, which constitute the next division. The sexes have been ascertained to be distinct.§

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

* Vid. ante, page 46.

† Zoological Researches, Memoir iv. page 78, plate ix.

‡ Lectures, page 155.

§ H. D. Goodsir, in Edinburgh Philosophical Journal, July, 1843.

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 (*Balanus, Fig.* 46) 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.

Fig. 46.
BALANUS.

CLASS III.—CRUSTACEA.

CRABS, LOBSTERS, SHRIMPS, &c.

——"What is man,
If his chief good, and market of his time,
Be but to sleep and feed? A beast—no more.
Sure He that made us with such large discourse,
Looking before and after, gave us not
That capability and godlike reason
To fust in us unused."—SHAKSPEARE.

"THE name of this class," says Professor Owen, "refers to the modification of the external tegument by which it acquires due hardness for protecting the rock-dwelling marine species from the concussion of the surrounding elements, from the attacks of enemies, and likewise for forming the levers and points of resistance in the act of supporting the body, and

moving along the firm ground. In the Crab and Lobster tribes, the external layer of the integument is hardened by the addition of earthy particles, consisting of the carbonate, with a small proportion of the phosphate, of lime."* In the smaller species it is more flexible, resembling the texture of horn or parchment.

Distribution.—The Crustacea are universally diffused, not only throughout the ocean, but through ponds, lakes, ditches, and running waters. In the polar seas they are found in great abundance, though the number of species is very limited. In the equatorial regions, while they are no less numerous, they present a greater diversity of form, attain a larger size, and exhibit, in the highest perfection, those peculiarities of structure by which the several groups are characterised. But though "the world of waters is their home," they are not confined within its boundaries, for there are some species which are occasional visiters to the land, and others which make it their permanent residence.

Form.—Their figures, when most faithfully delineated, present a variety of form so great that at first sight they seem in some cases to be the offspring of a fantastic fancy, rather than the correct delineation of living animals. We find legs so formed as to do the work of jaws (*Fig.* 56—60); others so constituted as to perform the function of gills; while some are so long and so slender that, were we to judge merely from appearance, they would seem quite disproportioned to the size of the body to which they are appended.

Characteristics.—As, in the radiated animals, we found the radiated structure most apparent towards what may be considered the centre of the group, so here we may point to the Crustacea as examples of the complete development of the jointed or articulated structure. In them we find the respiratory apparatus existing as branchiæ or gills, however varied its position or arrangement. The sexes are distinct, and all the individuals are free and locomotive. "It is the combination of branchiæ with jointed limbs and distinct sexes which constitute the essential characters of the class Crustacea."*

Integument.—As the integument is inelastic, and does not admit of enlargement to suit the growth of the animal, a

* Lectures, page 163.

beautiful provision exists, by which it is from time to time thrown off, and its place supplied by one of larger dimensions. In two or three days, the new covering assumes the hardness of the old one; and, until then, the animal, as if conscious of its defenceless state, avoids, as much as possible, all exposure. We shall revert to this subject in treating of the best known native species.

Reproduction.—All of them possess the capability of reproducing extremities which are injured. Thus, if the leg of a crab be fractured, it throws off the injured limb, near to the body. "It has the power of doing so apparently for two purposes,—to save the excessive flow of blood which always takes place at the first wound, and to lay bare the organ which is to reproduce the future limb.* As soon as the injured limb has been thrown off, the bleeding stops; but if the animal is unable, from weakness or any other cause, to effect this, "the result is fatal. The growth of the new limb is slow, until after the period of the next moult, when it rapidly assumes its full proportions."

Respiration.—Every one who has opened the "shell" of the common Crab has noticed a number of leaf-like organs, regularly arranged in two parcels, with the points of the little leaves or plates in each parcel brought nearly together (*Fig.* 47). These are the branchiæ or gills, organs admirably adapted to the aquatic life of the animal. In the Lobster, the arrangement of the parts is different (*Fig.* 48), being accommodated to the different form of the body, but providing no less effectually for the æration of the circulating fluid. In other Crustacea, the gills are formed like feathery tufts, and float freely in the water (*Fig.* 49); while, in one

Fig. 49.—SQUILLA.

* H. D. S. Goodsir on "the Mode of Reproduction of Lost Parts in the Crustacea." Anatomical and Pathological Observations. Edinburgh, 1845.

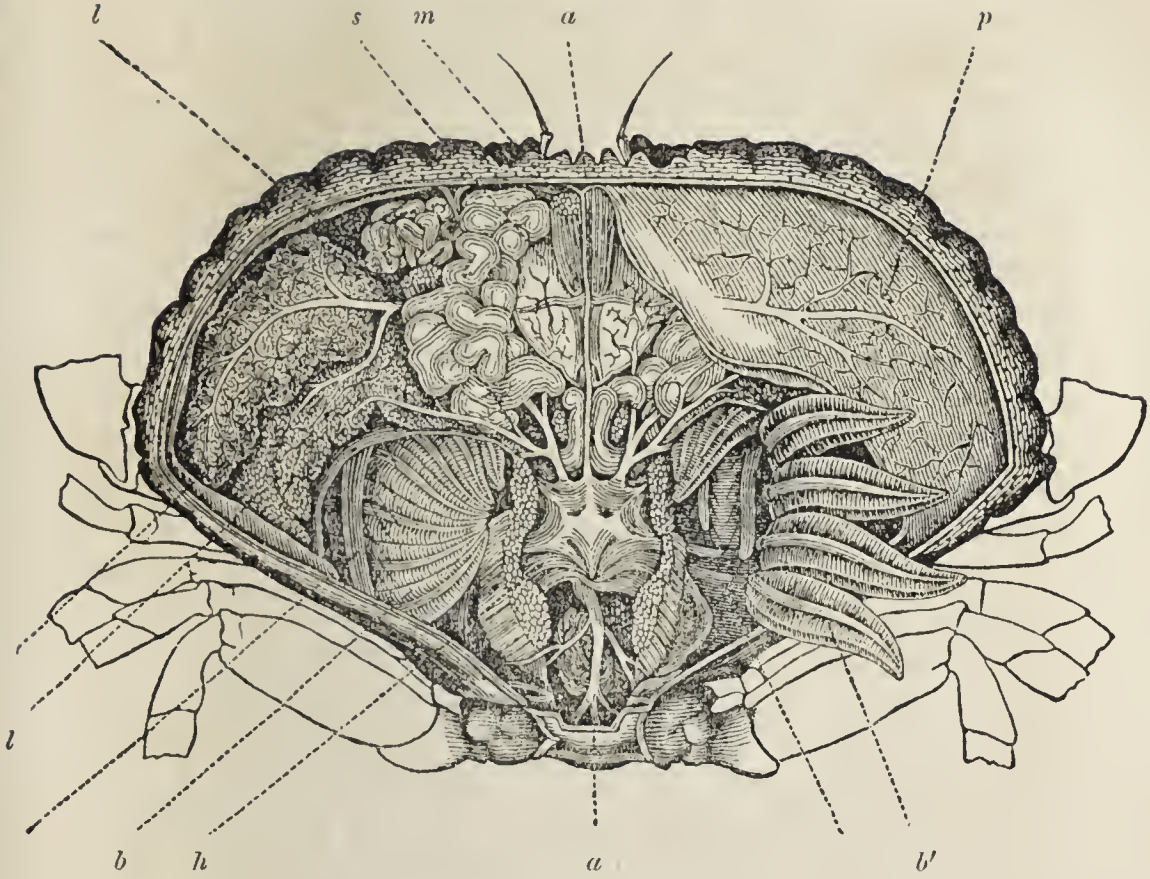

Fig. 47.—Anatomy of Crab.

Fig. 47.—*p*, Part of the lining membrane of the shell.—*h*, The heart.—*a*, Arteries.—*b*, Branchiæ in their natural position.—*b'*, Branchiæ turned back to show their vessels.—*s*, Stomach.—*m*, Muscles of stomach.—*l*, Liver.

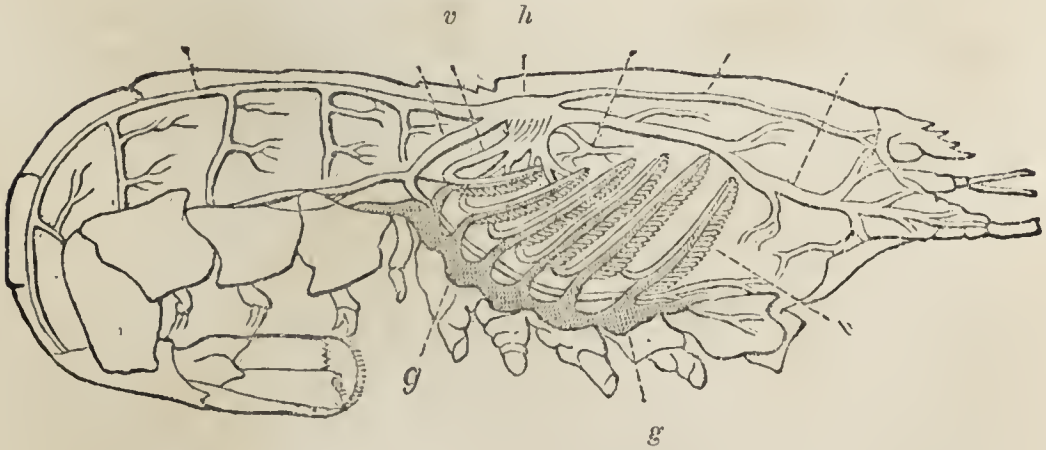

Fig. 48.—Circulatory Apparatus of Lobster.

Fig. 48.—*h*, Heart.—*g*, *g*, Sinus or dilated vein receiving the blood which comes from different parts of the body, and is thence sent to the branchiæ *b*, from which it returns to the heart by the branchial veins, *v*.

division, termed, from the circumstances, "gill-footed,"* the surface of the legs is extended, and made subservient to respiration. From this cause, in the minute tribes in which this structure prevails, the feet are sometimes seen in motion when the body is at rest. The more actively the body moves, the more brisk will be the circulation; "and since," as Mr. Owen remarks, "the muscular energy directly depends upon the amount of respiration, the two functions are brought into direct relation with each other by the simple connexion of their respective instruments."†

In those tribes that live partially or altogether on the land, the respiratory apparatus is modified, but is still, in its most essential features, aquatic. In the Wood-louse (*Oniscus*,‡ *Fig.* 50), which lives in dark and damp situations, respiration is effected by a series of plates, at the lower side of the abdomen.§ In the Land-crabs, contrivances of different kinds exist, to retain so much water as will supply the gills with the amount of moisture needful for the due performance of their functions. But the quantity of oxygen which water only can furnish is insufficient for animals whose respiration is so active. They must have access to air, or they inevitably perish. Hence we are able to understand why it is that they are drowned, if immersed for any long time in water.

Fig. 50.—Oniscus.

Vision.—In the eyes of the Crustacea a great diversity of structure is exhibited. Some species are furnished with two placed upon distinct peduncles or stalks; others have eyes of the same formation, but the peduncle is wanting; such eyes are therefore described as being "sessile" or sitting. In one

* Phyllopoda.

† Lectures, page 182.

‡ The *Oniscus* is well known, in the North of Ireland, by the provincial name of *Slater*.

§ Some of these animals have been found in a fossil state in Wiltshire, in those secondary rocks termed the Wealden formation. The eyes which, like those of the Trilobite, hereafter mentioned, are composed of a number of separate lenses, form beautiful objects when magnified. They are sometimes found not attached to the head, but loose in the limestone.—Fossil Insects in the Secondary Rocks of England, by the Rev. P. B. Brodie. London, 1845.

genus (*Daphnia*) a "smooth, undivided cornea protects and transmits the rays of light to an aggregation of small ocelli,"* or eye-specks; while in a fossil species (*Asaphus caudatus*, *Fig.* 51) we have an example of the cornea itself being divided into at least 400 compartments, each supporting a circular prominence, the whole being so arranged that where the distinct vision of one ceases, that of another begins.

Among the crustaceous animals now extinct, but whose remains are found in some parts of England and Ireland, and in other countries, is one tribe which, from the three longitudinal divisions of which the body is composed, is known by the name of *Trilobites* (*Figs.* 51, 52). In these fossils,

TRILOBITES.†

Fig. 51.

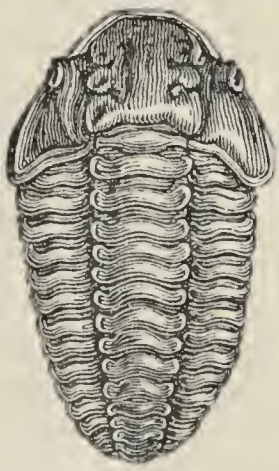

Fig. 52.

one of which has been mentioned in the preceding paragraph, the compound structure of the eyes is so well developed and preserved, that we are enabled to compare it with that of existing species. This circumstance has happily suggested to the Rev. Dr. Buckland a train of reasoning respecting "the condition of the ancient sea, and the ancient atmosphere, and the relations of both of these media to light," which furnishes so admirable an example of the manner in which knowledge in one department throws light upon researches in another, that we give the passage in full.

"With respect to the waters in which the Trilobites‡ maintained their existence throughout the entire period of the

* Owen, page 175.

† Fig. 51.—*Asaphus caudatus.* Fig. 52.—*Calymene blumenbachii.*

‡ Bridgewater Treatise, vol. i. page 401.

transition formation, we conclude that they could not have been that imaginary, turbid, and compound chaotic fluid, from the precipitates of which some geologists have supposed the materials of the surface of the earth to be derived; because the structure of the eyes of these animals is such, that any kind of fluid in which they could have been sufficient [for vision] at the bottom, must have been pure and transparent enough to allow the passage of light to organs of vision, the nature of which is so fully disclosed by the state of perfection in which they are preserved. With regard to the atmosphere, also, we infer that, had it differed materially from its actual condition, it might so far have affected the rays of light, that a corresponding difference from the eyes of existing Crustaceans would have been found in the organs on which the impressions of such rays were then received."

"Regarding light itself, also, we learn from the resemblance of these most ancient organizations to existing eyes, that the mutual relations of light to the eye, and of the eye to light, were the same at the time when Crustaceans, endowed with the faculty of vision, were first placed at the bottom of the primeval seas as at the present moment.

"Thus we find, among the earliest organic remains, an optical instrument of most curious construction, adapted to produce vision of a peculiar kind, in the then existing representatives of one great class in the articulated division of the animal kingdom. We do not find this instrument passing onwards, as it were, through a series of experimental changes, from more simple into more complex forms; it was created, at the very first, in the fulness of perfect adaptation to the uses and condition of the class of creatures to which the kind of eye has ever been, and is still, appropriate."

Ova.—All crustacea are produced from fertilized ova, which the female, after they have passed from the oviduct, continues to carry about with her until they have attained a certain amount of development. Various are the appendages employed for this purpose; perhaps no example will be more generally known than the one afforded by the common lobster when "in pea."

Metamorphoses.—The young do not, on their liberation from the ova, present a miniature resemblance to the species to which they belong. The contrary opinion was formerly entertained, and it was even regarded as one of the charac-

teristics of the higher crustacea, that they did not undergo a metamorphosis. It will not be uninstructive to advert briefly to the observations, which have led to more correct ideas on this subject.

In a Dutch work, published in 1778, there appeared the figure of a small crustaceous animal (*Fig.* 53), unlike any previously known. A French naturalist took another in the Atlantic, five or six hundred leagues from the coast of France, and included both under the generic appellation of *Zoea*. A third was taken in the course of Captain Tuckey's voyage to the Congo, and two were observed by Mr. J. V. Thompson when returning, in 1816, from the Mauritius. All the five specimens were those of distinct species, and constituted the only examples known of these crustacea until the spring of 1822. In that year, Mr. J. V. Thompson, to his great surprise, met with *Zoeas* in considerable abundance in the Cove of Cork. Further research showed that these animals, which had been regarded as so rare that the capture of each was recorded as an event, were to be found in vast profusion in our bays and estuaries; and instead of being perfect and anomalous creatures, were but the immature state of the common crabs!

Fig. 53. Zoea (Magnified).

The observations of Mr. Thompson, amply corroborated by those of other naturalists, have established the fact, that the crustacea undergo metamorphoses; but to what extent this takes place in the several tribes, we are as yet unable to determine. Here is an ample field for inquiry, in which the careful accumulation of facts, and even the collecting of specimens, may render good service to the cause of science.

The young state of the crabs, that to which the term *Zoea* was formerly applied, exhibits, so far as known, a different appearance in each species. The one in which our readers will be most interested is the common edible crab (*Cancer pagurus*), and those who have only seen the animal in its mature condition will perhaps be surprised to learn that it existed at one time under the form repre-

sented in *Fig.* 54, its members being adapted for swimming, and its body so minute that its natural size, when in that state, is shown by the speck adjoining the letter *n*.

Fig. 54.—Young of the Common Crab.*

Land-crabs.—In the limited space to which, in a work of this kind, we are necessarily restricted, it is only our intention to notice the habits of a small number of our native species; but the land-crabs of foreign countries constitute a group too remarkable to be altogether omitted. Of the genus Thelphusa† (*Fig.* 55), one fresh-water species, a native of the rivers of southern Europe, was well known to the ancients, who often represented it on their medals. Colonel Sykes states, that another species is found in the valleys along the Ghāts in India, and also on the most elevated table-lands.‡ They are there not only numerous but troublesome, intruding themselves into the tents, and even invading such beds as are placed on the ground. He also informs us, that the table-land of the elevated hill-fortress Hurreechundurghur, 3900 feet above the sea, is inhabited by such multitudes of land-crabs that their burrows render

Fig. 55.—Thelphusa.

* The figures 53, 54, and the information by which they are accompanied, are taken from "Zoological Researches," by J. V. Thompson. A Zoea, different from any of the species noticed by that author, is described by Templeton, in the Trans. of the Entomological Society, vol. ii. p. 114. It was taken by us in Larne Lough, County Antrim, in May, 1835.

† Carpenter's Zoology, vol. ii. page 250. *Vide*, also, Milne Edwards' "Histoire des Crustaces," tome ii. page 10.

‡ Trans. Entomological Society, vol. i. page 182.

it unsafe to ride over many parts of the mountain. From his own observation, and from the concurrent testimony of the natives, he is of opinion that these Crabs do not migrate. Another Indian species is thus noticed in the Journal of Bishop Heber. "All the grass through the Deccan usually swarms with a small Land-crab, which burrows in the ground, and runs with considerable swiftness, even when encumbered with a bundle of food almost as big as itself; this food is grass, or the green stalks of rice, and it is amusing to see the Crabs sitting, as it were, upright, to cut their hay with their sharp pincers, then waddling off with their sheaf to their holes as quickly as their sidelong pace will carry them." The Land-crabs of the Antilles* have long been celebrated for their nocturnal and burrowing habits, and for the determination evinced, by some species, to take the most direct line to the coast, when the period of visiting the sea, for the purpose of depositing their eggs, has arrived.

Classification.—Among the numerous tribes of Crustacea, it is to be expected that at considerable difference must exist as to the nature of their food, and a corresponding difference in the form of their mouths, and the structure of those organs by which the food is taken. Some are furnished with jaws or mandibles suited for mastication; others with a beak or tubular apparatus adapted for suction. This enables us at once to separate the class into two great divisions, the masticating and the suctorial. There is, however, a tropical genus, the Limulus or King-crab (*Fig.* 56), whose mouth has no peculiar appendages, but is surrounded by legs,

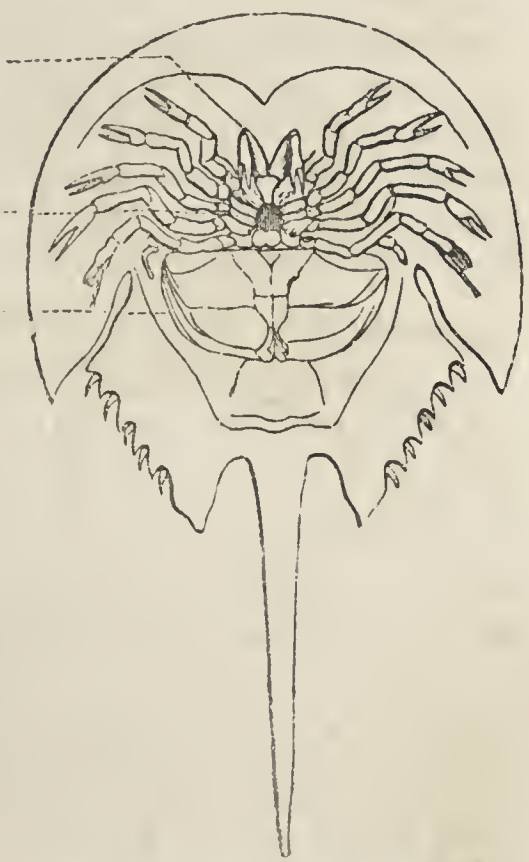

Fig. 56.—LIMULUS (REDUCED).

* *Gregarciniens.* Milne Edwards' Crustaces, vol. ii. page 18.

the bases of which perform the office of jaws; and for its reception a third division—*Xiphosura** has been specially constituted.

Reverting to our native species, we find some, as already mentioned (page 76), with the eyes on footstalks, others with the eyes sessile. This forms an excellent characteristic distinction. Again, some have the gills enclosed in the body, and have ten legs; others have the gills external, and the number of the legs or appendages variable. By such characters they are divided into sections, orders, sub-orders, genera, and species. All of those which are the best known and the most valued, are, with regard to their food, masticating (*Maxillosa*); have the eyes on footstalks (*Podopthalma*); and have ten legs (*Decapoda*).† These scientific terms, though startling to beginners, do nothing more than express, in a different form, the same meaning that the simple English words convey.

The animals composing the first group we shall mention among our native Crustacea, familiarly known as "Spider-crabs," from their length of legs. Mr. W. Thompson gives an instance of one of them (*Hyas aranea*) only two and a quarter inches across the "shell" which had an oyster three inches in diameter upon his back, and remarks that the Crab must have enacted the part of Atlas for some successive years, as the oyster was encrusted with large acorn-shells, and could not have been less than five years old.‡ A series of such observations would

* Sword-tailed. Figure 56 represents the lower surface of the animal. *m*, The mouth.—*f*, Feet, the bases of which perform the office of jaws.—*a*, Abdominal appendages bearing the branchiæ.—*t*, Sword-shaped tail.

† In the ten-footed Crustacea (*Decapoda*), there is a striking difference in the form and development of the tail, as in the Crab and in the Lobster; and they are thus divided into two very natural groups. The Hermit-crabs, in which the tail is prolonged, but defenceless, may be regarded as a connecting link. Hence, Milne Edwards, in his excellent "Histoire des Crustaces," arranges them in three sections, distinguished by terms expressive of these peculiarities of structure. Thus:—

DECAPODA.

1st section, *Brachyura*, or short-tailed, as the Crabs.
2d ,, *Anomoura*, or irregular-tailed, as Hermit-crabs.
3d ,, *Macroura*, or long-tailed, as the Lobster, Cray-fish, &c.

‡ The information given in this page, and acknowledged elsewhere, by the initials, W. T. is derived almost exclusively from a paper on "the Crustacea of Ireland, order Decapoda," by William Thompson, Esq.; President Nat. Hist. Society, Belfast, published in Annals Nat. Hist. vols. x. xi. 1842–3; and we have not scrupled, on many occasions, to avail ourselves of the language there employed.

help us to a solution of the question, "what is the longevity of different species of Crustacea?" one which, at present, we are quite unable to answer. Those who wish to obtain specimens of the Spider-crabs, without going out to dredge for that purpose, will occasionally find them along with shells, Star-fishes, &c. in the stomachs of the Cod and the Haddock.

The Crabs used as food are, of course, those which are most valued and sought after. The large edible Crab is that which in the North of Ireland is known as *the* Crab (*Cancer pagurus*, *Leach*, *Fig.* 57). It is distributed round all our coasts, and is generally taken by wicker-baskets, like the cage-shaped wire mouse-traps, and baited with guts of fish, or other garbage; but it is also taken by means of a piece of hooked iron thrust into its retreats at low water. M. Edwards mentions that, on the French coast, their weight sometimes exceeded 5 lbs.; at Falmouth it has reached 14 lbs. In the London market they very commonly weigh 9 lbs.; and some equally large have been taken on the Irish coast. The smaller edible Crab of British authors (*Carcinus mænas*) is the most common species round the entire coasts of Great Britain and Ireland, lurking beneath stones or tangle, or half concealed in the moist sand. It appears to be very tenacious of life. Some which were buried in a garden to the depth of twelve or fourteen inches, with a little sea-weed placed between them and the soil, were found alive at the end of seventeen days; and one individual evinced his customary promptitude in the use of his nippers.

Fig. 57.—Cancer Pagurus.

We learn from Leach* that this species "is sent to London in immense quantities, and eaten by the poor, who esteem it a great delicacy;" and M. Edwards observes it is used in like manner in Paris. It is never offered for sale in the markets

* Malacostraca Podopthalmata Britanniæ, Table 5.

of the North of Ireland, nor, as far as we know, is it ever employed there as an article of food. Mr. R. Ball states,* that when these Crabs are about to change their shells, or have recently done so, they are sought for under the sea-weeds, at low tide, by the fishermen at Youghal, chiefly as bait for flat-fish. In this soft state they are called *Pilcrabs*. From their habits of elevating their claws in a threatening attitude, when molested, they have, on the coast of Normandy, the name of "Crâbes enragés."

The Pea-crabs form an interesting group, from their diminutive size, and their singular habitation in bivalve shells, one of which was celebrated in connexion with the Crab; as,

"The anchored Pinna and her cancer friend."

The Pinna, according to tradition, being warned of the approach of danger by the alacrity of the little Crab, who was the joint and friendly occupant of her mansion. One species (*Pinnotheres pisum*) is so common on the Irish coast, that Mr. W. Thompson obtained fourteen of them, by opening eighteen of the large or "horse-mussel," dredged off the County Down shore; and in the common Cockle at Youghal, Mr. Ball found them so abundantly, that about nine out of every ten cockles contained a Crab. Two and even three Crabs are occasionally found in one mussel, or one pinna.

The Hermit-crabs belong to a different order. The tail is prolonged and soft, being destitute of the hard calcareous covering which protects the anterior portion of the body; and hence, in self-defence, the animal is obliged to occupy some univalve shell, which has been deserted by its original occupant. From the fact of each Crab being thus the solitary inmate of its retreat, the common English name has no doubt been bestowed. The species most abundant on our coast (*Pagarus Bernhardus*) is found in shells of very different dimensions, and from time to time leaves its abode, as it feels a necessity for a more commodious dwelling. It is said to present, on such occasions, an amusing spectacle, as it inserts the tail successively into several empty shells, until one is found to fit.† We learn from Professor Bell, however, that

* In Mr. W. Thompson's Paper.
† Carpenter's Zoology, page 252.

it does not always wait until the house is vacant, but occacasionally ejects the rightful occupant *vi et armis*.*

In the Crustacea of the next order, the tail is not only longer but is different in form, being divided into five broad

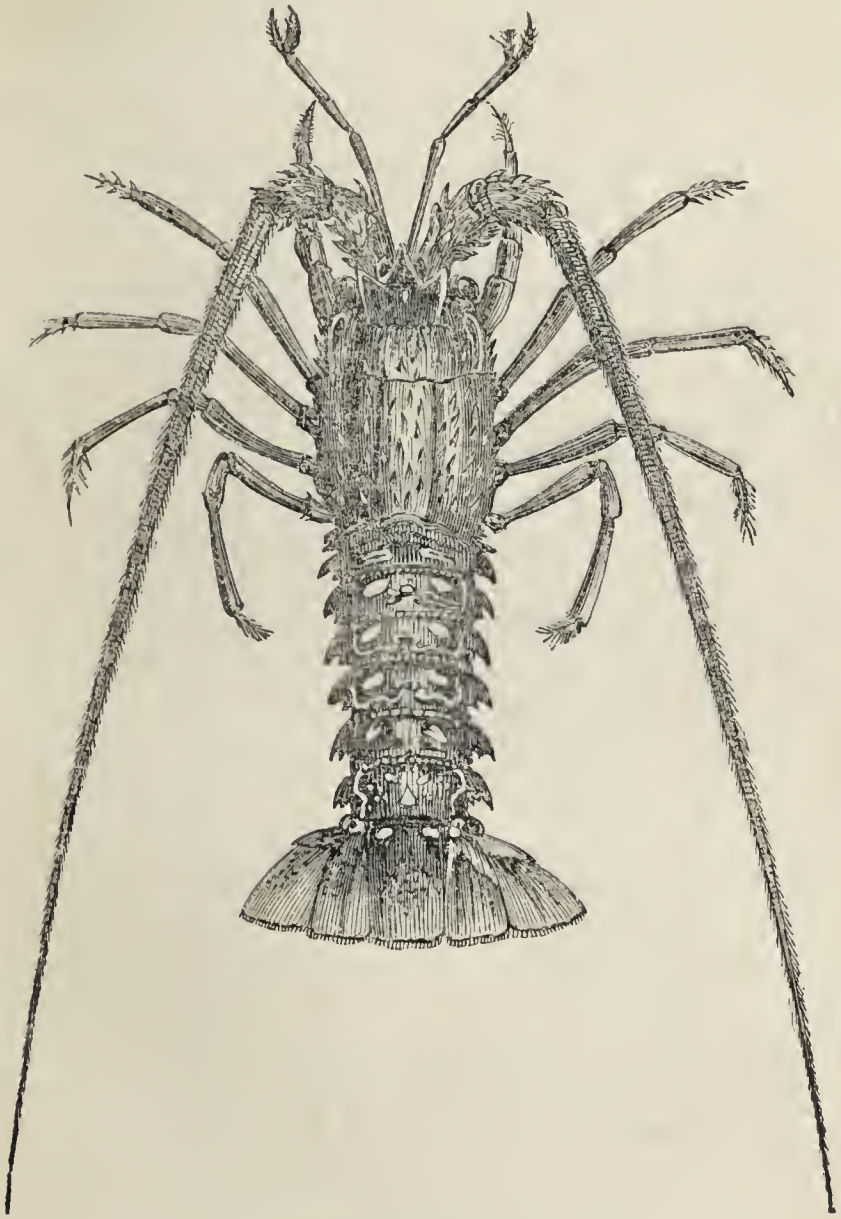

Fig. 58.—Spiny Lobster (reduced).

flat pieces, so as to act with great effect upon the water. The common Lobster (*Homarus vulgaris*) is perhaps the best

* History of British Crustacea, page 173; published by Van Voorst.

known example; it is taken all round the rocky portions of the coast. So much is it valued, that the finest flounders and plaice are, in some places, cut up to furnish the most tempting bait for the Lobster-pots.* Another species, the Spiny Lobster (*Palinurus vulgaris*, *Fig.* 58), attains even larger dimensions, being occasionally taken of eighteen or twenty inches in length, and weighing so much as twelve or fifteen pounds.* It frequents deep water, and only approaches the shores in spring, for the purpose of laying its eggs.

The Cray-fish (*Fig.* 59) inhabits rivers in many parts of

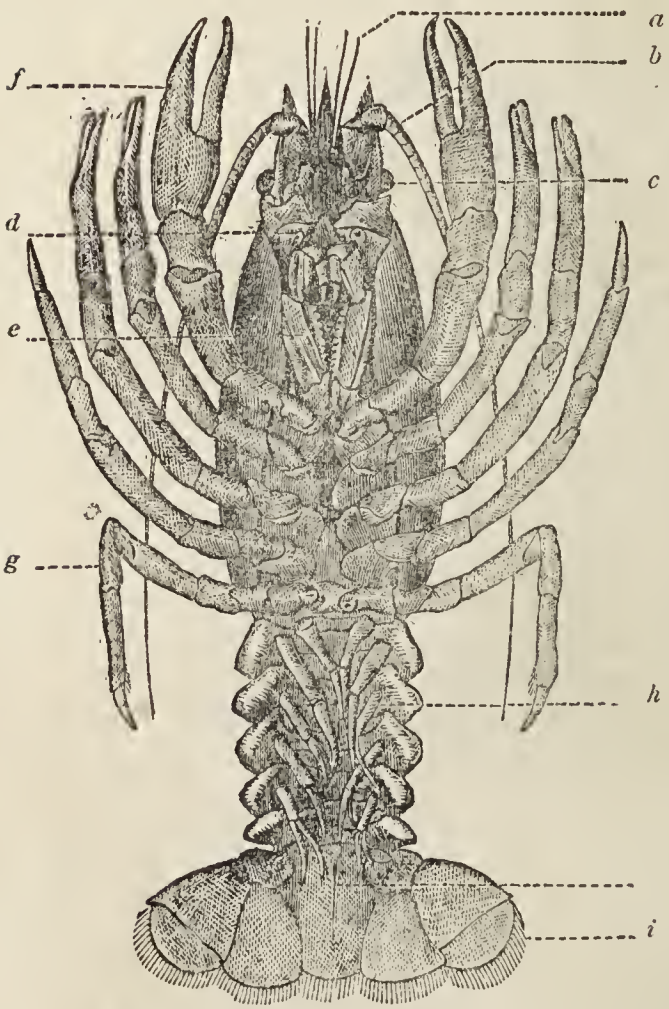

Fig. 59.—Cray-fish (reduced).†

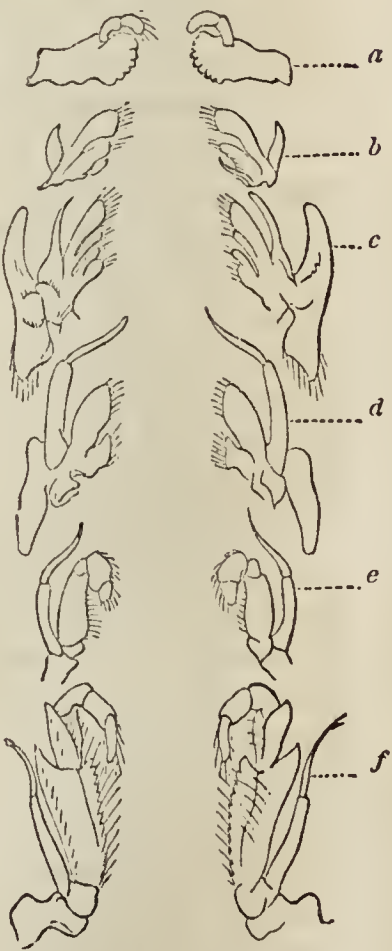

Fig. 60.—Masticating apparatus.‡

* W. T.

† Fig. 59.—Exhibits the lower side of the Cray-fish. *a* and *b*, Antennæ.—*c*, Eyes.—*d*, Auditory tubercle or organ of hearing.—*e*, External feet-jaws.—*f*, First pair of thoracic legs.—*g*, Fifth pair.—*h*, Abdominal false legs.—*i*, Tail formed for swimming.

‡ Fig. 60.—Shows, in their detached state, the six pair of appendages which constitute the apparatus for mastication. *a*, Mandibles.—*b* and *c*, First and second pair of jaws or maxillæ.—*d*, *e*, *f*, Three pair of feet-jaws.

Ireland, but is generally stated to have been introduced. It is said to be possessed of great longevity: M. Edwards asserts, that it lives for more than twenty years, and continues to grow during that entire period.* It is the office of the males to cater for the female and young; and a very intelligent observer states, that he has frequently seen them catching and breaking up small fish as their food.† On being disturbed, both sexes gather the young under their tails; but a singular difference prevails between the sexes, with regard to the manner of protecting their progeny. The male, on being lifted, retains them under his tail; but the female, on being captured, wiser than her lord, "slaps" them into the water with such force, as to produce the effect of a shower of rain upon the surface.

The cast-off shell of many of the Crustacea preserves its former appearance so completely as to exhibit the form of the animal, and even its most minute appendages. This we have not been so fortunate as to observe, but it is fully confirmed by the following note from Mr. R. Ball, who adds, at the same time, some other particulars, illustrative of habits. "Some years ago, I kept a Cray-fish for a considerable time, in a shallow glass vessel, about twenty inches in diameter, and containing about two inches' depth of water. This animal gradually acquired great viciousness, and would eagerly attack the fingers of any one who chose to put them within his range, pursuing the intruding digits round the boundaries of his demesne. After he had been thus a year in my possession, I was one day surprised to see a second Cray-fish in the vessel; but on taking the intruder in my hand (believing it to have been placed in the vessel by a waggish relative), it proved to be the exuviæ of my old friend, so perfect as to present his exact counterpart. Instead of his usual boldness, he now exhibited the most remarkable timidity, which continued for three or four days. He was at first quite soft, and appeared considerably larger than usual, but gradually grew firmer, and on the fifth day felt to the touch as hard as usual, and advanced with open pincers to the attack of my finger, though evidently not without some little doubtfulness of his powers. Before the end of the week he was himself again, came on

* Histoire des Crustaces, tome ii. page 330.

† These notices of the Cray-fish are entirely extracted from Mr Thompson's article on the Crustacea, already referred to.

more boldly than ever, and with greater effect, as his weapons were sharper. He lived nearly two years with me, and during the whole time received no food excepting one or two worms."*

The Shrimp* (*Crangon vulgaris*) is common on the sandy shores, and adjacent saline marshes, from the north to the south of Ireland. About thirty years ago, it was regularly exposed for sale at Belfast, but the side of the bay on which it was taken has now become soft and oozy, and the Shrimps so small and scarce that they are no longer sought for.†

The Prawn (*Palæmon serratus*, *Fig.* 61), so common in

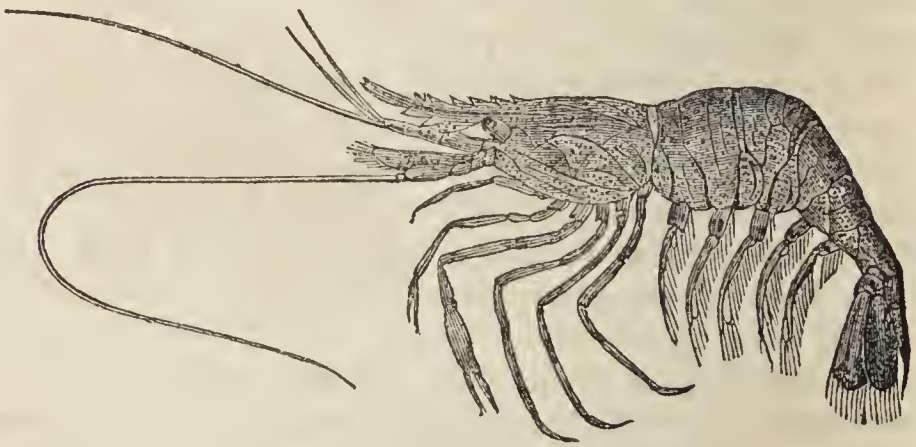

Fig. 61.—Prawn (reduced).

some of the English markets, is still taken abundantly in some localities in the south and west, but "a good dish of

* W. T.

† No apology is needed for introducing, in this place, the following beautiful passage from the writings of Archdeacon Paley.

"Walking by the sea-side, in a calm evening, upon a sandy shore, and with an ebbing tide, I have frequently remarked the appearance of a dark cloud, or rather very thick mist, hanging over the edge of the water, to the height, perhaps, of half a yard, and the breadth of two or three yards, stretching along the coast as far as the eye could reach, and always retiring with the water. When this cloud came to be examined, it proved to be nothing else than so much space filled with young "Shrimps," in the act of bounding into the air from the shallow margin of the water, or from the wet sand. If any motion of a minute animal could express delight, it was this:—if they had meant to make signs of their happiness, they could not have done it more intelligibly. Suppose then, what I have no doubt of, each individual of this number to be in a state of positive enjoyment, what a sum collectively, of gratification and pleasure, have we before our view!"

prawns," is a delicacy quite unknown along the north-eastern shores of Ireland.

It would be inconsistent with our limits to enter into detail respecting the smaller Crustacea, which present themselves to our notice under circumstances so different, and at times so unexpected, that they often excite some feelings of novelty or of interest.

Certain species we find in the deep water of our bays; others, like the little sand-hoppers (*Fig.* 62), on the moist margin of the strand; but there is, perhaps, no place that better repays our investigation than the beautiful little rock-pools, fringed with sea-weeds and corallines, and inhabited by multitudes of small Crustacea, which climb upon their branches, or enjoy themselves in the clear expanse of their waters. It is interesting to know the extraordinary fertility of these apparently insignificant creatures, whether living in such situations or in the ponds and ditches of our fields. "Jurine has, with great fidelity, watched the hatching and increase of one freshwater species (*Cyclops quadricornis*), and has given a calculation which shows its amazing fecundity. The female carries, on each side, a little packet of eggs, and he has seen her, when isolated, lay ten times successively; but, in order to be within bounds, he supposes her to lay eight times within three months, and each time only forty eggs. At the end of one year, this female would have been the progenitor of 4,442,189,120 young!"* This genus, from being furnished with one large compound eye, bears the classic name of Cyclops (*Fig.* 63); but its cannibalism is worse than that of the fabled

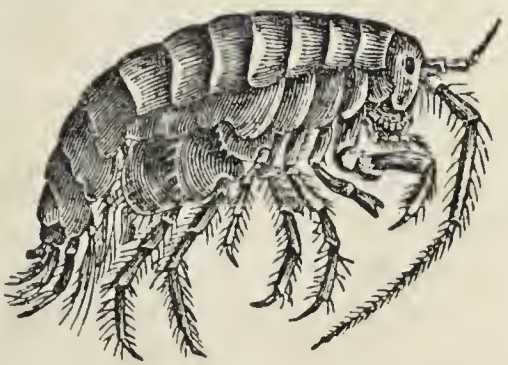

Fig. 62.—Talitrus (magnified).

Fig. 63.—Cyclops (magnified).

* From some excellent papers, entitled "The Natural History of the British Entomostraca, by William Baird, Surgeon," published in the Magazine of Zoology and Botany, 1837, vol. i. page 314.—It should, perhaps, be mentioned, that the female, when once fecundated, is so for life.

giant, for the mother has been seen to devour her own young. Jurine, while he admits the fact, urges, in vindication of his little favourites, that she does not do so from choice, but that the helpless young cannot resist the action of the whirlpool the mother causes around her, and are thus carried unconsciously into the old one's mouth.

Another one-eyed Crustacean deserves mention for the exhibition it affords of one of those striking instances of providential care which the little, no less than the great, experience from the Maker of all. In drains and ditches there is found in abundance a minute creature, which, from its branching horns (*antennæ*), and its peculiar movements, is called the arborescent water-flea (*Daphnia pulex*). It looks like a small crustaceous animal enclosed in a transparent bivalve shell. The eggs are developed in the space between the body of the animal and the shell. The Daphne continues its moultings even when full grown, but perishes with the cold of winter. Ere that season, however, comes on, two eggs are produced, enclosed in a horny case, and are thrown off with the shell. These float on the water, protected from injury by their peculiar covering, and from these the numerous progeny of the ensuing summer is derived. Nor is this all; the impregnated female is not only fertile for her own life, but conveys that fertility to her female offspring for five or six successive generations, whether they be derived from the ordinary eggs or from those enveloped in the horny covering.*

It is obvious, from the particulars we have stated, that the Crustacea afford matter for curious inquiry and patient investigation, whether sought for

> "By paved fountain or by rushy brook,
> Or on the beached margin of the sea."

But it will be exhibiting them in a different light, if we mention to our readers a species that attacks the works of man, and crumbles into dust the wood-work of his piles and floodgates, piers, or jetties, constructed in salt-water. It is the *Limnoria terebrans*,† a pigmy assailant, scarcely more than

* See note in preceding page.

† Kirby and Spence's Entomology, vol. i.; W. Thompson, in Edinburgh New Phil. Journal, January, 1835. Another species, *Chelura terebrans*, has been recorded as native by Dr. Allman, in Annals of Nat. Hist. June, 1847; and some further particulars are given by Mr. Thompson in the same periodical for Sept. 1847.

the one-eighth of an inch in size, but whose destructive powers have been manifested on many parts both of the British and Irish shores.

Some of the Crustacea possess luminous powers, and together with the minute Medusæ formerly mentioned (page 41), give to the sea the splendid phosphorescence described by mariners.

There is a singular race, which we have not yet mentioned —those which infest the skin, the eyes, and the gills of fishes, and other marine animals (*Fig.* 64). Like the Entozoa, they are parasites; but from they situation they occupy, not *in* but *upon* other animals, they are spoken of by some naturalists under the name Epizoa. They are crustaceous animals, undergoing transformations, and ere the brief period of their locomotive state is ended, selecting the situation to which they afterwards adhere. Each species is known as the parasite, not only of some one particular animal, but also of some one particular organ. Hence their number is perhaps greater than that of the whole class of fishes. The sexes are distinct, "The male appears always to retain his freedom, and is singularly smaller than the female, generally not more than a fifth part of her size."*

Fig. 64.—LERNÆA (MAGNIFIED).

We shall close this brief notice of the structure, classification, and habits of the Crustacea, by an extract from the Zoological Researches of Mr. J. V. Thompson. It occurs in his description of the opossum shrimp, a species found in "countless myriads" on some parts of our coast, and so named from a singular pouch, analogous to that of the opossum, in which the young are carried about. The spirit of this remark is, however, applicable to a wide range of objects.

"It is in looking closely into the structure of these little animals, that we see the PERFECTION of the Divine Artist. Nature's greater productions appear coarse, indeed, to these elaborate and highly-finished master-pieces; and in going higher and higher with our magnifiers, we still continue to bring new parts and touches into view. If, for instance, we

* Owen's Lectures, page 149, &c.

observe one of their members with the naked eye—which may be the utmost stretch of unassisted vision—with the microscope it first appears jointed, or composed of several pieces articulated together; employing a higher magnifier, it appears fringed with long hairs, which, on further scrutiny, gain a sensible diameter, and seem to be themselves fringed with hairs still more minute; many of these minute parts are evidently jointed and perform sensible motions; but what idea can we form of the various muscles which put all these parts in movement, of the nerves which actuate them, and the vessels which supply them with the nutriment essential to their growth and daily expenditure, all of which we know from analogy they must possess?"

Class IV.—INSECTA—INSECTS.

"The insect youth are on the wing,
Eager to taste the honied spring,
And float amid the liquid noon:
Some lightly o'er the current skim,
Some show their gaily-gilded trim,
Quick-glancing to the sun."—Gray.

"We now come to a class of Articulata in which," says Professor Owen, "the highest problem of animal mechanics is solved, and the entire body and its appendages can be lifted from the ground and be propelled through the air. The species which enjoy the swiftest mode of traversing space breathe the air directly; but their organs of respiration are peculiarly modified, in relation to their powers of locomotion."*

Fig. 65.—Scolopendra.

Note.—The total number of Irish insects at present known is about 3850. Vid. note by A. H. Haliday, Esq. appended to the report on the Fauna of Ireland, by William Thompson, Esq. Proceedings British Association, 1843.

* Lectures, page 192.

The body is deeply cut into segments, a peculiarity which explains the origin of the word insect.* In the lower tribes the segments of the body are numerous, and in some cases so many as sixty or eighty pairs of legs may be counted on one individual. From this circumstance the term "Myriapoda" has been applied to the Centipede (*Scolopendra*, *Fig.* 65), and others of similar organization (*Fig.* 37).

In the true insects, the body consists of three portions (*Fig.* 66); the head, with the "horns" or antennæ, and the organs of sensation; the thorax or chest, with the organs of

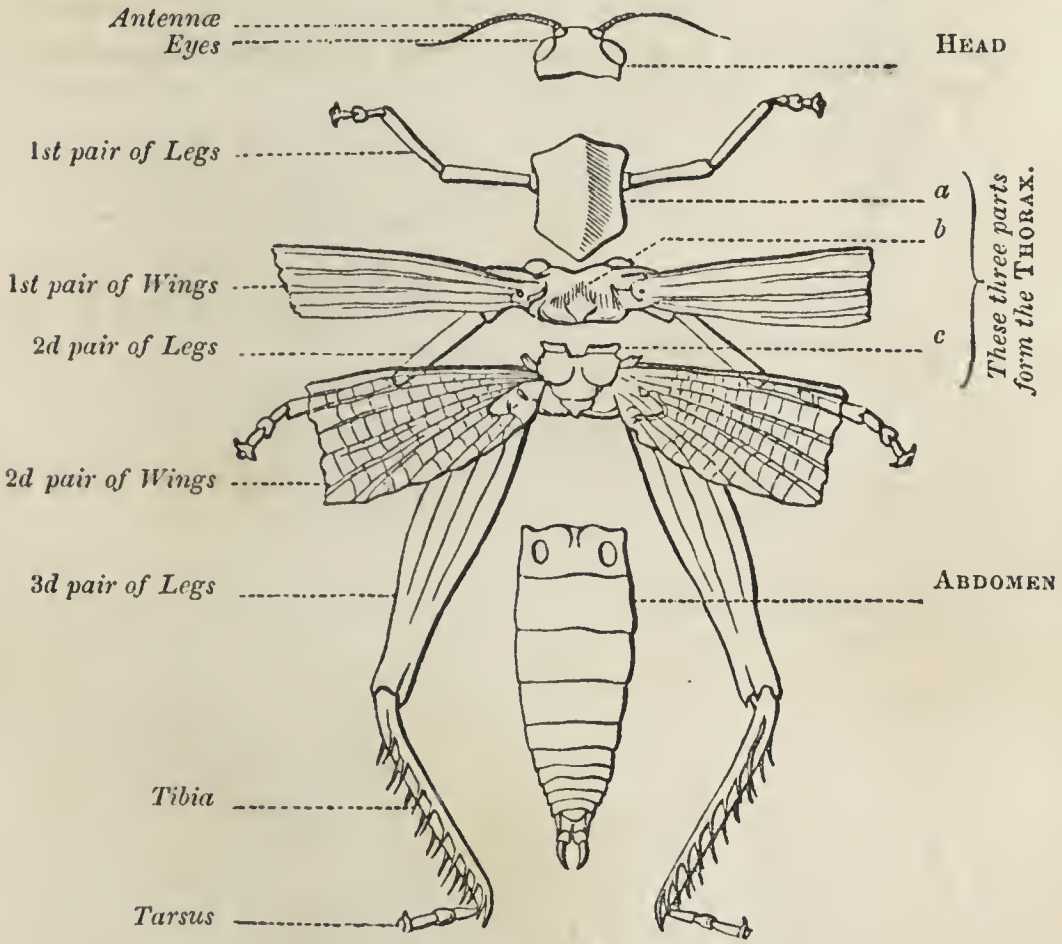

Fig. 66.—External Anatomy of an Insect.

locomotion, whether wings or legs; and the abdomen, including the organs needful for nutrition and reproduction.

The heart is an elongated muscular tube, situated along the middle of the back, and hence called the dorsal vessel. The circulating fluid is cold, transparent, and nearly colourless.† "The action of the heart is accelerated, as in other

* Latin, *insectus*, cut or notched.

† Westwood, Int. to Classification of Insects, page 15, vol. i.

animals, by muscular exertion and excitement; and Mr. Newport has counted as many as one hundred and forty-two pulsations in a minute in a species of wild Bee so excited."*

Respiration is effected by means of two great canals (tracheæ) running along the sides of the body, beneath the outer surface, and communicating with the atmosphere by means of numerous short tubes, terminating at or near the sides of the body in breathing pores (spiracles); internally the tracheæ divide into innumerable branches, conveying the air to every portion of the body, and thus pervading its organs and tissues. This structure will easily be understood by referring to the accompanying figures. The Water-Scorpion (*Nepa*, *Fig.* 67) is an insect common in fresh water; and the respiratory apparatus of the same insect, as it appears when highly magnified, is shown in *Fig.* 69.

Fig. 67.—Nepa.

"There is one circumstance connected with the tracheæ which is specially deserving of admiration, whether we consider the obvious design of the contrivance, or the remarkable beauty of the structure employed. It is evident that the sides of canals so slender and delicate as the tracheæ of insects would inevitably collapse and fall together, so as to obstruct the passage of the air they are designed to convey; and the only plan which would seem calculated to obviate this would appear to be to make their walls stiff and inflexible. Inflexibility and stiffness, however, would never do in this case, where the vessels in question have to be distributed, in countless ramifications, through so many soft and distensible viscera; and the problem therefore, is, how to maintain them permanently open, in spite of external pressure, and still maintain the perfect pliancy and softness of their walls. The mode in which this is effected is as follows:—Between the two thin layers of which each air vessel consists, an elastic spiral thread (*Fig.* 68)

Fig. 68.—Air-tube of Insect.

* Owen's Lectures, page 223.

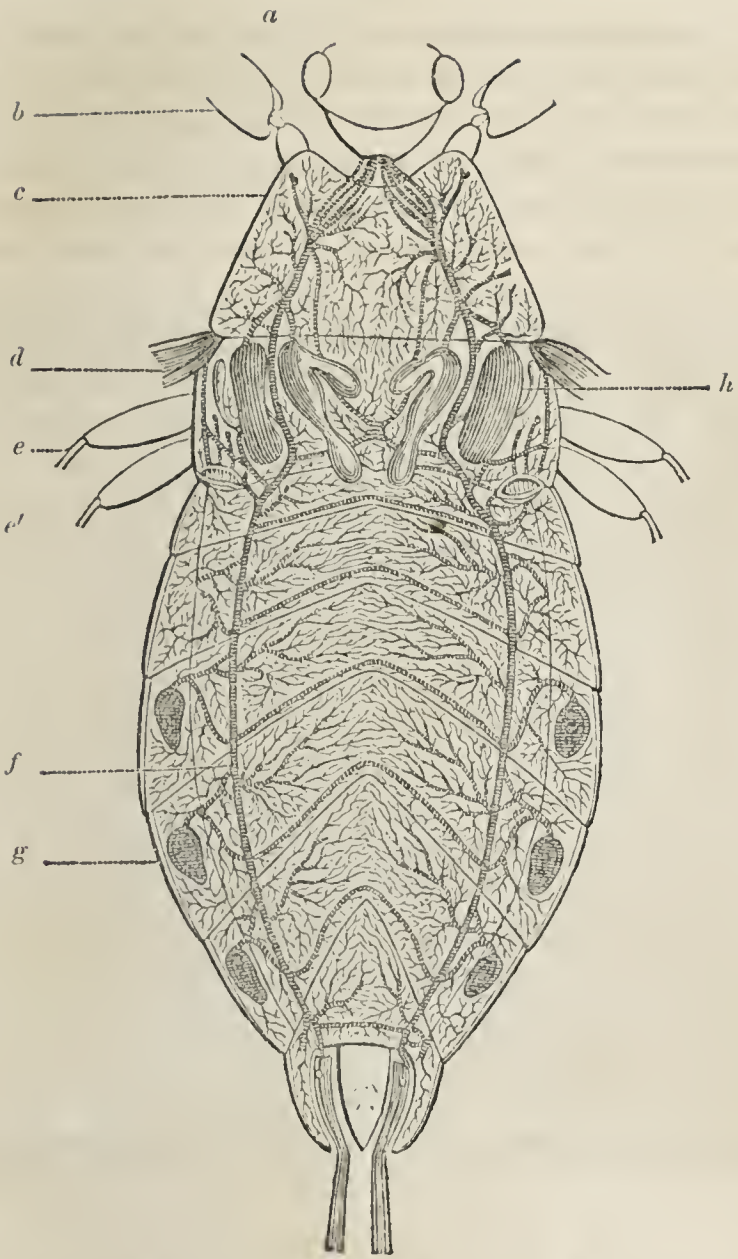

Fig. 69.—Respiratory System in Nepa (magnified).

is interposed, so as to form, by its revolutions, a firm cylinder of sufficient strength to insure the calibre of the vessel from being diminished, but not at all interfering with its flexibility or obstructing its movements; and this fibre, delicate as it is, may be traced with the microscope even through the utmost ramifications of the tracheæ, a character whereby these tubes may be readily distinguished."*

Fig. 69.—*a*, Head.—*b*, First pair of legs.—*c*, First segment of thorax.—*d*, Base of wings.—*e*, Second pair of legs.—*e'*, third pair of legs.—*f*, Tracheæ.—*g*, Stigmata or spiracles.—*h*, Air sacs.

* Outline of the Animal Kingdom, by Professor Rymer Jones, p. 266.

It is unnecessary here to dwell on the nervous system of insects; their general character is given in that of the class (page 57). In different families of insects, the ganglions, or nervous centres, whence nerves are sent to the several organs, are different in their number, and in the amount of concentration which they present (*Fig.* 70); and, as might

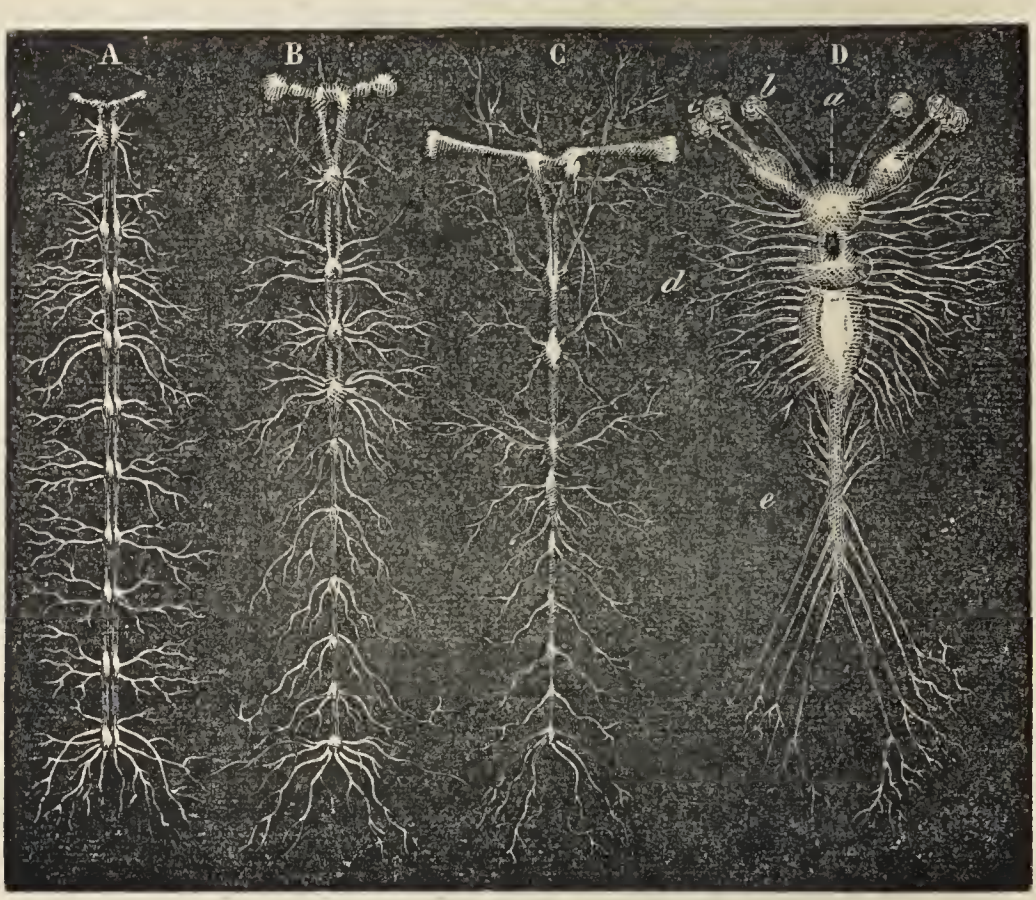

Fig. 70.—Nervous System of Insects.

naturally be expected, they undergo modifications, according to the changing form and powers of the same insect, in its different stages of development.

With regard to the external senses, insects differ from the higher animals in the possession of two processes appended to the head, and which, in the Butterfly, resemble delicate horns terminated by a knob. The entomologist* calls them *antennæ;*

Fig. 70.—A, Nervous system of an Ear-wig.—B, Of a Grasshopper.—C, Of a Stag-beetle.—D, Of a Field-bug (*Pentatoma*).—*a*, Brain.—*b*, *c*, The Optic nerves.—*d*, Thoracic ganglions.—*e*, Abdominal ganglions.

* Entomology is that department of Natural History which treats of insects.

the less scientific observers, horns, or feelers; and the latter term shows that they are applied to external objects in such a manner as to indicate that they are organs of touch. There is also reason to believe they are to some extent organs of hearing; but great doubt yet exists as to the precise extent and nature of their functions. They are very diversified in their form and structure, and vary not only in different genera, but often in the males and females of the same species.

That insects have the sense of touch and of taste, is generally conceded; and that of smell they have been supposed to possess in such perfection, that one of our most popular poets has asserted that Bees return to their hives by retracing

"The varied scents which charmed them as they flew."*

While we dissent from this poetical theory, we would by no means deny the powerful influence which certain odours exert in repelling or attracting these creatures. Of this Mr. Knapp gives an instance, in speaking of one of the Beetles, which from their habits are called "Dung-chafers." One or two only of the common Dor or blind Beetle (*Geotrupes stercorarius*) are usually seen at the same time. But, on one evening, such numbers of these insects were passing, as to constitute a little stream. This naturally excited his attention; and "I was led," he continues, "to search into the object of their direct flight, as in general it is irregular and seemingly inquisitive. I soon found that they dropped on some recent nuisance; but what powers of perception must these creatures possess, drawn from all distances and directions, by the very little fætor which in such a calm evening could be diffused around! and by what inconceivable means could odours reach this Beetle, so as to rouse so inert an insect into action! but it is appointed one of the great scavengers of the earth, and marvellously endowed with powers of sensation and means of effecting the purpose of its being."†

The sense of hearing was formerly denied to insects, even by naturalists so distinguished as Linnæus and Bonnet. Shakspeare entertained a different and more correct opinion, when he used the words,—

"I will tell it softly;
You Crickets shall not hear me."

* Rogers, "Pleasures of Memory."

† Journal of a Naturalist, 3d edition, page 319.

On this point the observations of Brunelli, an Italian naturalist, are quite conclusive. Several of the field Crickets which he kept in a chamber, "continued their crinking song through the whole day; but the moment they heard a knock at the door they were silent. He subsequently invented a method of imitating their sounds, and when he did so outside the door, at first a few would venture on a soft whisper, and by-and-by the whole party burst out in a chorus to answer him; but upon repeating the rap at the door, they instantly stopped again, as if alarmed. He likewise confined a male in one side of his garden, while he put a female in the other at liberty, which began to leap so soon as she heard the crink of the male, and immediately came to him—an experiment which he frequently repeated with the same result."*

There are some insects in which no organs of vision have been discovered; but in general they are not only very obvious, but present considerable variety in colour, form, position, and structure.† They are generally sessile; and when, to give them a wider range, they are fixed, like those of many crustacea, on peduncles, those stalks are not moveable. The most usual number of eyes is two; but when it is needful that the insect should, at the same time, have the power of observing objects in the air and in the water, it is gifted with four eyes, as in the common Whirl-gig (*Gyrinus natator*, *Fig.* 71), which may be seen performing its rapid evolutions on our ponds and streamlets. The eyes are sometimes simple, sometimes a number of simple eyes are collected together, and are then called conglomerate; but the most common kind is that which is termed compound. Such eyes, when seen under the microscope, appear to consist of an infinite number of convex hexagonal pieces. When separated and made clean, they are as transparent as crystal. Their number is extremely variable, and cannot but strike the most indifferent with astonishment. "What would be thought of a quadruped whose head, with the exception of the mouth and place of juncture with the neck, was covered by two enormous masses of eyes, numbering upwards of 12,000 in each mass? Yet such is the condition of the organs of vision in the Dragon-fly."

Fig. 71.—Gyrinus.

* Insect Miscellanies, page 77.

† Kirby and Spence's Introduction to Entomology, vol. iii.

In the common Bee the same structure is not less apparent. The fiery eyes of many Gad-flies (*Tabani*, *Fig.* 72), which present vivid bands of purple and green, are composed of similar lenses, and each eye contains nearly seven thousand.* The Ant has 50 lenses; the House-fly 4,000; while above 17,000 have been counted in the eye of a Butterfly, and more than 25,000 in that of a species of Beetle.†

Fig. 72.—Tabanus.

It is impossible to read the simple facts which science thus makes known, and not be struck with the complexity of structure shown in those diminutive creatures, considered with regard to only one of their senses and its manifold functions. Nor can we hesitate for a moment to attribute to the beneficence of our common Creator the compensating contrivances by which the want of motion

Fig. 73.—Pyralis of the Vine.

Fig. 73.—Vine-leaf attacked by the *Pyralis*.—4, The male.—4 *a*, The female.—4 *b*, The Caterpillar.—4 *c*, The eggs.—4 *d* and 4 *e*, The pupæ.

* Kirby and Spence, vol. iii. † Mordella Beetle.

in the eyes is more than counterbalanced by the abundance in which these organs are bestowed.

No one circumstance connected with insects, has perhaps arrested the attention of ordinary observers so much as what is termed their metamorphoses. The vertebrate animals retain through life, with some variations in size and colouring, very much the same forms which they had at birth. Insects, on the contrary, pass through four states of existence, and these are in general distinctly marked (*Fig.* 73). They are first contained in eggs, which are deposited by the parent in suitable situations, and with a degree of instinctive care which fills us with admiration. They then become active and rapacious, and are well known by the names of grubs, maggots, and caterpillars, according to the tribes to which they belong (*Fig.* 77). To this condition Linnæus applied the Latin word *larva* (a mask), as if the perfect insect were masked or concealed in the figure of the Caterpillar. The ravages of which the forester and the gardener complain, result most generally from the voracity of insects in their larva state. They eat much, increase rapidly in size, change their skin several times, and pass into another state, in which, in some tribes, all appearance of vitality is for a time suspended. The Caterpillar of the Butterfly or Moth, when the period for this change arrives, seeks out a secure asylum for its period of helplessness, and suspends itself by a thread (*Figs.* 74, 78), envelopes itself in silk, makes a covering of leaves, or entombs itself in the earth, according to the habits of the species. Some of them in this state appear, on a miniature scale, like Egyptian mummies, or like an infant wrapped up in swaddling-clothes. From this peculiarity the term *pupa* (a baby) has been given to them; and *chrysalis*, a word of Greek origin, referring to the bright or golden colours which some of them display, has also been applied. We shall use the terms *pupa* and *chrysalis* indifferently, meaning, in all cases, the insect in the form it has prior to its appearance in the last and perfect form;—that which is termed the Imago (*Figs.* 75, 79), as though it had not until then its perfect or fully developed image. All insects, however, do not assume the quiescent state of those just mentioned. The young of the common Gnat (*Fig.* 76) pass the early stages of their existence as inhabitants of the water, jerking about with great agility, or swimming with ease and swiftness. The Crickets and Cockroaches are as active and

Fig. 74.—Chrysalis.

Fig. 75.—Vanessa.

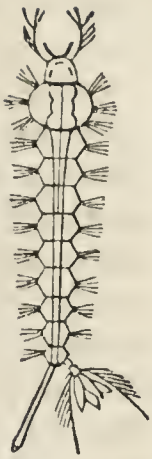

Fig. 76.—Larva of Gnat.

Fig. 77.—Larva of Papilio Machaon.

Fig. 78.—Pupa of Papilio Machaon.

Fig. 79.—Imago of Papilio Machaon.

lively at this period of their lives as at any other, and differ in appearance from the perfect insect only in the absence of wings.

There is something in the contemplation of these changes highly suggestive of poetic thought. The Caterpillar is seen crawling on the earth, then apparently lifeless in its self-constructed sepulchre, then flinging off the vestments of the tomb, and, with beauty of form and powers unknown before, entering on the enjoyment of a new state of existence. Hence it is not surprising that the ancients found, in its transformations, a symbol of the vague and shadowy ideas they entertained of the life of man here, of his repose in the tomb, and of the probability of a more glorious state of being hereafter. "Psyche," says an ingenious and learned writer, "means, in Greek, the human soul, and it means also, a Butterfly; of which apparently strange double sense the undoubted reason is, that the Butterfly was a very ancient symbol of the soul."*

A number of terms have been employed by entomologists to denote the variety observable in insect metamorphoses; but a better acquaintance with the laws observable in the development of animals in their several stages, and a more accurate acquaintance with the functions performed by different organs and tissues in the animal frame, have stripped these changes of much of their distinctive character. Some insects are not, at any time, possessed of wings; but up to the period at which wings are developed, it is found that all insects undergo a similar series of changes. In some, however, an amount of change is undergone, before their liberation from the egg, which others do not experience until they have been some time in the enjoyment of active existence. The duration of the several progressive stages of growth differs widely in the several tribes; and this also tended to give to each an apparently distinctive character, to which it was not in reality entitled.†

With regard to their food, insects may be said to be omnivorous; for there is no animal or vegetable substance which does not form the aliment of one or more species. Some live entirely on putrifying substances, and, by thus removing them, prevent the salubrity of our atmosphere from being impaired; others are rapacious, and subsist by the destruction of those

* Nare's Essays, i. 107. Quoted by Kirby and Spence, iv. 74.

† Owen's Lectures, pages 236, 237.

that are weaker than themselves; some feed upon timber; others upon leaves and grass; some, like the "worm i' the bud," feast on our loveliest flowers; and others revel on the nectar of our choicest fruits. Some idea of the elaborate apparatus by which the food is assimilated may be formed from an examination of the digestive system in one of the carnivorous Beetles (*Fig.* 80).

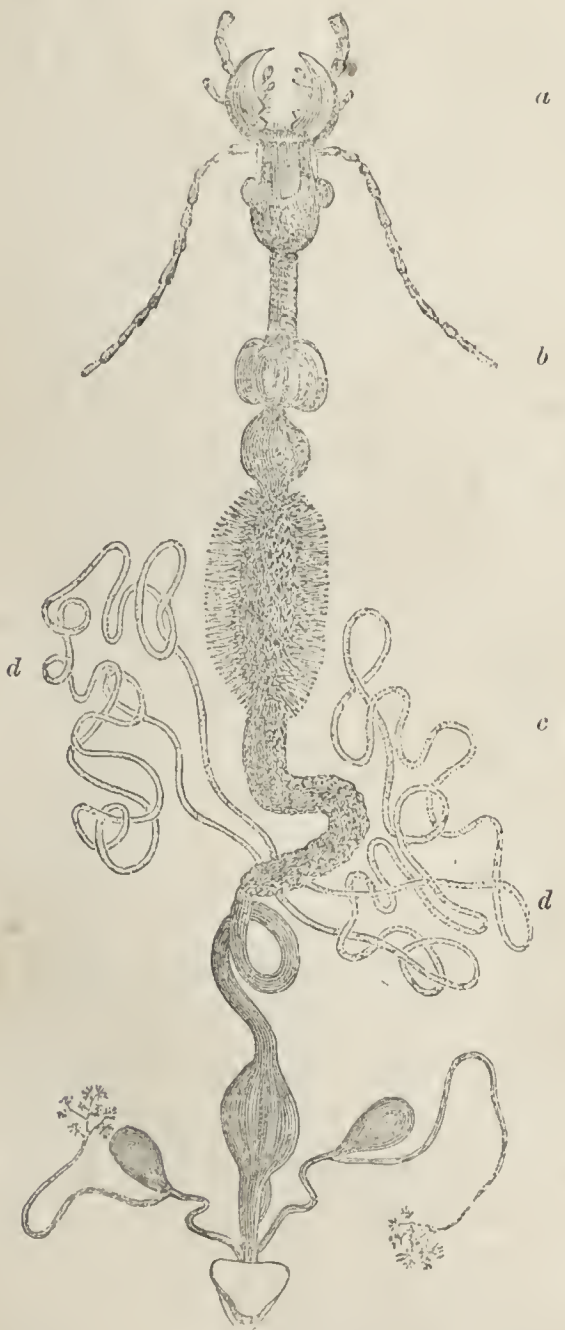

Fig. 80.—Digestive Apparatus of Beetle.

Fig. 80.—*a*, The head, with mandibles and antennæ.—*b*, The crop and gizzard.—*c*, Stomach and intestine.—*d*, Biliary vessels.

From the diversity of their food, and the great variety of circumstances under which it is obtained, we naturally expect considerable modification in the structure of the mouth and its appendages—in other words, of the instruments by which the food is obtained; and, accordingly, we find it is sometimes furnished with jaws for cutting and for masticating solids, and, at other times, with tubes of very different kinds, adapted for the imbibing of fluids, such as the blood of animals, the honey of flowers, or the sap of growing plants. Before noticing this admirable variety of structure, in connexion with the habits of different insect tribes, it may be well to acquire distinct ideas of the parts of which the mouth is composed.

The mouth of one of the rapacious Beetles (*Fig.* 81, *Carabus*), which are constantly crossing our path in quest of prey, will afford a familiar example. It consists of seven parts (*Fig.* 82). An upper lip (*labrum*); a lower lip (*labium*); a tongue (*lingua*); two upper jaws (*mandibulæ*); and two lower jaws (*maxillæ*). The motion of the jaws is not vertical, as in the vertebrate animals, but is horizontal; and the lower jaws are sometimes

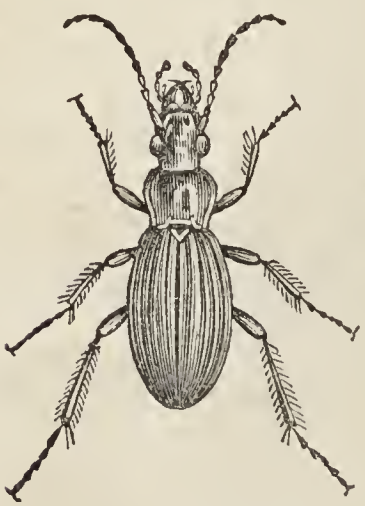

Fig. 81.—Carabus.

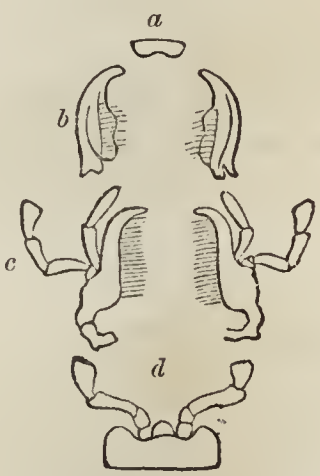

Fig. 82.—Parts of Mouth of Carabus.

employed in holding the food which the upper jaws or mandibles are engaged in cutting to pieces. In some orders the seven parts are not to be seen with such distinctness, some of them being prodigiously enlarged, and others diminished, or perhaps altogether wanting.

Fig. 82.—*a*, Labrum.—*d*, Labium.—*b*, Mandibles.—*c*, Maxillæ. The feelers attached to the Maxillæ are called *Maxillary palpi;* and those to the Labium, *Labial palpi*.

To bring this varied organism fully into play, it is necessary that each insect should possess the power of transporting itself with ease to whatever situation its necessities require, and that it should be furnished, for this purpose, with organs of flight adapted to the varying circumstances and requirements of the several tribes. These wings never exceed four in number. In beetles of burrowing habits the upper pair is hard and horny, and serves to protect the softer membranous pair when not in use. The wing-covers or shards (*elytra*) are expanded in flight, and, by their concavity, help to sustain the insect in the air; hence Shakspeare's description of

"The shard-borne beetle, with his drowsy hums,"

is not less accurate than poetical. In other tribes the wings resemble the finest lace; and in the butterflies and moths they are covered with a mealy substance, which examination under a lens shows to be composed of the most delicate scales, differing in form, in size, and in colouring, and giving to some of these "gilded butterflies" the gorgeous metallic tints for which they are so remarkable.

"The grand and characteristic endowment of an insect," says Professor Owen, "is its wings; every part of the organization is modified in subserviency to the full fruition of these instruments of motion. In no other part of the animal kingdom is the organization for flight so perfect, so apt to that end, as in the class of insects. The swallow cannot match the dragon-fly (*Fig.* 83) in flight. This insect ha

Fig. 83.—Dragon-fly.

been seen to outstrip and elude its swift pursuer of the feathered class: nay, it can do more in the air than any bird; it can fly backwards and sidelong, to right or left, as well as forwards, and alter its course on the instant without turning." These "limber fans" are of use in another capacity; they take their share in the business of respiration, and hence have been termed, from analogy, "aërial gills."

From the great importance of the wings, and from the modifications in their structure, they become naturally the basis for classification; and without going much into details, we shall endeavour to denote the principal groups of insects, and notice their most striking characteristic features and habits.

Note.—In the brief outline here given, we have, for the sake of simplicity, adhered to the Linnæan Orders, with the additions of *Orthoptera* and *Strepsiptera*. Some of them, it may be proper to mention, have been subdivided by modern entomologists. The meaning of the compound term by which each order is designated will be given where the term occurs: but it seems desirable, at the commencement, to place before the learner, at one view, a list of all the orders hereafter mentioned, with the literal signification of the names, and some well known example of the insects belonging to each division. Thus:—

I. Coleoptera,	sheath-winged,	beetles, &c.
II. Orthoptera,	straight-winged,	crickets, locusts, &c.
III. Neuroptera,	nerve-winged,	dragon-flies.
IV. Hymenoptera,	membrane-winged,	bees, ants, &c.
V. Strepsiptera,	twisted-winged,	stylops.
VI. Lepidoptera,	scale-winged,	butterflies, &c.
VII. Hemiptera,	half-winged,	cicadæ, water-scorpions, &c.
VIII. Diptera,	two-winged,	flies, gnats, &c.
IX. Aptera,	without wings,	fleas, spring-tails, &c.

The first of these orders *Coleoptera* (page 107) was established by Aristotle. The term is derived from two Greek words, meaning sheathed or encased wings. Of Beetles or *Coleopterous* insects we have about 950 Irish species, according to the catalogue mentioned at page 92, and referred to hereafter.

COLEOPTERA.

Fig. 84.
PTINUS (MAGNIFIED).

Fig. 85.
MALE GLOW-WORM.

Fig. 86.
FEMALE GLOW-WORM.

Among the various tribes of beetles constituting the present order, very great difference exists even in our native species, in size and colouring. The great water-beetle (*Dytiscus marginalis*) is sufficiently powerful to play the tyrant of the pool in which he lives, and even to attack and overcome small fishes. Others, again, are so minute, as to live in the perforations they make in the timber of our dwelling-houses, and thus to escape detection by ordinary observers.* Among the latter may be mentioned those little beetles (*Fig.* 84), to which vulgar superstition has given the name of "Death-watch."

"The solemn Death-watch click'd the hour she died."—GAY.

This sound, which is only the call of the insect to its companion, has caused many a heart to throb with idle fears, which a slight knowledge of natural history would for ever have dispelled. It so exactly resembles the ticking of a watch, that Mr. R. Ball, by placing his watch to the wainscot which the little beetle frequented, has caused the insect to respond to its ticking.

The structure of the mouth and of the wings has already

* Mr. Spence has given an interesting account of the destruction of large beams of timber in the dwelling-houses at Brussels, by one of those insects. "The mischief," he says, "is wholly caused by *Anobium tessellatum* which thus annually puts the good citizens of Brussels to an expense of several thousand pounds, much of which might have possibly been always saved, had the real cause of the evil been known."—Transactions of the Entomological Society, vol. ii. page 11.

been mentioned, but it must be understood that in both there are considerable modifications. In many beetles, the wing-cases, or, to use the more correct term, the elytra, are united together, and, as wings could not be used, they are not given. In the glow-worm (*Fig.* 85, 86), an insect we do not possess in Ireland, the female, being soft and wingless, does not seem to belong to the present order; but the male is possessed of elytra, and of expansive wings, by means of which he is enabled to shape his course to the "nuptial lamp" displayed by the more stationary female. This idea, though apparently fanciful, appears to be borne out by experiment.*

The "droning-flight" of the Dor-beetle, heard in the twilight of the summer-evening's walk, is a sound with which every one is familiar; and equally well known is the manner in which the creature startles us from our reveries by striking against our faces. It is from this circumstance, and not from any absence of the sense of vision, that its common epithet, the "blind-beetle," has been derived. Both peculiarities have been noticed by Collins in his "Ode to Evening":—

"Now air is hushed, save
Where the beetle winds
His small but sullen horn;
As oft he rises, 'midst the twilight path,
Against the pilgrim borne in heedless hum."

This common insect affords an example of the manner in which many animals feign death, in order to deceive their enemies. If taken in the hand, and tossed about, its legs will be set out perfectly stiff and immoveable (which is its posture when really dead), and will so continue until allowed to remain for a minute or two undisturbed. If the hand be closed, its strength is such, that it is difficult, by the strongest pressure we can exert, to prevent its escape.

To this family belongs the sacred beetle of the Egyptians (*Fig.* 87), whose image remains sculptured on many of their

* Vide Entomologia Edinensis, page 206. The idea has been embodied by Moore:—

——"beautiful as is the light
The glow-worm hangs out to allure
Her mate to her green bower at night."

obelisks and other monuments. Denon,* in his splendid work on Egypt, states that it was an emblem of wisdom, strength, and industry, and that it occupies the most distinguished place in the temples, not merely as an ornament, but as an object of worship. Among the Egyptian antiquities preserved in the British Museum, is a colossal figure of this insect, placed upon an altar, before which a priest is kneeling. Similar figures of the insect, but of a small size, are frequently found on the breasts of mummies, and were probably worn as amulets.

Fig. 87.—Sacred Beetle of the Egyptians.

All Egyptian travellers speak with surprise of the habits of this beetle, in collecting and rolling about a ball of dung, in which it deposits an egg. A similar custom prevails in one of our native species (*Geotrupes vernalis*); but in districts where sheep are kept, it wisely saves its labour, and ingeniously avails itself of the pellet-shaped balls of dung which these animals supply, and which are admirably adapted for its purpose.†

Among the beetle tribes are some which are cased in armour of brilliant metallic lustre, and there are species found on vegetables which are splendid objects when their beauties are revealed by the microscope. There is one which, though taken in many parts of Ireland, has not as yet been observed in the northern districts, and which is remarkable both for its beauty and its activity (*Cicindela campestris*). Its colour is a golden green, with white or yellow spots, and appears particularly rich when the insect is running rapidly along in the bright sunshine of a summer's day. It is one of a family, justly named by Linnæus the tigers of the insect tribes. "Though decorated with brilliant colours, they prey upon the whole insect race; their formidable jaws, which cross each other, are armed with fearful fangs, showing to what use they are applicable; and the extreme velocity with

* Vol. ii. page 60.

† Sturm, quoted by Kirby and Spence, vol. ii. page 475.

which they can either run or fly, renders hopeless any attempt to elude their pursuit"* (*Fig.* 88). In contrast with these carnivorous Beetles, we may mention some whose powers are exercised on vegetable matter. The best known of these is perhaps the common Cockchafer (*Melolontha vulgaris*), an insect extremely abundant in England, but in the North of Ireland of comparative scarcity. It spends three years in the ground feeding on the roots of grass and other vegetables. In its mature state its attacks are openly made on the leaves of our hedge roses and forest trees. There are others who carry on their proceedings so as to elude our observation. Thus:—

——"The red-capp'd worm, that's shut
Within the concave of a nut,"

is the larva of a Weevil. The mother is furnished with a long horny beak (*Fig.* 89), and while the nut is yet soft, she

Fig. 88.—Cicindela.

Fig. 89.—Nut Weevil (magnified).

drills a hole through the shell, deposits an egg, and thus furnishes her future offspring with a house for its defence and food for its support.

Much more laborious is the process by which the burying Beetles (*Fig.* 90) attain the same object. With united industry they excavate the earth from under the dead body of a frog, a bird, or other small animal, until at length it is interred to the depth of some inches, and covered

* Kirby and Spence, vol. i. page 268.

over with earth. The eggs are deposited in the decaying flesh, and thus the young grubs, when hatched, find themselves surrounded by a store of food provided by the instinctive labours of the parents.

Fig. 90.
Burying Beetle.

We have spoken of the coleopterous insects more fully than we shall of those belonging to some of the other orders; but not more fully than their variety and importance deserve. Mr. Westwood states, that the number of species of this order, with which entomologists are acquainted, cannot be less than 35,000; and he thinks it more than probable, that when those from foreign countries shall have been collected, the number will be doubled, if not trebled. The Berlin museum alone contains 28,000 species.

DIFFERENT STATES OF A GRANIVOROUS BEETLE (CALOSOMA).

Fig. 91.—
Larva.

Fig. 92.—
Imago.

Fig. 93.—
Pupa.

ORTHOPTERA.*

Fig. 94.—Phyllium Siccifolium.

This division includes in it the Cockroaches, Crickets, Grasshoppers, and Locusts, and those singular-looking creatures, from tropical countries, which have been, by common consent, named "walking-sticks" and "leaf insects." Some of the latter, which we see in our museums, have the wing-covers of so bright and fresh a green, that we can with difficulty persuade ourselves we are looking on an insect; while others present a no less striking resemblance to the colour of the leaf, and its delicate reticulations, as it lies on the ground in its withered state (*Fig.* 94).

Another foreign insect deserves mention, because it has

* Derived from two Greek words; one signifying *straight*, the other a *wing;* the arms being longitudinally folded when at rest. About fifty Irish species.

obtained from its attitude the appellation of the "praying Mantis" (*Fig.* 95); and popular credulity, both in Europe and Africa, has gone so far as to assert, that a child or a traveller, who has lost his way, would be guided by taking one of these pious insects in his hand, and observing in what direction it pointed. They have the character of being gentle, while in

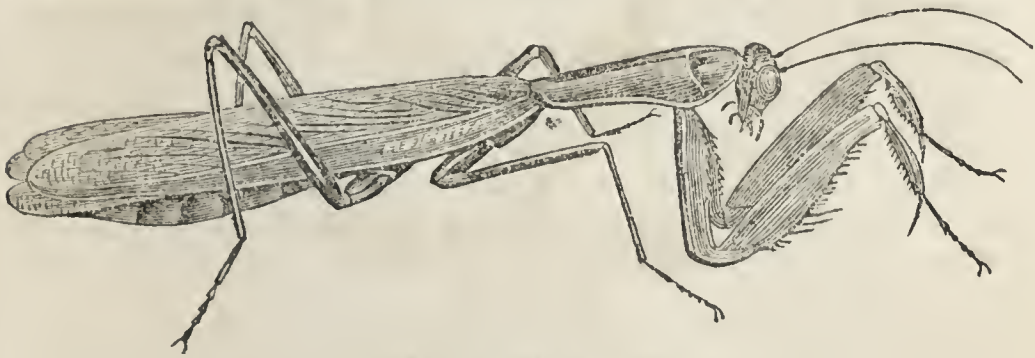

Fig. 95.—Mantis.

reality they are extremely ferocious. Using the fore-legs as a sabre, they can cut off the head of an antagonist at a single stroke, and are so pugnacious, that the Chinese children, according to Barrow, sell to their comrades bamboo cages, each containing a Mantis, which are put together to fight.*

Insects of this order have jaws no less powerful than those of the beetle tribes, and which are well-fitted for acting upon the vegetables that form their principal food. Their wings are different from those of the Coleoptera, the wing-covers being less opaque, and bearing some resemblance to parchment, while the wings themselves are folded, when not in use, in a different manner.

Fig. 96.—House-cricket.

Perhaps in these countries no individual of the order is so well known as the House-cricket (*Fig.* 96), which common

* Kirby and Spence, vol. i. page 275. Westwood, vol. i. page 427.

belief regards as foretelling cheerfulness and plenty. The more just exposition would be, that as crickets revel on the yeast, the crumbs, the milk, the gravy, and all the waste and refuse of a fireside, their presence does not prognosticate that plenty is to come, but that it already exists. In like manner, when they gnaw holes in clothes which are drying at the fire, the naturalist would say, that the action is not done, as is commonly said, because of injuries they have received, but simply because the moisture which the clothes contain is gratifying to their thirsty palates.

Shakspeare, Milton, and many other poets, have noticed the chirp of "the Cricket on the Hearth," but none have offered to it a more graceful tribute than Cowper:—

> "Thou surpasseth, happier far,
> Happiest grasshoppers that are;
> Theirs is but a summer's song,
> Thine endures the winter long,
> Unimpair'd, and shrill and clear
> Melody throughout the year."

The Rev. Gilbert White, in that charming "Natural History of Selborne," which it seems scarcely possible to quote without commendation, devotes a letter to a graphic and interesting account of the habits of the Field-cricket (*Acheta campestris*). In this he justly remarks, that "sounds do not always give us pleasure according to their sweetness and melody, nor do harsh sounds always displease. Thus the shrilling of the Field-cricket, though sharp and stridulous, yet marvellously delights some hearers, filling their minds with a train of summer ideas, of everything that is rural, verdurous, and joyous."

The Cockroaches (*Fig.* 97), which also belong to the present order, are regarded with feelings very different from those associated with the crickets. They devour bread, meat, cheese, woollen clothes, and even shoes. On board ship, barrels of rice, corn, and other provisions, are at times completely destroyed by them. In some tropical countries, they swarm by myriads in old houses, making every part filthy beyond description. They sometimes attack sleeping persons, and will even eat the extremities of the dead.*

There is another insect belonging to the present order, whose very name is associated, not with disgust, but with

* Westwood, vol. i. page 418.

terror: we allude to the Locust (*Fig.* 98). In these countries we are happily exempt from its devastations; but a few detached individuals are occasionally wafted hither, and, in this way, so many as twenty-three species are now recorded as British. For some account of the ravages which they have at various times committed, we refer to Kirby and Spence's Introduction to Entomology, vol. i. page 212, where much information on the subject has been carefully brought together. The description given by the Prophet Joel is not less remarkable for its fidelity than its grandeur. "A fire devoureth before them, and behind them a flame burneth: the land is as the Garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array."

Fig. 97.—Cockroach.

Fig. 98.—Locust.

NEUROPTERA.*

Fig. 99.—Indian Libellula, or Dragon-fly.

This order of insects includes the Dragon-flies, the May-flies, the Lacewinged-flies, the Ephemera, and the destructive Termites, or white ants. They have four large-sized wings, equal in size, furnished with numerous nervures, and presenting, in some species, an appearance of the most delicate network. The jaws are fitted for mastication.

No one who looks upon any of our native Dragon-flies (*Libellulæ*, *Fig.* 86) hawking over a pond on a bright summer day, and marks the facility with which their insect prey is taken and devoured, could ever suppose that these swift-flying creatures had but a few weeks before been inhabitants of the water. Yet it is there the early stages of their life are passed. The female has been observed to descend the leaf or stem of an aquatic plant to deposit her eggs. The larva, when excluded, is not less ferocious than the perfect insect, and is furnished with a singular apparatus, a kind of mask, which is used not only for seizing its prey, but for holding it while the jaws perform their customary office.† On one occasion we lifted one of these larvæ, when feeding on a

* From two Greek words, one signifying a *nerve*, the other a *wing*. The term "*nerves*" is commonly applied to the *nervures* or minute tubes by which the wings are expanded. The order contains about seventy Irish species.

† For a lucid description of this instrument, see Kirby and Spence, vol. iii. page 125.

tadpole, but it continued its repast without evincing the slightest discomposure. When the time for deserting the water has arrived, it climbs upon the stem or leaf of one of the water-plants, emerges from its pupa case, and, after resting until its wings are expanded and dried, enters, in the air, upon a course of the same ceaseless rapacity which it had waged while in the water.

Some have the wings expanded horizontally when at rest (*Figs.* 86, 99); others have them closed and erect (*Fig.* 100);

Fig. 100.—Agrion.

but in both, the movements of the insects are so light and graceful, their colours so splendid, and, at the same time, so varied, displaying the softest green and the richest azure, that our neighbours, the French, have bestowed on them the appellation of "demoiselles;" and one of our poets has applied to them a corresponding term.

> "Chasing, with eager hands and eyes,
> The beautiful blue *damsel* flies,
> That fluttered round the jasmine stems
> Like winged flowers or flying gems."—Moore.

The insects to which anglers give the name of May-flies (*Phryganeæ*, *Fig.* 101) also pass the beginning of their

Fig. 101.—Phryagnea.

existence in the water. Mr. Hyndman, of Belfast, noticed, some years ago, the proceedings of the female in one of the ponds in the Botanic Garden, near that town, and favoured us with the following note:—"I first observed the Phryganea on the leaf of an aquatic plant, from which it crept down along the stem under the water, very nearly a foot deep; it appeared then to have been disturbed by some stickle-backs, which approached and seemed inclined to attack it, and swam vigorously and rapidly beneath the water, over to some other plants. I there took the insect up, and found a large bundle of eggs, of a green colour, closely enveloped in a strong jelly-like substance, attached to the extremity of its abdomen."

The larvæ of these flies, well known under the name of Case-worms, or Caddis-worms (*Fig.* 102), are to be found in

Fig. 102.—Caddis-worms.

every running stream, and almost in every ditch. Their habitations are extremely singular, and differ considerably, both in the materials employed and in their external configuration. Some are formed of numerous little pieces of grass and stems of aquatic plants cut into suitable lengths and placed crossways, forming a rude polygonal figure; others are constructed of bits of stick, or grains of sand and gravel, cemented together; and others, again, are composed of fresh-water shells, each containing its own proper inhabitant, "a covering," as Kirby and Spence remark, "as singular as if a savage, instead of clothing himself with squirrel-skins, should sew together into a coat the animals themselves." But, whatever may be the material employed, the little builders contrive to make them of nearly the same specific gravity as the water, so as to be carried without labour. When about to assume the pupa state, they construct a kind of grating at each extremity of the case, and thus provide, at the same time, for respiration and defence.

Similar cases encrusted with carbonate of lime are found in Auvergne, in France, forming strata six feet in thickness, and extending over a considerable area.*

Fig. 103.—Ephemera.

The Ephemera (*Fig.* 103), whose brief period of existence in its perfect state has become proverbial, belongs also to this division. He who reads Dr. Franklin's charming paper† containing the soliloquy of an aged Ephemera, who had lived "no less than four hundred and twenty minutes," will ever afterwards look with interest upon the insect which has been made the means of conveying a lesson so true and so comprehensive.

HYMENOPTERA.‡

Fig. 104.—Tenthredo.

Fig. 105.—Ichneumon.

The insects of this order have four veined membranous wings, but they are not equal in size, nor are they reticulated,

* Lyell. Principles of Geology, vol. iv. page 165.

† The Ephemera, an Emblem of Human Life.

‡ From two Greek words; one signifying a *membrane*, the other a *wing*, all the four wings being membranous. About 1100 Irish species.

as in the preceding order. The female is furnished either with a string at the extremity of the abdomen, or with an instrument termed an ovipositor (*Fig.* 107), used in the deposition of the eggs. The jaws are powerful, and the tongue, instead of being small and inconspicuous, becomes in some tribes an organ of great size and importance. To this order belong the Saw-flies, Gall-flies, Ants, Wasps, and Bees, insects which have in all ages attracted attention, and among which the power of instinct, in directing the actions of populous communities, is displayed in its highest perfection.

The Saw-flies (*Tenthredinidæ*, *Fig.* 104) take their name from a pair of saw-like instruments, with which the female is furnished, and which she employs for making an incision, in which she deposits an egg. The turnip, the rose, the apple, and the willow, suffer from insects of this tribe. But the species best known in these countries, is perhaps that whose larvæ attack the gooseberry (*Nematus grossulariæ*). From fifty to more than a thousand are sometimes observed upon a single tree, of which they devour all the leaves at the beginning of summer, so that the fruit cannot ripen. There are two generations in the course of a year.* An allied species attacks the red currant; but we have been informed that it sedulously avoids the black currant, and in the course of its defoliating progress leaves it quite untouched.

The Gall-flies (*Cynipidæ*, *Fig.* 106) are those which puncture plants, and, in the wound thus made, insert one of their eggs along with an irritating fluid, the action of which upon the plant produces tumours or galls of various sizes, shapes, and colours. That found on the wild rose, and called the beguar or bedeguar of the rose, is well known. The galls which come to us from the Levant, and which are of so much importance for the manufacture of writing-ink and of black dyes, are about the size of a boy's marble, and each contains only one inhabitant; others support a number of individuals. Mr. Westwood procured so large a number as 1100 from one large gall found at the root of an oak.

Fig. 106.—Cynips.

* Westwood's Introduction, vol. ii. page 103.

The celebrated Dead Sea apples, described by Strabo, the existence of which was denied by some authors, have recently had their true nature ascertained. They are galls, not fruit, of a dark reddish purple colour, and about the shape and size of small figs. The inside is full of a snuff-coloured, spongy substance, crumbling into dust when crushed; and this furnishes the guides with an opportunity of playing "tricks upon travellers." "The Arabs," says Mr. Elliott, "told us to bite it, and laughed when they saw our mouths full of dry dust."* Moore has very felicitously referred, in his *Lalla Rookh*, to those

> ——"Dead Sea fruits that tempt the eye,
> But turn to ashes on the lips."

In the next division (*Ichneumonidæ*, *Figs.* 106, 107) we find the insects depositing their eggs, not on the leaf or stem of a tree, but actually in the body of a living caterpillar. Because of their services in thus preventing the too great multiplication of insects, Linnæus gave to them the name Ichneumon, thus indicating an analogy in their habits to those formerly attributed to the quadruped of that name, as the destroyer of the crocodile. About three thousand species of Ichneumons are at present known and described. "They all deposit in living insects, chiefly while in the larva state, sometimes while pupæ, and even while in the egg state, but not, as far as is known, in perfect insects. The eggs thus deposited soon hatch into grubs, which immediately attack their victim, and in the end ensure its destruction. The number of eggs committed to each individual varies according to its size, and that of the grubs which are to spring from them, being in most cases one only, but in others amounting to some hundreds."†

In order to convey an idea of the services rendered by these insects, Kirby and Spence inform us, "that out of thirty individuals of the common cabbage caterpillar, which Réaumur put in a glass to feed, twenty-five were fatally pierced by an Ichneumon; and if we compare the myriads of caterpillars that often attack our cabbages and brocoli with the small number of butterflies of this species which usually appear, we

* Trans. Entomological Society, vol. ii. page 14.
† Intr. to Entomology, vol. i. page 264.

may conjecture that they are commonly destroyed in some such proportion—a circumstance which will lead us thankfully to acknowledge the goodness of Providence, which, by providing such a check, has prevented the utter destruction of the Brassica genus, including some of our most esteemed and useful vegetables."*

It is worthy of remark that the caterpillar thus attacked continues to eat and apparently to enjoy life as usual. The larva placed within it avoids the vital parts, until the period for its own liberation or change of state has arrived; and it has been ascertained that many of these larvæ are, in like manner, preyed upon by Ichneumons still more minute than themselves.

Fig. 107.—Ichneumon.§

"The development of these parasites within the bodies of other insects was, for a long time, a source of much speculation amongst the earlier philosophers, who conceived it possible that one animal had occasionally the power of being absolutely transformed into another. Thus, Swammerdam records, as 'a thing very wonderful,' that 545 flies of the same species were produced from four chrysalides of a butterfly, 'so that the life and motion of these seem to have *transmigrated* into that of 545 others.'† How much greater would have been the astonishment of this ardent and laborious naturalist, could he have seen 20,000 of these minute Ichneumons issue from the chrysalis of a goat-moth, a number which one author regards as a moderate computation!'"‡

* Intr. to Entomology, vol. i. page 266. All the varieties of the turnip and cabbage belong to the genus *Brassica*.

† Westwood, vol. ii. page 145.

‡ Moses Harris. Vid. Westwood, vol. ii. page 9.

§ The three thread-like appendages at the extremity of the abdomen, in figure 107, consist of the ovipositor, and two filaments between which it lies, as in a sheath, when not in use.

We now enter upon the examination of those insect tribes which congregate into large and well-regulated communities, and in which new powers and instincts are developed. Among these are the Ants, in which we mark, with wonder and admiration,

> ——"The intelligence that makes
> The tiny creatures strong by social league,
> Supports the generations, multiplies
> Their tribes, till we behold a spacious plain,
> Or grassy bottom, all with little hills,
> Their labour, cover'd as a lake with waves;
> Thousands of cities in the desert place,
> Built up of life, and food, and means of life!"
>
> WORDSWORTH.

It may seem strange that the little, busy, wingless creatures, that we see foraging about our fields and gardens, with ceaseless activity, should be mentioned among insects having four membranous wings. But, if an ant's nest be examined towards the end of summer, numbers of them will then be found possessed of these appendages. They are young Ants, just liberated from the cocoon. The males and females rise together into the air; the males soon perish: some of the females return to their original home, and others, casting their wings aside, become the solitary founders of industrious and populous cities. On the neuters devolve the erection of the store-houses, the making of the highways, the nursing of the young grubs, the catering for all, and many other offices essential to the well-being of the community. For an account of their labours, their sports, their wars, their ingenious devices, their slave-taking expeditions, and their modes of communicating information, we refer to Kirby and Spence's delightful Introduction to Entomology, in which the most interesting observations of Gould, Huber, and many other naturalists, have been embodied.

The celebrated honey-dew of the poets is now found to be a saccharine secretion, deposited by many species of aphides or plant-lice. Of this the ants are passionately fond, not only sucking it with avidity whenever it can be obtained, but, in some cases, shutting up the aphides in apartments constructed specially for the purpose, and tending them with as much assiduity as we would bestow on our milch cattle.* It is a

* Kirby and Spence, vol. ii. page 90.

singular circumstance, and one that shows how infinite is the wisdom with which all these things are ordered, that the aphides become torpid, and remain so during the winter, at the same degree of cold that induces torpidity in the ants themselves.

The fact, now ascertained, that our ants pass the winter in a torpid state, is contrary to popular belief. The prevailing notion is, that during the summer and autumn, they sedulously lay up a stock of provision for the winter, one end of each grain being carefully bitten off, in order to prevent germination. This idea, current but erroneous, is embodied in the following extract from Prior:—

——"Tell me, why the ant,
In summer's plenty, thinks of winter's want?
By constant journey, careful to prepare
Her stores, and bringing home the corny ears—
By what instruction does she bite the grain?
Lest, hid in earth, and taking root again,
It might elude the foresight of her care."

In this, and many other examples which might be quoted, the poet gives utterance to the fallacious but prevailing opinion of his time. The error, in this instance, had probably arisen from the ants having been observed carrying their young about in the state of pupæ, at which time, both in size and shape, they bear some resemblance to a grain of corn; and it would receive confirmation from their being occasionally seen gnawing at the end of one of these little oblong bodies—not to extract the substance of the grain, or to prevent its future germination, but in reality to liberate the enclosed insect from its confinement.

The fact that no European species of Ant stores up grain, no way affects the lesson which Solomon so beautifully inculcates:—"Go to the ant, thou sluggard; consider her ways and be wise; which having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest."* Even if the insect did not collect a supply of food for future use, we might all, with great advantage, "consider her ways and be wise." But it is more than probable that Solomon referred to species living in a warmer climate, and,

* Proverbs, chap. iv. ver. 6, 7.

consequently, different in modes of life from those which are indigenous here. This view is corroborated by the discovery made by Colonel Sykes, of a species* living in India, which hoards up in its cell the seeds of grass, and takes the precaution of bringing them up to the surface to dry, when wetted by the heavy rains peculiar to the country.

We pass on to a tribe of Hymenopterous insects with which the generality of observers have but little sympathy—the Wasps. Their community consists of males, females, and neuters. At the commencement of spring, an impregnated female, who has survived the winter, commences the foundation of a colony, which, ere the end of summer, may contain twenty or thirty thousand individuals. The neuters are soon brought forth, and set themselves sedulously to their task of forming cells, collecting food, and attending to the young brood. It is while they are engaged in these labours that we find them so intrusive and troublesome.

The males and females are produced only towards autumn; the males and neuters die as the season advances, and each of the widowed females who survives comes forth in spring an isolated being, to establish another city not less populous than that which has perished. The singular treatment the young grubs receive appears to us, at first sight, unnatural and even revolting. On the approach of cold weather, they are dragged from their nests, and rigorously put to death by the old Wasps, who, until then, had laboured so assiduously for their support and protection.

It is a singular fact, that the nests of these insects are made of a material which we are apt to regard as a modern invention—paper. With their strong mandibles they cut or tear off portions of woody fibre, reduce it to a pulp, and, of the *papier maché* thus fabricated, the cells, and often the covering of their habitations, are formed. The exterior of the tree-nests of some of the foreign species is perfectly white, smooth, and compact, resembling in appearance the finest pasteboard. The nest of our common Wasp is less attractive; but when it has been carefully dug out of the earth, and the interior laid open to view, with its successive layers of symmetrical cells skilfully supported upon ranges of suitable pillars, the regularity and perfection it displays cannot

* *Atta providens.* Trans. Entomological Society, vol. i. page 103.

be contemplated without feelings of surprise and admiration (*Fig.* 108).

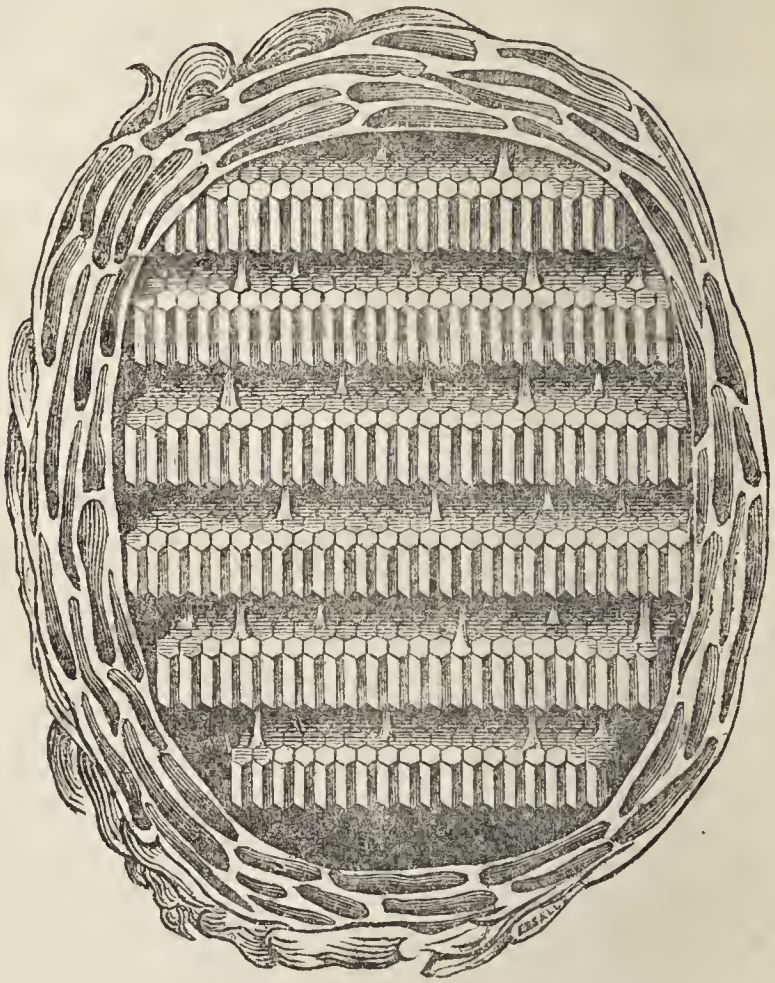

Fig. 108.—Interior of Wasp's Nest.

Besides the social Wasps, there are tribes which have obtained the name of "Sand-wasps." These consist only of males and females, who form their habitations in the crevices of old walls, or excavate them in wooden palings, in sand-banks, or similar situations. The female does not limit her maternal care to the placing of her eggs in safe and suitable situations; but with provident anxiety she collects a supply of food sufficient for the sustenance of the young grub. The food consists of other insects, larvæ, and spiders; and, this being provided, the entrance is carefully closed up.*

The Bee, "that at her flowery work doth sing," is so associated with pleasurable ideas of sunshine and flowers, of

* Westwood, vol. ii.—Kirby and Spence, vols. i. and ii.

industry and happiness, that all have felt what Archdeacon Paley has well expressed, "a Bee amongst the flowers in spring is one of the cheerfullest objects that can be looked upon. Its life appears to be all enjoyment; so busy and so pleased."

Bees may, like Wasps, be divided into the solitary and the social. Some of the solitary Bees, like the solitary Wasps, construct their cells in a cylindrical hole, scooped out of a dry bank; or in one of the vacant spaces of a stone wall. Others select the hollows of old trees, and have occasionally been found in the inside of the lock of a garden gate, taking the precaution, however, to cover their nests with the woolly portions of certain plants, and thus to secure, for their young, a more equable temperature.* A third group has been termed Carpenter Bees, as wood forms the material in which they excavate their nests. Among these, the female of one of our native species "chooses a branch of brier or bramble, in the pith of which she excavates a canal about a foot long, and one line,† or sometimes more, in diameter, with from eight to twelve cells, separated from each other by partitions of particles of pith glued together." But perhaps the most remarkable insect of the group is the *Xylocopa* (*Figs.* 109, 110), a large species belonging to southern Europe, and having wings of a beautiful violet colour. In the decaying espaliers, or other wood-work, she hollows out a tunnel of twelve or fifteen inches, which she divides into ten or twelve distinct apartments, in each of which she deposits an egg and a quantity of honey and pollen, for the support of the future grub.

Fig. 109.—Xylocopa, or Carpenter Bee.

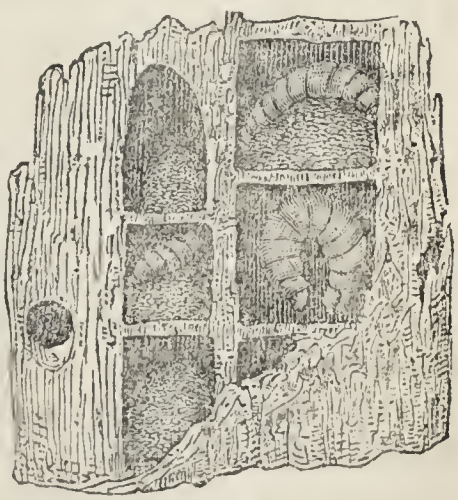

Fig. 110.—Nest of Xylocopa.

This must be a work of time, so that it is obvious the last

* Kirby and Spence, vol. i. page 437—439.

† A line is the twelfth part of an inch.

egg in the last cell must be laid many days after the first; and, consequently, the egg in the first cell must have changed into a grub, and then into a proper Bee, many days before the last. What, then, becomes of it? It is impossible that it should make its escape through eleven superincumbent cells without destroying the immature tenants; and it seems equally impossible that it should remain patiently in confinement until they are all disclosed. This dilemma our heaven-taught architect has provided against. With forethought never enough to be admired, she has not constructed her tunnel with one opening only, but at the farther end has pierced *another* orifice, a kind of back-door, through which the insects produced by the first-laid eggs successively emerge into day. In fact, all the young Bees, even the uppermost, go out by this road; for, by an exquisite instinct, each grub, when about to become a pupa, places itself in its cell with its head downwards, and thus is necessitated, when arrived at its last state, to pierce its cell in this direction."*

Another group of artisan Bees carry on the business, not of carpenters, but of masons, building their solid houses solely of artificial stone. This material is formed of particles of sand, agglutinated together, and the mansion is generally erected in some eligible site, sheltered by a projection, and facing the south. But there are others still more luxurious, who hang the interior of their dwellings with a tapestry of leaves or flowers. These are the upholsterers; among them is "a species (*Apis papaveris*), whose manners have been admirably described by Reaumur. This little Bee, as though fascinated with the colour most attractive to our eyes, invariably chooses for the hangings of her apartments the most brilliant scarlet, selecting for its material the petals of the wild poppy, which she dexterously cuts into the proper form."† The bottom of the chamber she has excavated is rendered warm by three or four coats, and the sides have never less than two. Other native species of the same family are content with more sober colours, generally selecting for their tapestry the leaves of trees, and especially those of the rose; whence they have obtained the name of *leaf-cutter* Bees.

The social Bees have, in each community, three kinds of

* Taken from Kirby and Spence, vol. i. page 440, who give the facts on the authority of Réaumur.

† Kirby and Spence, vol. i, pages 443, 444.

individuals—males, females, and workers or neuters; and, among other peculiarities, they are distinguished from the solitary species by the secretion of the wax of which the cells are constructed. The humble Bees, composing the genus Bombus (*Fig.* 111), are known by their large size and hairy

Fig. 111.—Bombus or Humble Bee.

bodies, often of a black colour with orange bands. "They form societies consisting of about fifty or sixty individuals, occasionally, however, amounting to two or three hundred. They construct their dwellings under ground, in meadows, pastures, or hedge-rows, generally employing moss for this purpose. Their union, however, lasts only till the cold weather kills the great mass of the inhabitants, a few impregnated females alone surviving, to become the foundresses of fresh colonies at the commencement of the following spring."*

The Hive-bee is, however, the species to which above all others our interest attaches; and it is curious that much of our knowledge of the habits and economy of these insects is derived from the labours of a blind man. The elder Huber lost his sight at the early age of seventeen; but, by means of glass hives variously constructed, he was able to exhibit to his wife all that was going on within them, and by her faithful recital of what she witnessed, and the aid of an untiring investigator, M. Burnens, he amassed the material for his celebrated work. Among the ancients, Aristotle, Pliny, and Virgil have recorded their observations upon Bees; in modern times, Swammerdam, Reaumur, Latreille, Bonnet, and some

* Westwood, page 280.

distinguished British naturalists, have contributed much that is valuable; yet the subject is still unexhausted.*

The accompanying figures (112, 113) exhibit the difference, in regard to size and figure, of the drones and workers. The

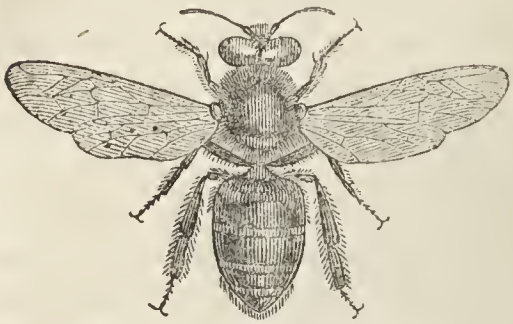

Fig. 112.—Drone Bee.

Fig. 113.—Worker Bee.

one female, to which we give the name of queen, had always a male epithet applied to her by the ancients; so also, in Shakspeare's splendid description of the economy of a hive:—

> ———"So work the honey Bees;
> Creatures that, by a rule in nature, teach
> The art of order to a peopled kingdom.
> They have a king and officers, of sorts;
> Where some, like magistrates, correct at home;
> Others, like merchants, venture trade abroad;
> Others, like soldiers, armed in their stings,
> Make boot upon the summer's velvet buds;
> Which pillage they with merry march bring home
> To the tent royal of their emperor:
> Who, busied in his majesty, surveys
> The singing masons building roofs of gold;
> The civic citizens kneading up the honey;
> The poor mechanic porters crowding in
> Their heavy burdens at his narrow gate;
> The sad-eyed justice, with his surly hum,
> Delivering o'er to executor's pale
> The lazy yawning drone."—Henry V. Act i. scene 2.

On the workers the business devolves of collecting honey and pollen, constructing cells, tending the young, and performing all the multiplicity of duties which the common welfare demands. The drones or males take no part in the labours of the hive; and when, by the fertilization of the queen, the

* Mr. Westwood (page 278) estimates the number in a populous hive at 2,000 males, 50,000 workers, and one queen. Some writers state 30,000 as the probable population. Perhaps the difference that exists in the same hive, at different periods, may account for the discrepancy.

great end of their existence is effected, and the continuance of the community is secured, they are dragged forth, and mercilessly stung to death by the workers. To this slaughter, which takes place in autumn, it is probable the poet may have referred, in the concluding lines.

The deference with which the queen is attended in her progress through the hive, her fierce encounters with rivals, the sagacity displayed by her attendants in promoting or in preventing these conflicts, according to the different condition of her subjects, and the conduct of the virgin queen, as she sets forth with her emigrants to found cities no less populous than the one they have forsaken, are matters on which our space does not allow us to dwell. But we must mention in what manner the anarchy which succeeds the death of the queen is terminated, and it is one of the examples with which the study of nature abounds, that the truth is stranger than the fiction. The workers select one or more cells, containing the grubs or young workers in their larva state. They give them more commodious, or, as they are termed, "royal cells;" they feed them with "royal jelly;" and, instead of small-sized sterile workers, they come forth virgin queens, with forms, instincts, and powers of production, altogether different!*

The tongue of the Bee—a piece of admirable mechanism—is furnished with numerous muscles, and protected by sheaths when not in use, yet fitted for being instantaneously unfolded, and darted into the blossom of a flower. Its structure in one of the humble Bees is shown in the accompanying figure (*Fig.* 114). The nectar thus swept up is at once consigned to the honey-bag. This being done, the tongue is sheathed with the same rapidity, retracted in part into the mouth, and the remainder doubled up under the chin and neck, until again required. When needful, the mandibles are called into

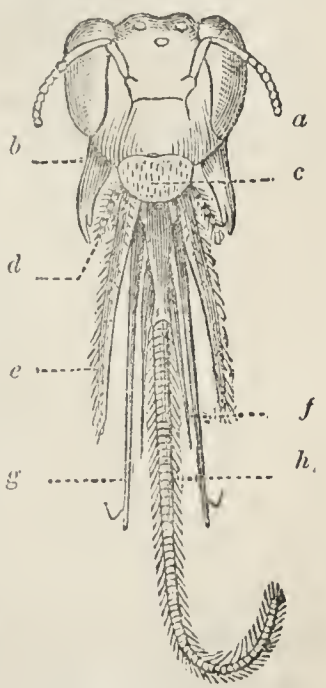

Fig. 114.—Head of Anthophora.

Fig. 114.—*a*, Antennæ.—*b*, Mandibles.—*c*, Labrum.—*d*, Maxiliary palpi.—*e*, Maxillæ.—*f*, Lateral lobes of tongue.—*g*, Labial Palpi.—*h*, Tongue.

* Kirby and Spence, vol. ii. page 129.

requisition, and the corolla of the flower is pierced, so that the honey it contains may be more conveniently procured.

The little pellets which we see the Bees carrying home on their hind legs consist of the pollen or farina of flowers. Shakspeare has, therefore, given utterance to the common, but incorrect idea, when he uses the words,

"Our thighs are packed with *wax*."

The pollen, when brought home, is mixed with honey, and forms what is called Bee-bread. The wax itself is not collected from flowers, but is secreted by means of peculiar organs, which may easily be seen by pressing the abdomen so as to cause its distension. It is not a secretion which is constantly going on; it takes place only when required for the construction of comb. To supply it, the wax-workers—which Huber has proved to be distinct from the nurses—are obliged to feed on honey, and remain inactive, generally suspended from the top of the hive, for about twenty-four hours previous to the deposition of the wax.

Mathematicians inform us that Bees have, in their hexagonal cells, given a solution to the problem of how the greatest strength may be combined with the least quantity of material, another proof of the perfection of their instinctive actions.* Wax and honey, the products of their labours, become, in some parts of the world, important articles of commerce. The honey of Mount Hymettus, so celebrated in ancient Greece, even yet retains its celebrity, though all around is changed.

STREPSIPTERA.†

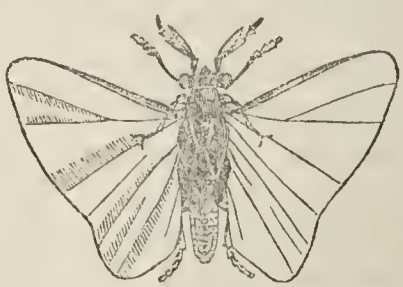

Fig. 115.—Stylops (magnified).

This order consists of only a single family (*Stylopidæ, Fig.* 115)

* See Paley's Natural Theology, edited by Lord Brougham.

† The term is derived from two Greek words, meaning "*twisted wings*," and was given by the Rev. Mr. Kirby, the discoverer of the order, from the first pair of wings being absent, and represented by twisted rudiments." Mr. Westwood regards these insects as "the most anomalous annulose animals with which we are acquainted."—Vol. ii. page 288.

which, however, is one of great interest to the entomologist. The individuals composing it are short-lived, diminutive in size, not exceeding a quarter of an inch, and pass the early stages of their existence as parasites in the bodies of Bees and Wasps, especially in those of different species of solitary bees. With this brief notice of their existence, we proceed to the numerous families of Butterflies and Moths, composing the order

LEPIDOPTERA.*

Fig. 116.—Peacock Butterfly.

The wings are four in number, large, extended, covered on both sides with minute scales, overlapping each other like the slates on the roof of a house; and on their removal showing that the wing itself is membranous. There is a pretty little Moth (*Fig.* 117), by no means rare in some parts of Ireland, which might, at first sight, appear to have a greater number of wings; but they are regarded as four wings only, cut into a number of longitudinal or feather-shaped pieces, so as to resemble a plume or fan.

The mouth of the Lepidoptera differs much from that of any of the insects we have hitherto been considering. The powerful jaws have disappeared, and instead of them we find a slender tubular apparatus, which is carried about coiled up

* "Scale-winged." The wings being covered with fine scales, resembling the most delicate feathers. About 450 Irish species are known.

like the mainspring of a watch (*Fig.* 118). In a moment it can be darted into a flower to obtain the nectar on which the insect lives, and which is sucked up through the centre of this delicate proboscis. Any one, by applying a pin to this

Fig. 117.—Plumed Moth (magnified).

Fig. 118.—Head of Butterfly.

"tongue"—as it is commonly but incorrectly called—will find that it consists of two pieces, and that by their union the canal is formed, through which the nutriment is imbibed.

The number of these insects is very great. "Dr. Burmeister supposes them to amount to not fewer than 12,000 species; and of these nearly 2000 have been described as British."* In expanse of wing, and beauty of colouring, they stand unrivalled. Some foreign species measure, when expanded, not less than nine or ten inches; and others display tints so splendid that they have been compared to those of gems and flowers.

Fig. 119.—Oak-leaf Moth.

Even in those which are natives of our more northern clime, considerable diversity exists. Some are scarcely distinguishable from the leaves of the plants, or the trunks of the trees on which they repose (*Fig.* 119); others vie with the snow-flake in the purity of their vesture. Some exhibit gorgeous metallic hues; and others an azure surpassing that of the summer sky at noon.

* Westwood, page 310.

They have been divided, according to the times of their appearance, into three groups. Those that fly during the day (*Diurna*), or Butterflies; those that appear in the twilight (*Crepuscularia*), or Hawk-moths; and those that come forth at night (*Nocturna*), or Moths; and though this arrangement is not very precise, it will be sufficiently so for our present purpose.

Many of the most splendid British Butterflies are not found in Ireland; and several species—as, for example, the Peacock Butterfly (*Fig.* 116)—are taken in the South of Ireland, but are quite unknown in the North. Hence, as certain kinds have but a limited range, each change of place brings fresh objects of interest before the eye of the naturalist; and as the appearance of different species is periodical, a similar gratification is connected with each change of season.

Sometimes lepidopterous insects, of species rare or unknown in a certain locality, appear there in considerable numbers for a few days and then vanish not to be seen again for years. Why they do so, is a question which, in the present state of our knowledge, we are quite unable to answer.

But apart altogether from the consideration of such phenomena, the person who studies the habits of this tribe of beings will, in all seasons, and in the most limited locality, find full scope for his mental activity. What can be a more common occurrence than the escape of the Nettle Butterfly from the chrysalis-case. Yet, let any one mark the progress of the phenomena from the time the insect bursts its prison-house until the miniature wings have expanded to their full extent and are ready for flight, and he will admit the truth which Ray long since inculcated. "There is a greater depth of art and skill in the structure of the meanest insect than thou art able for to fathom or comprehend."*

The Lepidoptera of the second great division—those which

* Wisdom of God in Creation, published 1690. The author, John Ray, F. R. S. born in Essex, 1627, was the son of parents of humble rank. He was the founder of true principles of classification, both in Botany and Zoology, and was not more respected for his scientific attainments than for his benevolence and his high moral and religious worth. An association for the publishing of valuable natural history works, has recently been established in these kingdoms, and has called itself "the Ray Society," in honour of this truly illustrious man. It consists of nearly a thousand members; to some of its publications we have more than once referred.

fly most generally in the cool of the morning or evening—have the swiftest and most powerful flight; hence the name Hawk-moths (*Fig.* 120). They are also called Sphinxes, in

Fig. 120.—Sphinx of the Vine.

consequence of the head of the caterpillar being held erect, so as to give it some resemblance to the attitude of the Egyptian Sphinx. The tube, which they insert into the blossoms for extracting the honey, is of considerable length: in one native species (*Sphinx convolvuli*), it measures nearly three inches. Some of the tribe come forth in the brightest sunshine, and have obtained the name of Humming-bird Hawk-moths. One very remarkable, both for its size and markings, is the Death's-head Moth. Its wings, when fully expanded, measure four inches and three quarters across, so that it is the largest of all European Lepidoptera. It has the habit of robbing bee-hives, and is said to utter a sound which stills the busy inmates, and enables their gigantic plunderer to carry off his booty in safety. We have one in our cabinet which was taken in Holywood (Co. Down), while engaged in battling against a sparrow. By the ignorant it has been always regarded with superstitious terror, as the precursor of war, pestilence, and famine.

The remaining tribes are all included under the common name of "moth." The word is sometimes used to express the extreme of littleness. Thus, we have in Shakspeare, "a *moth* will turn the balance;" "wash every *moth* out of his conscience;" and similar expressions. To show how inaccurate is this idea of their diminutive size, it is only necessary to

mention, that the Oak-moth measures three inches and a half across the expanded wings, and the Emperor-moth (*Saturnia pavonia minor*, *Fig.* 121) is of equal dimensions.

Fig. 121.—Emperor Moth.

To such species the lines of Spencer are strictly applicable,—

> "The velvet nap which on his wings doth lie,
> The silken down with which his back is dight,
> His broad outstretch'd horns, his airy thighs,
> His glorious colours, and his glistening eyes. *

The caterpillars of some moths are of large size; those of others are so minute that the thickness of an ordinary leaf is sufficient to afford them concealment, as they eat away its interior;—nay, half its thickness is sufficient, as an examination of any leaf, showing upon one side only their whitish zigzag lines, will testify.

Some, from their peculiar movement, which seem as if they were measuring the space they traverse, are called surveyors (*Geometræ*), and they can fix themselves to a twig in a manner so stiff and motionless as to seem a part of the plant. Others, with inimitable skill, construct vestures for themselves of very different materials, occasionally employing what to us would seem the most unsuitable. Some, like those represented in *Fig.* 122, possess the art of rolling a leaf, so as to convert it to a habitation; and others, spinning a snow-white canopy, dwell together in social communities.

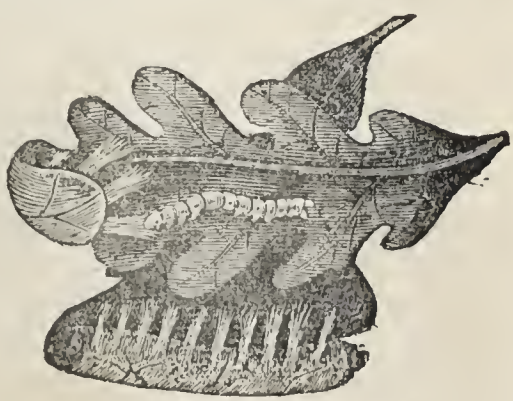

Fig. 122.—Nest of Tortrix.

* From his poem, entitled Minopotmos, or the Fate of the Butterfly.

Our space forbids us to enter into these details, however instructive or interesting they might prove; but we should be inexcusable, did we pass by in silence the effects which the labours of one insect of this order has produced, and is still producing, on the employments and habits of many hundred thousands of human beings. We allude, of course, to the Silkworm-moth (*Bombyx mori*, *Fig.* 125), whose larva (*Fig.* 123) forms the cocoons from which silk is manufactured.

Fig. 123.—Silkworm.

There was a time when this article, now so abundant, was valued in Rome at its weight in gold,* and the Emperor Aurelian refused his Empress a robe of silk because of its dearness. At that very period the Chinese peasantry, amounting in some of the provinces to millions in number, were clothed with this material; and both there and in India it has formed, from time immemorial, one of the chief objects of cultivation

Fig. 124.—Chrysalis of Silkworm.

Fig. 125.—Silkworm Moth.

* From Kirby and Spence, Intr. vol. i. page 331.

and manufacture. About the year 550 the eggs were brought to Constantinople, thence they were introduced into Italy, and under the auspices of Henry IV. of France, the cultivation of silk was commenced in his dominions. In its various states, it now constitutes in many parts of the world so important an article of commerce, that the learned authors, from whom we have taken these particulars, remark, "that when nature

——"Set to work millions of spinning worms,
That in their green shops weave the smooth-hair'd silk,
To deck her sons."—MILTON.

she was conferring on them a benefit scarcely inferior to that consequent upon the gift of wool to the fleecy race, or a fibrous rind to the flax or hemp plants."

HEMIPTERA.*

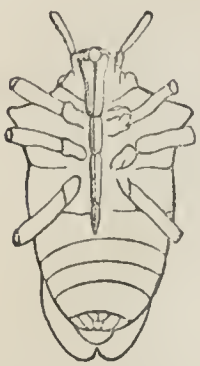

Fig. 126.—PENTATOMA (LOWER SURFACE).†

Fig. 127.—HALYS (UPPER SURFACE).

In the insects belonging to this order the mouth is formed for abstracting the juices of animals or plants (*Fig.* 126). The wings are four in number, partly overlapping each other, and with the portion towards the base of each wing tougher, or more coriaceous than the other portion, which is membranous. In some genera the coriaceous part is so small as to be inconspicuous; and such insects have, by modern entomologists, been separated from the others, and designated by a term expressive of uniformity in the appearance of the wings. An example of this structure is afforded by an insect, whose name

* Half-winged.

† This figure exhibits the shape and jointed structure of the proboscis, and its position when not in use. The legs and antennæ are represented as cut off near the base.

is familiar to every classic reader—the Cicada (*Fig.* 128). Its image, made of gold, was worn by the Athenians in their hair, and to excel its song was the highest commendation of a singer. We quote two stanzas from a spirited ode by Anacreon, addressed to the Cicada, as illustrative of the estimation in which it was formerly held.*

Fig. 128.—Cicada.

"Thine is each treasure that the earth produces;
Thine is the freshness of each field and forest;
Thine are the fruits, and thine are all the flowers,
Balmy spring scatters.

"Thee, all the muses hail a kindred being;
Thee, great Apollo owns a dear companion;
Oh! it was he who gave that note of gladness,
Wearisome never."

The clamorous "Catydids" of North America belong to this tribe; one species has been discovered in England.

The strange-looking creatures to which travellers have given the name of Lantern-flies, and which we see in our museums, belong to the present order. But better known to every inhabitant of these countries is the frothy substance known by the name of Cuckoo-spit, common on plants during

* The translation is extracted from the Entomological Magazine.

the summer months. It is an exudation proceeding from the larva of a little insect (*Aphrophora spumaria*), and affording it, at the same time, concealment from enemies and protection from vicissitudes of weather.

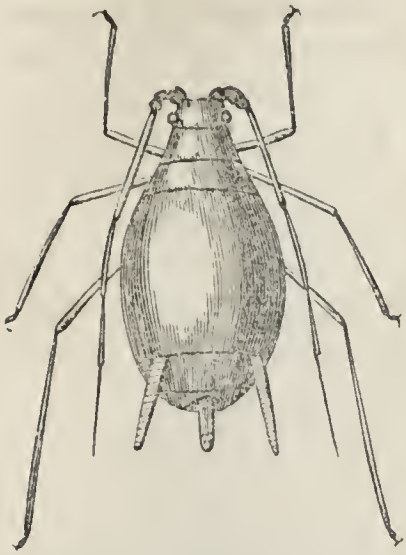

Fig. 129.—Larva of Aphis (magnified).

Fig. 130.—Aphis (magnified).

The minute insects which are black upon the woodbine, green upon the rose, and which have a cottony appearance upon the apple-tree, are all of them different species of Aphides or plant-lice (*Figs.* 129, 130).

> ——"A feeble race, yet oft
> The sacred sons of vengeance, on whose course
> Corrosive famine waits, and kills the year."—Thomson.

When very numerous, they weaken and occasionally destroy the plants on the juices of which they subsist.[1] The saccharine fluid of which the Ants are so fond is secreted by the Aphides; they are preyed upon and destroyed by insects of other orders. The most remarkable circumstance connected with their history, is their extreme fecundity, and the singular provision for the preservation of the race from year to year. A common species which infests the apple, and is known as the American Blight (*Aphis lanigera*), produces, in the course of a season, eleven broods of young. The first ten broods are viviparous, or are brought forth alive, and consist entirely of females. These never attain their full development as perfect insects; but, being only in the larva state, bring forth young, and the virgin Aphides thus produced are endowed with similar fecundity. But at the tenth brood this power ceases.

The eleventh does not consist of active female larvæ alone, but of males and females. These acquire wings, rise into the air, sometimes migrate in countless myriads, and produce eggs which, glued to twigs and leaf-stalks, retain their vitality through the winter. When the advance of spring again clothes the plants with verdure, the eggs are hatched, "and the larva, without having to wait for the acquisition of its mature and winged form, as in other insects, forthwith begins to produce a brood as hungry and insatiable, and as fertile as itself." Supposing that one Aphis produced 100 at each brood, she would at the tenth brood be the progenitor of one quintillion of descendants!—1,000,000,000,000,000,000!*

There is another tribe known to gardeners as scale insects, or mealy bugs, which are very destructive, especially to our hot-house plants. They constitute the family *Coccidæ*. The female, from her motionless aspect, bears a greater resemblance to a gall or excrescence upon a leaf than to a living insect with numerous young. But if these singular and inert beings are the cause of occasional injury to man, they repay the damage a hundredfold, by furnishing him with the brilliant scarlet dye known in commerce by the name of cochineal. The insect from which this is procured is the *Coccus Cacti*, of Mexico. It is found upon a plant termed "Cactus Cochinellifer," and is collected in such quantities, that, according to Humboldt, 80,000 pounds of cochineal are annually brought to Europe, each pound containing about 70,000 insects; and Dr. Bancroft estimated the weight of that annually consumed in England at 150,000 pounds, worth £370,000.† Lac, a substance much used for varnishes, sealing-wax, &c. is produced by another species of the same family.

Fig. 131. NOTONECTA.

Every pond affords examples of other insects whose structure exhibits, in a more obvious manner, the characteristics of the order. There we find the Boat-fly (*Notonecta*, *Fig.* 131), which rows gracefully along upon its back; and the Water-scorpion (*Nepa*, *Fig.* 132), in which the dark external covering of our most common native species contrasts beautifully with the scarlet body underneath; and others which glide

* Owen, page 235.

† Westwood, pages 448, 449.

rapidly along, or perform a more unusual feat—that of walking upon the surface of water.

Fig. 132.—Nepa.

To the present order belongs one insect, universally regarded as a very disgusting visitant (the Bed-bug, *Cimex lectularius*, *Fig.* 133). This creature would appear to be much more common now than in the days of Queen Elizabeth; for, although Shakspeare mentions several insects in his plays, and the word Bug occurs five or six times, it is never applied to the insect, but is always used as synonymous with Bugbear.* It is destitute of wings, differing in this respect from some of those (*Figs.* 126, 127) which feed on the juices of plants, and are sometimes of large size and brilliant colours.

Fig. 133.—Bed-bug (magnified).

DIPTERA.†

This order consists entirely of two-winged flies. The wings are membranous. The mouth is formed for suction; and in certain tribes, such as the Gnat (*Fig.* 134), the Gad-flies, &c. it is furnished with lancet or razor-shaped organs, to enable it to pierce the skin. So great is the number, not only of individuals but of species, that above a thousand species fully described and named are recorded as indigenous to Ireland. We do not, therefore, attempt any enumeration of the different families or their distinguishing characteristics, but merely bring forward a few examples of their powers, whether beneficial or injurious.

The larvæ of some species live in the most disgusting substances, and speedily effect their removal. Of the family (*Muscidæ*) to which the House-fly, the Blue Bottle-fly, &c. belong, Meigen has described nearly 1,700 European species. Among these are the Flesh-flies, whose office it is to consume

* Thus, "Tush! tush! fear boys with *bugs*."
"The *bug* which you will fright me with I seek."

† Two winged.

Fig. 134.—Gnat (magnified).

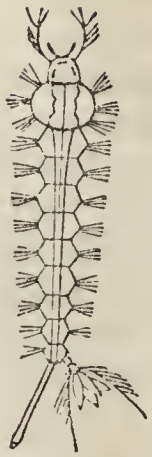

Fig. 135.—Larva (magnified.)

the dead and decaying bodies of animals, which soon would taint our atmosphere. They are gifted with wonderful powers for effecting this object. The young are brought forth alive, and the female will give birth to twenty thousand young.* Hence the assertion of Linnæus, with regard to *Musca vomitoria*, that three of these flies would devour a dead horse as quickly as a lion would, is perhaps not much overstrained.

So far these insects are the benefactors of man. Let us now regard them as his tormentors, or as the cause of irritation and suffering to many of his most valuable quadrupeds.

According to Arthur Young, flies—that is, the common House-flies—constitute "the first of torments in Spain, Italy, and the olive districts of France. It is not," continues he, "that they bite, sting, or hurt, but they buzz, tease, and worry. Your mouth, eyes, ears, and nose are full of them; they swarm on every eatable; fruit, sugar, milk, everything is attacked by them."† Humboldt, in his Personal Narrative, frequently mentions "these noxious insects, which, in spite of their littleness, act an important part in the economy of Nature." The annoyance occasioned by the Mosquito is noticed by every traveller in the southern parts of Europe and the northern parts of Asia and America. Dr. Clarke states, in his journey along the frontier of Circassia, that the Cossack soldiers "pass the night upon the bare earth, pro-

* Westwood, page 569, on the authority of De Geer and Reaumur.

† Travels, vol. ii. page 35.

tected from the Mosquitos by creeping into a kind of sack sufficient only for the covering of a single person.*

Let us now notice, with equal brevity, the sufferings inflicted by insects on some of our domestic animals. No words which we could use for this purpose would be so graphic as those of Spencer:—

> "As when a swarme of Gnats at eventide
> Out of the fennes of Allan do arise,
> Their murmuring, small trumpets sounden wide;
> Whiles in the air their clust'ring armies flyes,
> That as a cloud doth seem to dim the skyes;
> Ne man nor beast may rest, or take repast,
> For their sharp wounds and noyous injuries;
> 'Till the fierce northern wind, with blustering blast,
> Doth blowe them quite away, and in the ocean cast."
>
> FAERY QUEENE, Book II. c. ix. st. 16.

Besides being subjected to the biting of Gnats, our horses and oxen suffer from the various species of Gad-flies (*Tabanidæ*, *Fig.* 135), which make them the peculiar object of attack. They pierce the skin, and suck the blood, their razor-shaped weapons performing the double office of making the wound and pumping out the liquid. The peculiar noise which they make, and which has gained them the name of "the breeze," constitutes of itself a source of fright and annoyance.†

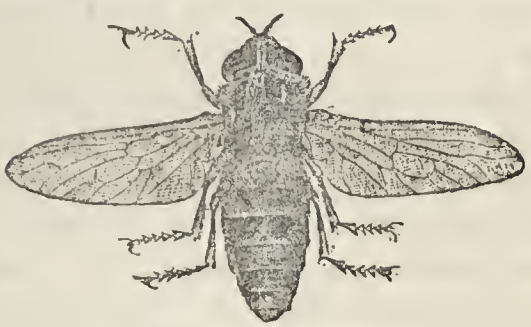

Fig. 135.—TABANUS.

Perhaps the terror caused by the Bot-flies, or Œstri (*Fig.* 136), is still more striking; it has long been observed, for it is accurately described by Virgil.‡ Each species of Œstrus not only selects the peculiar species of quadruped on which it is parasitic, but with unfailing instinct fixes its eggs in the situation best adapted for the welfare of its future progeny.§ Thus, the species which attacks the ox deposits its eggs on the back of the animal, and these, when hatched, produce the

* Travels by Edward Daniel Clarke, LL.D. 2d edition, page 387.
† Westwood, page 539.
‡ Georgics, Book III.
§ Bracey Clarke in Trans. Linnæan Society.

Fig. 136.
Œstrus.

Fig. 137.
Larva.

tumours known among the country people by the name of "wurbles;" while one devoted to the horse fixes them on the parts most liable to be licked by the animal. They are thus taken into the stomach, and there they remain at a temperature of one hundred degrees, until they attain their full size, as the larvæ so well known by the name of "bots" (*Fig.* 137).

But it would be unjust to allow the reader to leave the Dipterous insects without bringing some of the tribes before him in their hours of enjoyment. Every person is familiar with the appearance of that large-winged, long-bodied insect, known as the "Harry Long Legs;" the largest species we have of the *Tipulidæ*. The members of this family and those which are spoken of as "Midges" (*Culicidæ*) have long been noted for their aërial dances. Every one has observed how they come forth in the sunshine, how they sometimes keep pace with the traveller as he journeys along,* and how even in winter they occasionally present themselves in multitudes. Some instances are recorded of their appearing in such numbers as to excite surprise, and even alarm. Thus, in Phil. Trans. 1767, it is stated that in 1736 the common Gnat (*Culex pipiens*) rose in the air from Salisbury Cathedral in columns so resembling smoke, that many people thought the cathedral was on fire. In Norwich, in 1813, a similar alarm was created. At Oxford, in 1766, "a little before sunset, six columns of them were observed to ascend from the boughs of an apple-tree, some in a perpendicular, and others in an oblique direction, to the height of fifty or sixty feet."

For some successive evenings towards the middle of June, 1842, a phenomenon similar to that last mentioned was observed by us in the vicinity of Belfast. "The insects appeared in columns above the trees, the shade of colour varying according

* This circumstance has been thus noticed by Wordsworth:—

> "Across a bare, wide common I was toiling,
> With languid feet, which by the slippery ground
> Were baffled; nor could my weak arm disperse
> The hosts of insects gathering round my face,
> And ever with me as I paced along."—The Excursion.

to the greater or less density of the mass, from that of light vapour to black smoke, the columns not only differing in this respect from each other, but each column being frequently different in different parts. They might have been mistaken for dark smoke-wreaths but for their general uniformity of breadth, and for a graceful and easy undulation, similar to that of the tail of a boy's kite, when at some height and tolerably steady. The individual insects flew about in each column in a confused and whirling multitude, without presenting in their mazy dance any of those regular figures which Gnats frequently exhibit over pools of water, while the motion of their wings filled the air with a peculiar and not unmelodious humming noise. The columns rose perpendicularly to the height of from 30 to 60 feet, and in some instances to the height of 80 feet. They were equally abundant over trees of every kind, as ash, beech, birch, poplar, &c.; and so numerous were these distinct columns, that so many as from 200 to 300 were visible at the same time. As each column was every instant undergoing a change in density of colour, diameter, elevation, or form, the phenomenon was one of exceeding interest, especially as connected with the living myriads which, in these aërial gambols, gave expression to their enjoyment."

If we ask, why do they thus associate together? by what principle are they impelled to congregate in this ever-varying dance? we are unable to give any reply to the question more just, or more philosophical, than that suggested by the Poet:—

"Nor wanting here, to entertain the thought,
Creatures that in communities exist,
Less as might seem for general guardianship,
Or through dependence upon mutual aid,
Than by participation of delight
And a strict fellowship of love combined;
What other spirit can it be that prompts
The gilded Summer-flies to mix and weave
Their sports together in the solar beam,
Or in the gloom of twilight hum their joy?"—Wordsworth.

APTERA.*

Under this term numerous insects, and tribes allied to insects, have, since the time of Aristotle, been artificially grouped together, the common bond of union being their agreement in the negative character derived from the absence of wings. The Linnæan order *Aptera* is subdivided by modern entomologists into four orders.

I. Myriapoda.—Insects which are possessed of numerous feet, such as the Centipede and the Millepede, belong to this order. The Centipede (*Scolopendra, Fig.* 139) is carnivorous

Fig. 138.—Scolopendra.

in its habits, and infuses a poisonous secretion into the wound inflicted by its mandibles. Some of the foreign species of Centipede are above a foot in length, and proportionately formidable. The Millepede (*Julus, Fig.* 139) feeds principally on decaying vegetable matter, and is frequently found under the bark of trees, coiled up like the mainspring of a watch.

Fig. 139.—Julus.

II. Thysanoura (*fringed-tail*).—In this order there is great diversity of structure; but the peculiarity whence the name of the order is derived, will be understood by reference to

* *Without wings.* The *Crustacea* and *Arachnida*, which now constitute distinct classes, were formerly included in this order.

Fig. 140), representing an insect which frequents stony places, and is allied, in its structure, to that found in sugar (*Lepisma*). The name *Podura*, meaning literally a "leg in the tail," was bestowed by Linnæus on those which have the tail forked

Fig. 140.
MACHILIS (MAGNIFIED).

Fig. 141.—PODURA (MAGNIFIED).

Fig. 142.—THE COMMON LOUSE (MAGNIFIED), WITH THE EGGS THE NATURAL SIZE AND MAGNIFIED.

(*Fig.* 141). It is kept bent underneath the body when not in use; when unbent it acts as a spring, and has given origin to their English name of Spring-tails."* Some species abound on pools, leaping even on the surface of the water; others may be found under stones or beneath decaying leaves.

III. PARASITA.—The Louse (*Fig.* 142) and its allies—insects parasitic on man and the lower animals—form the numerous but unpopular genera comprised in the present order.

* A Paper, by Robert Templeton, Esq. on the Irish species of spring-tailed insects, is published in the Transactions of the Entomological Society, vol. i.

Fig. 143.
Flea (magnified).

IV. Suctoria.—These insects may be represented by the common Flea (*Pulex irritans*, *Fig.* 143). The mouth of the Flea is formed for suction, and the hind legs for jumping. The length of its leap has been measured, and found to be two hundred times that of its body—an extraordinary instance of muscular power.

Class V.—ARACHNIDA—SPIDERS, &c.

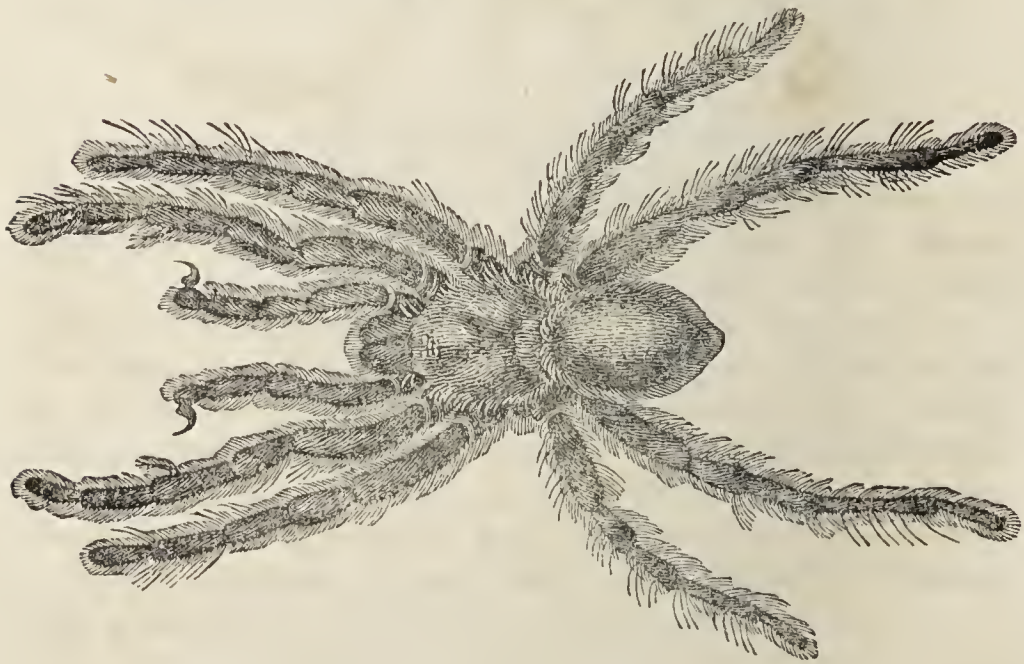

Fig. 144.—Mygale.

The present class includes Mites, Scorpions, and Spiders. They exhibit a more concentrated state of the nervous system than insects; they do not undergo similar transformations; and in the larger tribes there is a higher condition of the respiratory system; for they breathe not by air tubes, but by "air sacs, or lungs."* They differ from true insects, also, in their having four pair instead of three pair of legs.

The eyes vary in number and position, but are never compound. Spiders have the sense of hearing, but neither the organ nor its situation is known: the same may be said of the sense of smell.

* Owen, pages 250, 251, 257, 260.

All Spiders secrete a poisonous fluid, which is, no doubt, formidable and even fatal to insects, though it produces but little effect on the human frame. The poison is conveyed through a perforated fang in the mandibles. In the Scorpion (*Fig.* 145),

Fig. 145.—Scorpion.

on the contrary, it is lodged in the extremity of the slender flexible tail, and the wound is inflicted by the recurved sting by which the tail is terminated.

Spiders have another secretion, still better known;—that which furnishes the material of which their threads are composed. The little teats, whence the threads proceed, are at the hinder extremity of the body, and are four, six, or eight in number. Each of these is composed of orifices so fine, that Leeuwenhoek and other eminent microscopic observers have regarded a Spider's thread, even when so fine that it is almost imperceptible to our senses, not as a single line, but as a rope composed of at least four thousand strands. From Mr. Blackwall's observations, there is reason to think that this estimate is too high, and that the total number of the *papillæ*, whence the lines proceed, does not greatly exceed a thousand; yet, even admitting this to be the case, our wonder at the complex structure of a Spider's thread is scarcely lessened.*

That any creature could be found to fabricate a net, not less ingenious than that of the fisherman, for the capture of its prey; that it should fix it in the right place, and then patiently await the result, is a proceeding so strange, that if we did not see it done daily before our eyes by the common House-spider and Garden-spider, it would seem wonderful; but how much is our wonder increased when we think of the complex fabric

* Trans. Linnæan Society, vol. xvi. page 220.

of each single thread, and then of the mathematical precision and rapidity with which, in certain cases, the net itself is constructed; and to add to all this, as an example of the wonders which the most common things exhibit when carefully examined, the net of the Garden-spider consists of two distinct kinds of silk. The threads forming the concentric circles are composed of a silk much more elastic than that of the rays; and are studded over with minute globules of a viscid gum, sufficiently adhesive to retain any unwary fly which comes in contact with it. A net of average dimensions is estimated by Mr. Blackwall, to contain 87,360 of these globules, and a large net of fourteen or sixteen inches in diameter, 120,000; and yet such a net will be completed by one species (*Epeira apoclisa*) in about forty minutes, on an average, if no interruption occur.* In ordinary circumstances, the threads lose their viscidity by exposure to the air, and require to have it renewed every twenty-four hours. Any observer, by scattering a little fine dust over the web, may satisfy himself that it is retained only on the circles where the minute globules are placed, and not upon the radii.† If the globules are removed, both lines are unadhesive; but in other respects they are essentially different, the circular lines being transparent and highly elastic, while the radial lines are opaque, and possess only a moderate degree of elasticity. The astronomer finds the opaque silk of the radial lines and of the egg-bag a convenient substitute for platina wires in the telescopes attached to his instruments; but the silk of the circular lines being transparent, is, from that circumstance, unsuitable for his purpose.‡ The nets of some Spiders are constructed under water—the secretion being insoluble—and are spread out for the capture of aquatic insects.

A great deal of false commiseration has been bestowed upon the flies which fall victims to the voracity of the Spider, who has accordingly been regarded as "Cunning and fierce, mixture abhorred." But considered aright, there is no cruelty in any animal exercising, for its support, those powers with which it has been endowed by its Creator. It does not kill

* Trans. Linnæan Society, vol. xvi. page 478.

† Kirby and Spence, vol. i. page 419.

‡ This fact has been very kindly communicated to us by the Rev. Dr. Robinson, Armagh Observatory. The silk there employed is procured from the egg-bags of the common Garden Spider (*Epeira Diadema*).

from wantonness but from necessity. It must kill, or it must cease to live.

Gossamer, the origin of which was formerly conjectural, is now known to be the production of a minute Spider. Spencer speaks of it as "scorched dew," and Thomson regards it as "the filmy threads of dew evaporate."

Spiders have been divided into families, which present very considerable differences in their modes of life. Some are hunters, and live by the chase; some leap upon their prey; some more deliberately move sideways or backwards, as the exigency requires; some fix long threads and prowl about them to secure their game, while others construct nets of various kinds in the air, or exercise their skill in the water.

Not less varied are their habitations. Perhaps the most remarkable is that of the *Mygale cæmentaria*, who, having formed a subterraneous tube or gallery, lines it with silk, and constructs a door formed of several coats of cemented earth and silk. "This door (*Fig.* 145) the ingenious artist fixes to the entrance of her gallery by a hinge of silk; and, as if acquainted with the laws of gravity, she invariably fixes the hinge at the highest side of the opening, so that the door, when pushed up, shuts again by its own weight." The part against which it closes with great accuracy, and the defences by which it is secured, are not less excellent as mechanical contrivances.

Fig. 145.—Nest of Mygale.

The female Spider is remarkable for her parental affection. One species (*Epeira fasciata*) makes an elaborate envelope for her eggs, attaches it to a branch of a high tree, and guards it with ceaseless vigilance. The habits of another are thus described by Professor Hentz: "When a mother is found with the cocoon containing the progeny, if this be forcibly torn from her, she turns round and grasps it with her mandibulæ (mandibles). All her limbs, one by one, may then be torn from her body without forcing her to abandon her hold. But if, without mangling the mother, the cocoon be skilfully removed from her, and suddenly thrown out of sight, she

instantaneously loses all her activity, seems paralysed, and coils her tremulous limbs, as if mortally wounded: if the bag be returned, her ferocity and strength are restored the moment she has any perception of its presence, and she rushes to her treasure to defend it to the last."

We now close our notice of the Articulated animals. We have spoken of Worms, Barnacles, Crabs, Insects, and Spiders; to common observers a motley and unattractive group. Yet, how varied in their structure! how wondrous in their habits! To the humble-minded and patient observer, they are suggestive of ideas and emotions too multiplied and fugitive to be embodied in words, but affording an example of the truth so beautifully expressed by the poet:—

"The air in which we breathe and live,
Eludes our touch and sight;
The fairest flowers their fragrance give,
To stillness and to night:
The softest sounds that music flings,
In passing from her heaven-plumed wings,
Are trackless in their flight!
And thus life's sweetest bliss is known
To silent, grateful thoughts alone."—B. Barton.

MOLLUSCA.

"O what an endlesse work have I in hand,
To count the sea's abundant progeny!
Whose fruitful seede farre passeth those in land,
And also those which wonne in the azure sky;
And much more eath to tell the starres on hy
Albe they endlesse seeme in estimation;
Then to recount the sea's posterity,
So fertile be the flouds in generation,
So huge their numbers, and so numberlesse their nation."

SPENSER'S FAERY QUEENE, Book iv. canto xii.

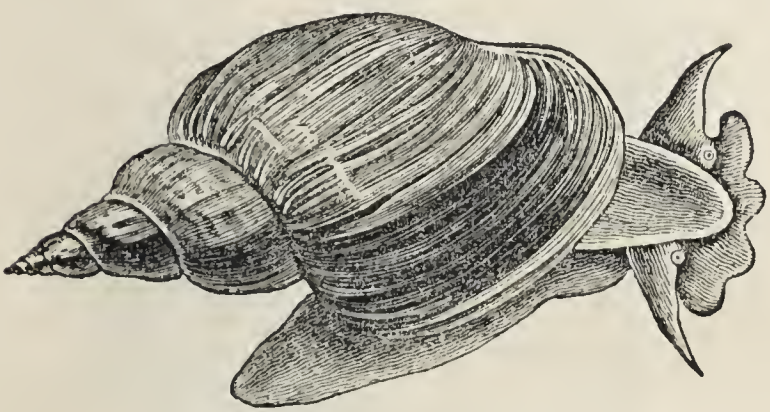

Fig. 147.—LYMNEUS STAGNALIS.

THE soft-bodied animals, to which the term "*Mollusca*" is applied, constitute another of the primary groups of the animal kingdom. In them we see no longer the jointed or articulated structure characteristic of the crustacea and insects. The body, as the very name of the group implies, is soft, and it is devoid of the jointed legs, which, in some of the preceding tribes, were applied to such diversified uses. The nervous system is also different, being unsymmetrical; it consists of a ring surrounding the gullet, with one or two ganglions or knots of nervous matter connected with similar masses in other parts of the body. "The blood is colourless, or not red,"* and the respiratory organ or gill, which is never

* Owen, page 13.

wanting, presents great diversity in position and figure, and is, in some species, a very remarkable and attractive object.

The Mollusca are very widely diffused, abounding not only in tropical and arctic seas, but in lakes, ponds, and rivers. Some, round our coasts, are found buried in sand or mud; others construct their dwellings in indurated clay, and even in limestone rocks. Some species (*Fig.* 147) delight in quiet sunny nooks, on the margin of fresh-water pools; some in rapid and mighty rivers; and others dwell in the ocean at depths which have been but seldom explored by the dredge of the naturalist. But though the greater number are aquatic, all are not so. The terrestrial species, even in our own country, are found in our pastures, our gardens, and our plantations; some may be found on sandy banks, others in moist and shady places; some lurking under withered leaves, and others at various heights on the trunks of our forest trees.

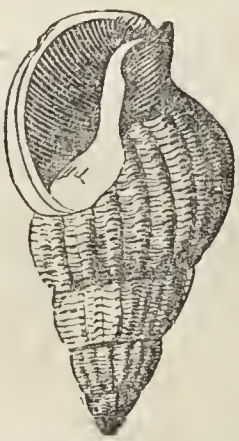

Fig. 148.—Buccinum.

Fig. 149.—Volute.

The beautiful variety of form (*Figs.* 148, 149, &c.) observable in the shells of different species of Mollusca, has, in all ages, attracted attention; and the splendour of their colouring is not surpassed by that of our brightest garden-flowers. In some respects it is even superior, for their most delicate tints become here unfading and permanent; and a peculiar structure of the surface gives rise occasionally to iridescent hues. Among savage tribes, shells are formed into elaborate ornaments, and applied to numberless uses. In a part of Africa a species of shell called "cowry" is the current coin. The *wampum* belts of some of the North American Indians, whether constituting their records or presented to strangers when they enter into or recognise a treaty of amity, are

formed of shells. "The thin inner layers of some large flat bivalves, when polished, are used in the south of China, and in India, instead of glass, for windows."* Many of the domestic utensils of uncivilised nations are shells; and they are converted into drinking-cups, knives, spoons, fishing-hooks, and even razors. "In Zetland, one of our common univalve shells (*Fusus antiquus*), suspended horizontally by a cord, is used as a lamp, the canal serving to hold the wick, and the cavity to contain the oil." In former times the scallop (*Pecten maximus*, or *opercularis*) was worn by religious pilgrims, a custom occasionally referred to by our poets. Thus, Parnell says of his hermit,—

> "He quits his cell, the pilgrim staff he bore,
> And fixed the *scallop* in his hat before."

The difference in point of size is not less remarkable than that of the form and colouring. The Tridacna, or Giant Clamp-shell (*Fig.* 150) is said to attain occasionally a weight

Fig. 150.—Tridacna.

of more than 500 pounds; from which circumstance the story may have originated of an oyster which furnished a dinner to a whole regiment. Let us, in imagination, contrast with this the microscopic chambered shells, of which Soldari collected the astonishing number of 10,454,† from less than an ounce and a half of stone found in the hills of Casciana, in Tuscany. "Some idea of the diminutive size of these shells may be

* From a series of papers on Molluscous animals, signed "G. J." in Loudon's Magazine of Natural History. They are from the pen of Dr. Johnston, author of the History of British Zoophytes, &c. who has, in the kindest manner, authorised us to make use of them.

† Dr. Buckland's Bridgewater Treatise, vol. i. page 117.

formed from the circumstance, that immense numbers of them passed through a paper in which holes had been pricked with a needle of the smallest size." Even without going to foreign countries, or having recourse to the microscope, we have, on our own shores, examples of shells remarkable for their minuteness. On one occasion we gathered some handfuls of a small univalve shell (*Paludina muriatica.*—Lamarck), which was lying in dark, irregular patches on the strand, near Belfast. It bore considerable resemblance, except in size, to the common fresh-water species (*Fig.* 151). The weight of four quills, when filled with these shells, was 80 grains; and, as twenty-two of the shells, with their contained animals, weighed only two grains, the number of shells thus enclosed was 880. The weight of the quills and their contents, when enclosed in a letter, was less than half an ounce; and we were, therefore, enabled to transmit 880 living animals and their habitations from Belfast to Dublin, per mail, for one penny.

Fig. 151. PALUDINA.

We have just used the word "habitations," and it is in this light that shells should be viewed. They are not beautiful productions formed merely to please the eye, but are mansions constructed by molluscous animals for their own especial use and safety. How much is the worth of a shell enhanced in our eyes by this one consideration! Before, it seemed little else than a toy, a pretty thing to look at, and nothing further; but now it assumes an interest in our thoughts;—we ask, how was it fashioned? of what is it composed? whence were the materials derived? by what means was it so exquisitely coloured? by what architectural skill was the edifice so contrived that it was adapted, at all periods, to the progressive growth and requirements of its occupant?

The shelly matter is secreted by a peculiar organ, termed the "collar" in shells consisting of one piece (*univalves*), such as the common snail-shell; and by the margins of the cloak or mantle in those of two pieces (*bivalves*), such as the oyster or the cockle. The shell was formerly regarded merely as an exudation of calcareous matter, held together by a kind of animal glue. But microscopic observation has shown, that it is a membrane composed of minute cells, dif-

fering in size, shape, and arrangement, in different families, and containing secreted calcareous matter. There seems reason to believe, "that this membrane was, at one time, a constituent part of the *mantle* of the Mollusk;" and Dr. Carpenter regards the cells as "the real agents in the production of shell, it being their office to secrete into their own cavities the carbonate of lime supplied by the fluids of the animal."*

The deposition of the colouring matter is the province of glands situated on the margin of the cloak or collar; and in many instances we are able to trace an agreement in the pattern or tracings on the shell and the arrangement of the colours in the secreting organ. Thus, in the banded Snail, there are as many coloured spots on the edge of the collar as there are zones on the shell; and if a part of the margin of the shell be cut away, the piece reproduced is brown opposite to the dark portion of the collar, but in other parts yellow.

The changes of form which shells undergo, as they approach maturity, is sometimes so great, that the full-grown specimen is altogether different from the appearance presented by the same shell in its immature state. Of this the common Leg-of-mutton Shell (*Aporrhais pes pelicani*, *Fig.* 152) of our shores, and the beautiful tribe of Cypreas (*Fig.* 153), furnish familiar examples. We have reason to believe that there is, in all cases, an effort on the part of the animal to accommodate the form of its mansion to the changes in the form or dimensions of its body. Professor Owen† has stated that an oyster kept without food will frequently expend its last energies in secreting a new layer, "at a distance from the old internal surface of the concave valve, corresponding to the diminution of bulk which it has experienced during its fast, and thus adapt its inflexible outward case to its shrunken body."

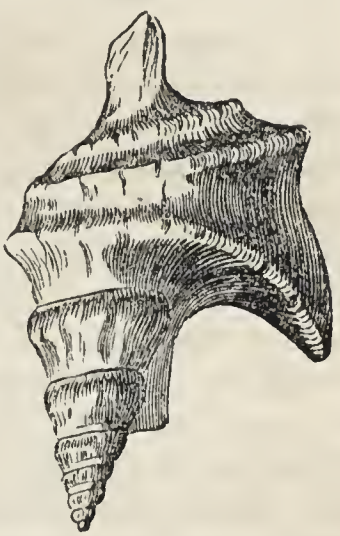

Fig. 152.—Aporrhais.

It has been justly remarked, that the beauty of shells was for ages exerting an influence injurious to the study of

* On the Microscopic Structure of Shells. Report of British Association, 1844.

† Proceedings Zoological Society, No. liv.

conchology on philosophical principles, for it fixed the attention of men more upon the covering than upon the humble animal contained within. Such was not the spirit with which Aristotle regarded them ; for the structure and habits of the creatures were the main objects of his study, while their relations to the other animated beings by which they were surrounded, and their own mutual affinities, were not forgotten.* To conchology as a science, Pliny added nothing that Aristotle did not supply; but he has furnished some anecdotes regarding its economical applications, and has graced its history with some amusing fictions.

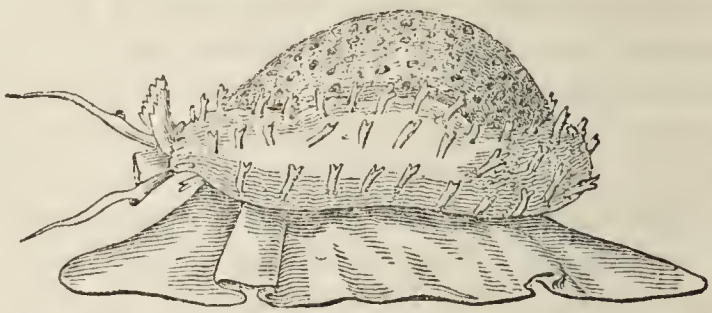

Fig. 153.—Cypræa.

Passing from the ancients to the distinguished Swede, whose labours in the last century have done so much for the advancement of natural science, we come to the system of Linnæus, which was perfected in 1766. Shells were at that time arranged into three primary divisions—univalve, bivalve, and multivalve—according to the number of pieces of which the shell was composed. The animals were spoken of as *naked* mollusca, when, like our common slug, they were destitute of an external shelly covering, and as *testaceous* mollusca (*testa*, a shell), when, like the garden snail, they were furnished with this protection. In the system of Linnæus, the testaceous mollusca occupy one order by themselves, in which there are four sections—multivalve, bivalve, univalves with a regular spire, and univalves without a regular spire. The naked tribes are placed in the order denominated "mollusca," along with worms, zoophytes, and star-fishes.

"In estimating," says Dr. Johnston, "the merits of this system, it is not fair to look back from our present vantage-ground, and magnify its defects by a comparison with modern

* The few remarks here made on the progress of conchology are taken from an article by Dr. Johnston, in Magazine of Zoology and Botany, vol. ii. page 238.

classification: we are, in candour, to place ourselves behind its author, and, looking forward, say how far his efforts have been useful or quickening." "The superiority of it lies in its simplicity; in the regular subordination of all its parts; in the admirable sagacity with which the families or genera are limited;" in the conciseness of the specific characters, the skill with which they were chosen, and the facility with which species could be named. It labours under the censure of having too small a regard to the animals, and to their position in the groups, as regulated by the affinities of their organization.

We now pass on to the labours of Baron Cuvier, who, when scarcely nineteen years of age, went, in 1788, to reside some time at Caen, in Normandy. There the marine mollusca attracted his attention, and he commenced that series of observations on their habits and investigations into their anatomical structure which afterwards formed the sure and enduring basis of his classification. Cuvier's object was not merely "to give us a key to the name, but to make that key open, at the same time, a knowledge of the structure and relations of the creature." According to his system, the student, when in search of the name and place of an object, was obliged, at the same time, to acquire a knowledge of its principal structural peculiarities. On these again, as Cuvier beautifully explained, all its habits in relation to food, to habit, and to locomotion, were made dependent. His division of the animal kingdom into four primary groups or sub-kingdoms has already been mentioned; the essential character of the mollusca, as one of these groups, has also been stated. It is derived from the peculiar arrangement of the nervous system, consisting of some ganglions scattered, as it were, irregularly through the body, and from each of which nerves radiate to its various organs. Their further division into classes is founded on characters derived from the organs of locomotion, or others not less influential.

Since the time of Cuvier, the system which he propounded has been elaborately worked out in detail by succeeding naturalists, and has, from time to time, been slightly modified, according to the advance of knowledge; but in its essential characteristics it remains unchanged. Dr. Johnston, in speaking of the effects of Cuvier's example and views, remarks: "They raised the character of the conchologist, and gave a more philosophical tone to his pursuit; they originated a new

school, with better directed zeal and a higher aim, and numbers became disciples when they saw that here as much satisfaction and profit were to be reaped as in the study of almost any other class; for it may be laid down as an axiom, that no branch of natural history, however apparently trifling, "but may be ennobled by the manner in which it is pursued; and when the student carries all its wonders back to the one Great Source, the smallest worm, and the most beautiful of his own species, will afford him subjects for the deepest contemplation."

We now proceed to examine some of the leading divisions of the mollusca. The first and most obvious is into two great groups, one containing those which, like the common oyster, are destitute of a head (*Acephala*); and the other those which, like the snail, are provided with a head, and generally with mouth, eyes, and tentacula (*Encephala*).* Each group is divided into three classes—the former "according to the modifications of the integument or of the gills;" the latter, according to those of the locomotive organs. We shall briefly notice the characteristics of these six classes, and enumerate some of the best known examples of each.

* The names of the classes into which the mollusca are divided may be exhibited thus:

ACEPHALA.

I. Tunicata ..... with a cloak or tunic.

II. Brachiopoda ..... arm-footed.

III. Lamellibranchiata ..... plate-shaped gills.

ENCEPHALA.

IV. Pteropoda ..... wing-footed.

V. Gasteropoda ..... belly-footed.

VI. Cephalopoda ..... head-footed.

Fig. 154.—Perophora.*

There are some Mollusks which are not naked like the slug, nor provided with a shelly citadel like the oyster, but are furnished with a kind of leathery covering or tunic, and are hence termed "*Tunicated.*" They have already been casually mentioned in our notice of the higher organized polypes (page 27), to which, in certain points of structure, they present a considerable affinity. Some of them are aggregated together, and form compound animals; others are solitary, and so inert that to common observers they exhibit no indications of life. The kind best known to our fishermen is a solitary species (*Ascidia communis*) about the size of the largest common mussel, and to which, from its shape, the name of "paps" is given. The exterior is darkish, warty, and unattractive, and exhibits two orifices, from one of which the animal can squirt water with considerable force. The internal structure is extremely beautiful and delicate. A great part of it consists of a large chamber, lined with a delicate membrane, over which the blood-vessels are widely distributed. The surface is abundantly covered with vibratile cilia; and, as the sea-water is freely admitted into the cavity, the ceaseless action of the cilia propels it in currents over the surface of the membrane, which thus performs the office of an internal gill. The chamber itself is hence appropriately termed the "branchial sac." Through it the nourishment of the animal must pass ere it can be received into the stomach, which is at

* Fig. 154.—*m*, Mouth.—*s*, Stomach.—*i*, Intestine.—*o*, Orifice.—*t*, Common Stem. The arrows indicate the direction of the currents of water subservient to respiration.

the lower extremity. On many occasions we have found specimens of a small crustacean* swimming about in the branchial cavity, and looked upon it as a parasite, established in its appropriate quarters, not as a casual occupant, destined, like some unfortunate wight in the fairy tale, as food for the Ogre into whose fortress it had intruded.

But although some species of Ascidia are rough and darkish, others of smaller size are possessed of glassy transparency, and, when kept alive in vessels of sea-water, furnish a spectacle of novelty and interest. Some of the compound species are branched (*Fig.* 154); and such is their transparency, that the movements of the internal organs can be distinctly seen. This has enabled Milne Edwards† to detect, in these animals, a very singular condition of the circulating system. The blood actually moves backwards and forwards, to and from the heart, in the same vessel, which thus performs the office both of a vein and of an artery, in the manner it was of old supposed to do in the human body. The young Ascidians are not fixed to the place of their birth, but gifted for a short period with locomotive powers, analogous to those of other marine animals already mentioned.

Some of these compound Ascidians are found arranged in regular radiating patterns on the fronds of our large sea-weeds. In such cases, the young, in its early state, has possessed a reproductive power by gemmation or buds, analogous to that of the larva of the medusa already mentioned (page 37). This fact, which has been established by Milne Edwards, explains the origin of the characteristic patterns which they sometimes exhibit on rocks washed by the waves, or on sea-weeds thrown upon the beach. These singularly-formed creatures (*Botrylli*) are, in their colours, gay and diversified, and their general aspect is such as would be presented by minute but brilliant medusæ, set with great regularity round a common centre.

Among the Tunicata are some (*Pyrosoma*) which are found in the open sea, especially in tropical climates, sometimes united together in masses of more than a mile in extent, and lighting up the sea by a beautiful pale greenish light, which passes with great rapidity into the other prismatic colours.

* *Notodelphys ascidicola.* For description and figure, vid. Professor Allman, in Annals of Natural History, vol. xx. July 20, 1847.

† Sur les Ascidies composees des cotes de la Manche. 1841.

A remarkable circumstance regarding the reproduction of some genera, is stated on the authority of Chamisso. The *Salpæ* (*Fig.* 155) are found linked together in long chains;

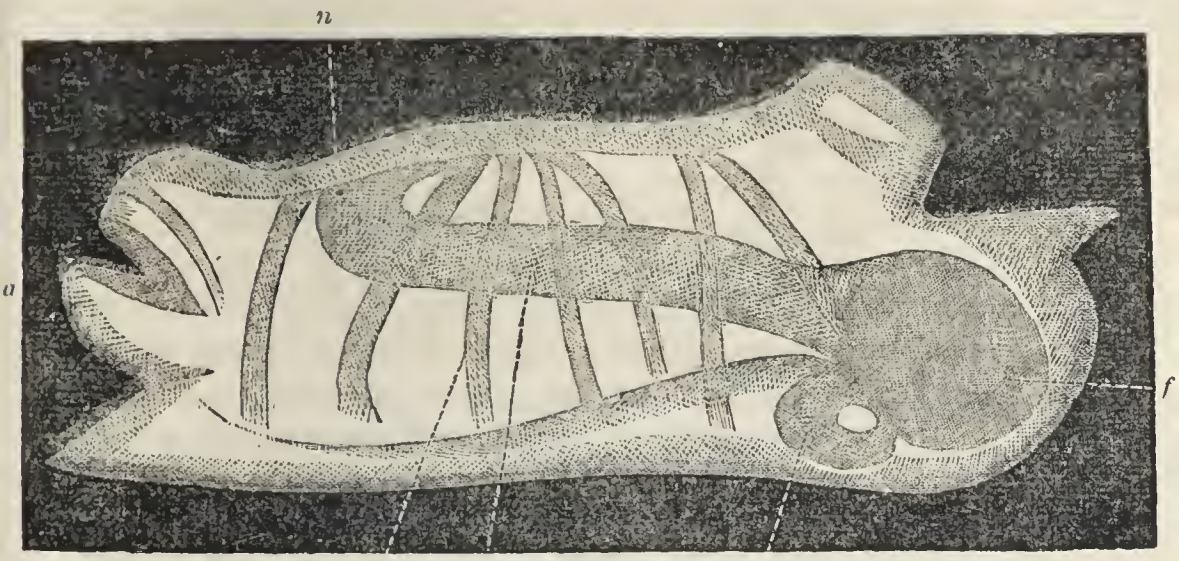

Fig. 155.—Biphora, one of the Salpæ.*

after a time their union is dissolved, and each individual propagates a solitary young one. This attains the full size of the species, and then brings forth a social chain of young *salpæ*, which again give origin to solitary individuals;—"so that a *salpa* mother," to use Chamisso's familiar expression, "is not like its daughter or its own mother, but resembles its grand-daughter and its grandmother."†

BRACHIOPODA.

These are bivalve Mollusca, and, like some of those just mentioned, are destitute of the power of locomotion. They are attached to foreign bodies, and are furnished with two long ciliated arms (*Fig.* 156; hence the name of the class, "arm-footed." They are found abundantly in a fossil state. The species now existing are few in number, and some of them have been brought up from depths of from sixty to ninety fathoms. Mr. Owen, in reference to this circumstance, remarks, that both the respiration and nutrition of animals

* Fig. 155.—*a*, Mouth.—*f*, Liver, &c.—*b*, Branchial Sac.—*m*, Muscular Bands.—*h*, Heart.—*n*, Nervous Ganglion.

† Steenstrup on Alternation of Generations, page 39.

Fig. 156.—Terebratula Psittacea.

Fig. 157.—Valve of the shell of Terebratula.

existing under the pressure of such a depth of sea-water "are subjects suggestive of interesting reflections, and lead one to contemplate with less surprise the great strength and complexity of some of the minutest parts of the frames of these diminutive creatures. In the unbroken stillness which must pervade those abysses, their existence must depend upon their power of exciting a perpetual current around them, in order to dissipate the water already laden with their effête particles, and to bring within the reach of their prehensile organs the animalcules adapted for their sustenance."* Some of these animals have been taken in deep water on the Irish coast, at Cork, Youghal, Kinsale, and the entrance to Belfast Bay.†

LAMELLIBRANCHIATA.

Fig. 158.—Mactra.

The third and last class of those Mollusks which are headless comprises those which have their gills in the form of mem-

* Lectures, page 279.

† W. Thompson, Report on the Invertebrate Fauna of Ireland.

branous plates; and, as the Latin word *lamella* means a plate, the compound term above employed denotes that structural peculiarity by which the class is distinguished. It includes the oyster, the scallop, the cockle, the mussel, and other well-known bivalves.

The sexes are distinct. The ova remain, for some time, in receptacles within the gills, which are thus made to perform the office of a marsupial sac; and here the young of some species, in their more advanced state, may be observed swimming freely about. The young of others anchor themselves, after exclusion from the parent, by means of silken filaments which are wanting in the mature individual, thus furnishing to the naturalist a beautiful example of "prospective design for the well-being of the weak and defenceless." *

The mouth of the oyster is situated near the hinge, beneath a kind of hood formed by the edges of the mantle (*Fig.* 159). But the question naturally arises, how is it supplied with food, the animal itself being utterly incapable of any active exertion for that purpose? We shall answer in the words of Professor Rymer Jones:—"Wonderful, indeed, is the elaborate mechanism employed to effect the double purpose of renewing the respired fluid and feeding the helpless inhabitants of these shells! Every filament of the branchial fringe, examined under a powerful microscope, is found to be covered with countless cilia in constant vibration, causing, by their united efforts, powerful and rapid currents, which, sweeping over the entire surface of the gills, hurry towards the mouth whatever floating animalcules or nutritious particles may be brought within the limits of their action, and thus bring streams of nutritive molecules to the very aperture through which they are conveyed to the stomach, the lips and labial fringes acting as sentinels to admit or refuse entrance, as the matter supplied may be of a wholesome or pernicious character."† Furnished with an apparatus so effectual, we can imagine that these animals realise the condition described by the poet; and,

> ——"In their pearly shells at ease, attend
> Moist nourishment."—Milton.

If, however, while the oysters are thus lying "at ease," the

* Owen, pages 289, 290.
† Outline of the Animal Kingdom, page 378.

shadow of an approaching boat is thrown forward, so as to cover them, they close the valves of their shells before any undulation of the water can have reached them, thus showing they are sensible to changes of light.*

"The principal breeding season of the common oyster (*Fig.* 159) is in April and May, when they cast forth their

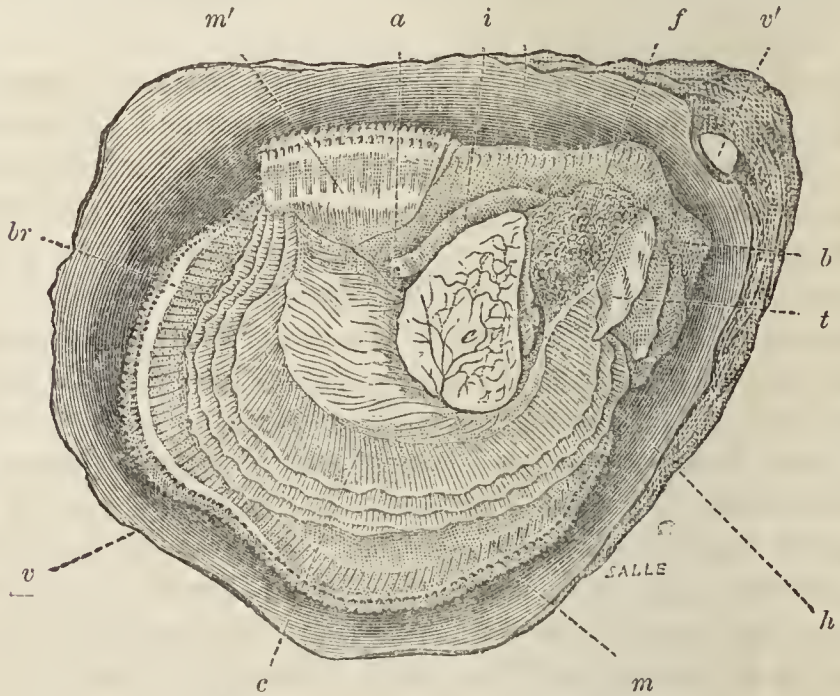

Fig. 159.—Anatomy of the Oyster.†

young in little masses like drops of grease, formed of several united together by an adhesive fluid, upon rocks, stones, or other hard substances that happen to be near; and to these the *spats*, as they are termed by fishermen, immediately adhere, soon forming a thin shelly covering. Very commonly they adhere to adult shells, and thus are formed the large masses termed *banks*. Their growth is very rapid. In three months they are larger than a shilling; and, at the end of the first year, they have a diameter of two inches."‡

Shakspeare has said, "Honesty dwells like a miser in a poor-house as your pearl in your foul oyster;" and the con-

* Owen, page 285.

† Fig. 159.—*v*, One of the valves of the shell.—*v'*, Hinge.—*m*, One of the lobes of the mantle.—*m'*, Portion of the other lobe folded back.—*c*, Adductor muscle.—*br*, Branchia, or gills.—*b*, Mouth.—*t*, Tentacula.—*f*, Liver.—*i*, Intestine.—*a*, Orifice.—*h*, heart.

‡ Carpenter's Zoology, vol. ii. page 398.

nexion of the oyster with the pearl is one of the interesting circumstances connected with its history. Moore, with his usual felicity, has referred to the Eastern fable of

> ——"That rain from the sky
> That turns into pearls as it falls in the sea."

The real facts, as at present known, are scarcely less wonderful. The shell is pierced by some worm, and the oyster deposits the "nacre," or mother-of-pearl, on the perforated part; or grains of sand or gravel gain admission into the substance of the mantle, and become encrusted by a similar deposit. This would appear to be, in many instances, the origin of the pearls, so highly prized, and still so eagerly sought for. The Romans were extravagantly fond of these ornaments, which they ranked next to the diamond, and are said to have given almost incredible prices for them. "Julius Cæsar presented Servilia, the mother of M. Brutus, with a pearl worth £48,417 10*s.*; and Cleopatra, at a feast with Antony, of which Pliny has given a long and interesting account, swallowed one dissolved in vinegar of the value of £80,729 3*s.* 4*d.*" Such statements are generally regarded by naturalists of the present day with distrust, as exaggerated or erroneous.

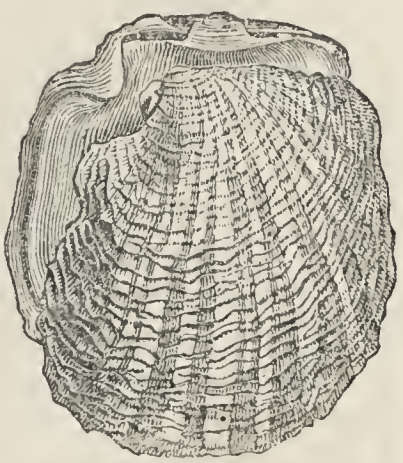

Fig. 160.—Pearl Oyster.

The shell (*Avicula margaritacea, Fig.* 160) from which the greater number of pearls and the largest quantity of mother-of-pearl is obtained, is not an oyster strictly so called, but belongs to an allied genus. It is not our intention to enter into any history of the pearl fisheries of Ceylon or the Persian Gulf, which annually give employment to some hundreds of boats and many thousand men. But we would mention, that a very exaggerated idea prevails as to the length of time a pearl-diver is in the habit of staying under water. The usual period on the Aripo banks is stated by Captain Steuart to be 53 to 57 seconds; when paid for the

effort they stay 84 or 87 seconds.* The depth is commonly from four and a half to eight fathoms. The entire amount of revenue derived from the pearl-fisheries of Ceylon, from March, 1828, to May, 1837, amounted, according to the same authority, to £227,131, but has decreased very considerably since that time.

The large Scallop, or, as it is called in the North of Ireland, the "Clam-shell" (*Pecten maximus*), is said to have the power of moving rapidly through the water by striking the valves of the shell together, and thus propelling itself in the contrary direction. Though we have, on many occasions, dredged up the animal, we have not had the good fortune to witness this procedure.

The common Mussel (*Mytilus edulis*) enjoys no such power of locomotion, being moored to its "bed" by the silken cable which it constructs for the purpose. This *byssus*, or, to use a more common term, this *beard*, of the Mussel, has been employed to assist in giving additional strength to works of human construction. At the town of Bideford, in Devonshire, there is a long bridge of twenty-four arches across the Towridge river, near its junction with the Taw. At this bridge the tide flows so rapidly, that it cannot be kept in repair by mortar. The corporation, therefore, keep boats in employ to bring mussels to it, and the interstices of the bridge are filled by hand with these mussels. It is supported from being driven away by the tide entirely by the strong threads these mussels fix to the stonework; and by an act, or grant, it is a crime liable to transportation for any person to remove these mussels, unless in the presence and by the consent of the corporative trustees.†

The Pinna, a bivalve already mentioned (page 84) excels any other in the quantity and fineness of its silk, "which has been woven into some articles of dress, that in early times were so highly prized as to be worn only by emperors and kings." At Taranto, in Italy, it is still mixed with about one-third of real silk, and made into gloves, caps, stockings, &c.

* Pearl Fisheries of Ceylon, by James Steuart, Master Attendant at Colombo, and formerly Inspector of Pearl Banks.—Printed at Ceylon, 1843.

† Daniel's Rural Sports, vol. ii. page 90.

of a beautiful brownish colour, valued as objects of curiosity, but too expensive for general use, the price of a pair of gloves on the spot being about six shillings, and that of a pair of stockings, eleven.*

But all the bivalves of this class are not destitute of organs specially adapted for locomotion. The "foot" of the common Cockle is an example of the contrary. By means of this instrument, the animal can, with ease, bury itself in the sand. In some of those bivalves the creature excavates its dwelling in mud, and, furnished with a tubular apparatus, thus keeps up its communication with the water above, and feels no want of either respiration or nourishment. The foot, in its structure, "almost exactly resembles the tongue of a quadruped, being entirely made up of layers of muscles crossing each other at various angles; the external layers being circular or oblique in their disposition, while the internal strata are disposed longitudinally."†

Perhaps this is the place where we may best direct the attention of the reader to the vast importance of the marine Mollusca of our coast, as an article of food. As such they find their way into the dwellings of the rich, and are prized as a cheap and wholesome article of diet in the cabins of the poor. If it were possible to obtain from each locality some tabular returns of the number of persons employed in collecting "shell-fish," to use the common appellation, and of the average weight which each individual procured, we doubt not that the result would be so great as to excite astonishment. While residing, in July, 1837, near the town of Larne, County Antrim, we endeavoured to form some calculation of the quantity of the common Limpet taken from the rocks about that part of the coast, and used as food, and had reason to believe that the weight of the boiled "fish" was above eleven tons.‡ The weight, as carried from the beach, was, however, much greater, as there is to be added that of the shell, and of a small quantity of sea-water which it contained. Whelks or Periwinkles (*Turbo littoreus*, Linn.) were also collected at the same time; and thus made the probable weight of these two kinds of shell-fish as taken from one locality, in a single

* Dr. Johnston. Mag. Nat. Hist. vol. iii. page 257.

† Jones's Outline, page 381.

‡ *Vide* paper "On the Common Limpet as an Article of Food." Annals Nat. Hist. vol. iii. June, 1839.

season, not less than forty tons. This must, however, be greater than the average of ordinary seasons, when causes connected with the scarcity or high price of provisions, which then prevailed, are not in operation. But after every such allowance has been made, the quantity used as food is very considerable. This is attested in other localities round the coast, by the large heaps of shells which may be seen about the dwellings of the humbler classes.

The entrance to the Bay of Belfast, and the loughs of Strangford and Carlingford, furnish a valuable supply of oysters, which are conveyed for sale to considerable distances. The Carrickfergus oysters are large in size, and so much in demand, that their price in the Belfast market is generally from twelve to fifteen shillings per hundred of 120 oysters. It is occasionally 20*s.*; and we have known one instance in which so much as 30*s.* was paid. The price of the pearl oysters,* when landed on the beach at Condatchy, varies from 14*s.* to £6 per thousand; so that the best edible oysters are sold in these countries at more than the pearl oysters at Ceylon.

It is interesting to the botanist, in passing over moor, and mountain, and valley, to observe the kind of plants which are found in each of these situations, and which could not thrive, or perhaps could not live, if removed to any of the others. A similar pleasure awaits the zoologist, who, in his progress round the coast, notes how the species of marine animals which are abundant in one district have disappeared as the coast changes its character, and have their place supplied by species altogether different, but suited to the nature of the locality where they are found. Thus the coast, both to the north and to the south of Belfast Bay, is rocky, and Limpets are, accordingly, plentiful. Within the bay, and opposite to the village of Holywood,† are extensive mud banks, which,

* Steuart on the Pearl Fisheries at Ceylon.

† An old inhabitant of that village has favoured us with the following particulars:—

"The year 1792 or 1793 was remarkable for the great drought that prevailed, and the distress consequent upon it. In the month of June or July, that year, about twenty families of poor people came from the interior of the country, and encamped along the road side and on the beach, a short way to the west of Holywood. They remained there about five weeks, during which they subsisted partly on such vegetable food as they were able to pick up about the hedge-rows and fences, but principally upon the mussels which are so abundant on 'the bank,' about

towards their outer edges, are the chosen residence of millions of mussels, forming continuous beds, from which the people of the village procure an abundant supply, and where boats are sometimes filled with mussels for the Belfast market. By crossing the narrow neck of land which separates the loughs of Belfast and Strangford, we come at once upon a wide extended beach of sand. Here the Limpets have disappeared—the Mussels abound no longer, and their place is more than supplied by multitudes of the common Cockle, which alike furnish food and occupation.

Fig. 161.
Teredo.

Among the Mollusks of the present class, are those which possess the art of boring into hard substances, and living in the excavation thus formed. We have dug out of indurated clay, so hard as to make our progress in it a work of labour, perforating bivalves of two genera (*Pholas* and *Venerupis*). Some even bore into the solid limestone rock, and the piers and breakwater at Plymouth, which are formed of this material, bear evidence of their powers. Perhaps none of these animals is so noted for its ravages as the *Teredo* (*Fig.* 161), which Linnæus emphatically termed "calamitas navium." "They are now common in all the seas of Europe, and, being gifted with the power of perforating wood, they have done, and continue to do, extensive mischief to ships, piers, and all submarine wooden buildings. The soundest and hardest oak cannot resist them; but in the course of four or five years they will so drill it as to render its removal necessary, as has happened in the dockyard of Plymouth. In the year 1731 and 1732, the United Provinces were under a dreadful alarm, for it was discovered that these worms had made such depredations on the piles which support the banks of Zealand, as to threaten them with total destruction, and to claim

half a mile distant. No instance of disease from this diet occurred; and, during that summer, the poorer classes in the village appeared quite as healthy as in other years, though mussels formed the chief part of their food."

from man what he had wrested from the ocean. Fortunately, they, a few years after, totally abandoned that island, from causes unknown, but suspected to be from their not being able to live in that latitude when the winter was rather severer than usual."*

Owing to the general use of metal sheathing, the Teredo is now nearly extinct on the British coast. The last account of its ravages was one in 1834, relative to the injury it had caused to the piers of Portpatrick, in Wigtonshire.†

It is occasionally the pleasing duty of the naturalist to direct attention to some of the many examples where there springs from "partial evil, universal good;" and perhaps the Teredo, notwithstanding the evidence of its destructive powers, might, if the whole truth were known, be ranked among the number of our benefactors. Mr. R. Ball has remarked to us, "that but for the maligned Teredo, the sea would be so covered with floating logs of timber, as to be to some extent unnavigable; that the rivers of warm latitudes would be choked up by the accumulated driftwood at their mouths, and that their fertile banks would, in many cases, be converted into morasses."

On one occasion, on our northern coast, a piece of the carved and painted woodwork of some unfortunate vessel was flung up by the waves as we strolled along the beach, and never shall we forget the interest with which we examined the numerous perforations of the Teredo. The animals were still living in the galleries which they had excavated, and which were lined, throughout all their windings, with a smooth, white, shelly secretion. While all had applied with effect the curious auger-shaped valves by which their perforations are made, none had interfered with the progress of his fellows. Almost in every instance, when the borings approached too close, their direction had been changed, and contact thus avoided. It was strange to look upon this piece of drift timber, the sport of the wind and waves, and reflect upon the little world of animated existence it contained, and the skill and perfection shown in the structure of their sea-borne dwellings.

* Dr. Johnston, in 1829. Mag. Nat. Hist. vol. ii. page 23.

† Wm. Thompson, in Edinburgh New Phil. Journal. Jan. 1835. The same gentleman has since recorded in Annals of Nat. History, Sept. 1847, its occurrence at Ardrossan, Ayrshire.

We now proceed to notice, with equal brevity, some of the best known examples of the different classes of the *encephalous* Mollusca, or those which have a distinct head. The classes, as already mentioned (page 162), are three in number.

I.—PTEROPODA.

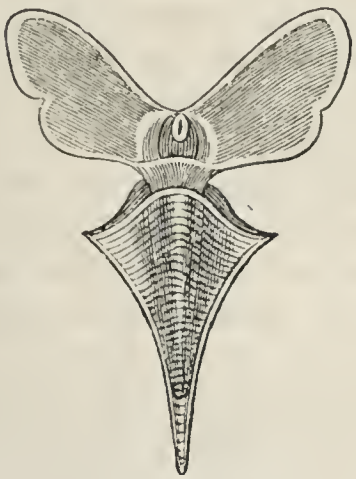

Fig. 162.—Hyalæa.

The little Mollusks belonging to this order are furnished with two membranous expansions, like fins or wings (*Fig.* 162), and hence the compound term, which signifies "wing-footed," points out the obvious distinguishing characteristic of the class.

There are several genera, but the species best known (*Clio borealis*) is about an inch in length, and so abundant in the Arctic seas as at times to colour the surface for leagues, and to form an important supply of food to the great whale. Our knowledge of its structure is principally derived from the researches of Professor Eschricht, of Copenhagen. The head is furnished with six retractile appendages, which are of a reddish tint from the number of distinct red spots distributed over their surface, and amounting on each to about 3,000.* When examined under a high magnifying power, each of these specks is found to consist of about twenty suckers, each mounted on a footstalk, so as to be projected beyond the edge of their sheath, and applied to their prey. "Thus, to use

* *Vide* Owen, page 293; Carpenter, p. 359; Jones, p. 425.

the words of Professor Jones, "There will be (3,000 × 20 × 6) 360,000 of these microscopic suckers upon the head of one *Clio;* an apparatus for prehension perhaps unparalleled in the creation."

II.—GASTEROPODA.

Fig. 163.—Volute (the animal represented in motion).

If we look at the common Snail, as it crawls along, we notice that the only organ it possesses as a substitute for legs is a broad muscular disc, forming the lower surface of the body. Hence the compound term *Gasteropoda* (belly-footed) indicates the peculiarity of its locomotive structure, and is used as the name of the class in which a similar structure prevails (*Figs.* 147, 153, 163).

The class is extremely numerous, and is conveniently distributed into orders distinguished by modifications of their respiratory organs.* Into any minute details of these structural

* It may be convenient to enumerate, in one place, the orders into which the class is divided, accompanied by an explanation of the scientific names.

Nudibranchiata	gills naked.
Inferobranchiata	gills inferior or lower.
Cyclobranchiata	gills round the body.
Tectibranchiata	gills covered by mantle.
Pulmonata	breathing by lungs.
Scutibranchiata	gills with a shield.
Tubulibranchiata	gills with a tube.
Pectinibranchiata	gills like a comb.

The order last mentioned is the highest in point of organization; in it the sexes are distinct.

characteristics it is not our intention to enter; still less do we purpose giving any enumeration of the genera into which the several orders are subdivided. We shall merely endeavour to convey some idea of the principles on which the classification is conducted, and relate some particulars with regard to the habits, structure, or uses of a few well-known species.

In two orders the animals are all marine, and are destitute of any shelly covering. In that to which the term *Nudibranchiata* is applied, the gills are also naked or unprotected, and are arranged in various forms, and attached to different parts of the body. The animals are found upon the rocks and seaweeds on our shore, and floating with the foot uppermost, on the smooth surface of our bays; they are also dredged up from considerable depths. When placed in sea-water, they exhibit figures of great delicacy, variety, and elegance, and with a beautiful diversity of colouring. Their size is very different, some of our native species being less than half an inch in length, while others measure so much as four inches.* The eggs of many are in the form of a delicate spiral ribbon-shaped coil, and are attached to stones near the shore or to corals in deep sea-water, according to the habits of the species.† Some gaily-coloured members of this group are found in the Mediterranean and the Indian seas, and swim with great rapidity.

Fig. 164.—Eolis.

The common Limpet forms an example of a Mollusk of a different order, in which the gills extend like a fringe round the lower edge of the body, and between the body and the foot (*Cyclobranchiata*). Those who see the Limpet only when left uncovered by the tide have no idea of the ease with which it can march about when the returning waters once more surround its dwelling. Its little excursions are not, however, "idlesse all;" they are undertaken for the important

* R. Ball. *Vide* W. Thompson, on Mollusca of Ireland, in Annals of Nat. Hist. 1840.

† *Vide* an elaborate Monograph on the British Species of Nudibranchiate Mollusca, by Messrs. Alder and Hancock, now in course of publication by the Ray Society. It is illustrated with figures of exquisite delicacy.

object of procuring food. This consists of sea-weeds of different kinds, which it rasps down by means of a ribbon-shaped instrument longer than its entire body, and covered with minute recurved hooks. The first time we chanced to

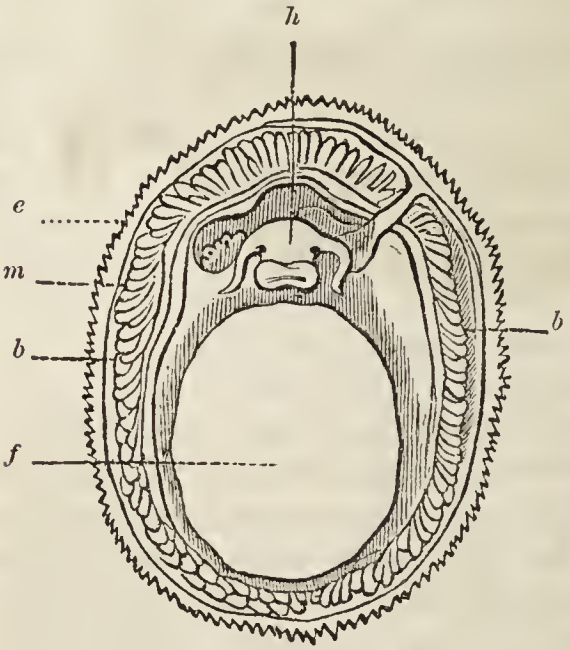

Fig. 165.—Limpet.*

Fig. 166.—Chiton.

see this, we mistook it for some strange species of worm; but, on examining several Limpets, the supposed worm was seen in all; and great was our astonishment when we discovered that we had, in every case, been looking at the *tongue* of the Limpet, and not at any intruder into the privacy of his conical fortress.

The shell of the Limpet consists of one piece; but in the *Chiton* (*Fig.* 166), an allied genus found near low water-mark, and under stones, the shell is composed of a number of distinct plates. These are so arranged that the edges overlap like the slates of a house, and the ligaments possess such flexibility, that the shell can, at the pleasure of the animal, be rolled into a ball.

That order which is characterised by having the gills concealed under a fold of the mantle (*Tectibranchiata*) may be illustrated by reference to a creature not uncommon on our shores, the Aplysia or Sea-hare, the *Lepus marinus* of the

* Fig. 165.—The animal of the Limpet, as seen from below.—*h*, Head.—*e*, Edge of shell.—*m*, Mantle.—*b*, Branchiæ.—*f*, Foot.

ancients (*Fig.* 167). The first which our dredge brought up was placed on one of the rowing benches of the boat, and emitted a rich purplish fluid so copiously that it ran along the

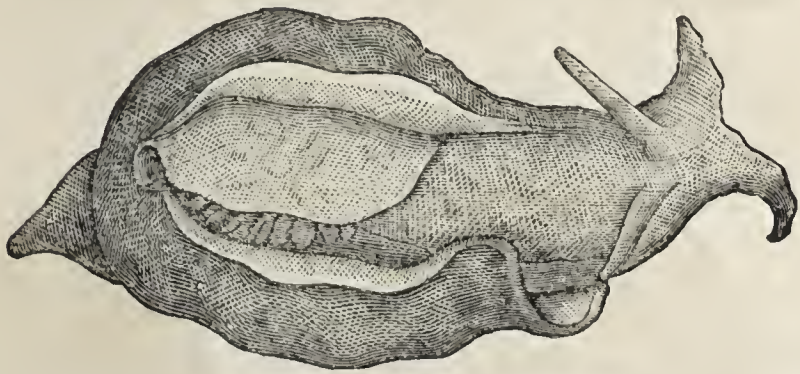

Fig. 167.—Aplysia.

board. Being transferred to a phial of sea-water, the purple dye was still given off in such abundance that the creature soon became indiscernible. It was not until the water was changed that we had the opportunity of observing the ease and grace with which it moved about, elevating and depressing its mantle, altering the outline of its body, and extending and retracting its tentacula so incessantly, that an artist would have found a difficulty in catching its characteristic figure. It is probable that the form of the upper pair of tentacula suggested the idea of the ears of the hare, and thus gave origin to its common title. The body of this species (*A. depilans*) was marked with numerous brownish spots, of irregular size and form; but when the animal died and the body was placed in spirits, the beautiful spotted epidermis disappeared off the larger portion. This creature, it was once believed, held such antipathy to man that its touch would cause the hair to fall off; and it also was said to supply a poison, the operation of which was speedy and inevitable. Time has stripped this inoffensive creature of these imaginary powers.

Of the tribes which breathe by lungs (*Pulmonata*) the common Slugs and Snails offer familiar examples. Even of these species, which are aquatic, many come to the surface for respiration, and float or move with the back downwards. "On a Summer's day," says Dr. Johnston,* "any one may

* Mag. Nat. Hist. vol. iii. page 531.

see the Lymnæa and Planorbes (*Figs.* 147, 168) thus-

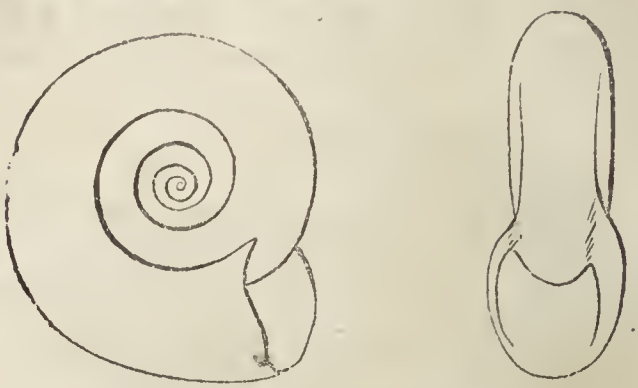

Fig. 168.—Planorbis.

traversing the surface of ponds and ditches, in an easy undulating line, or suspended there in luxurious repose, perhaps

> "To taste the freshness of heaven's breath, and feel
> That light is pleasant, and the sunbeam warm."

The soft skin of those species which are unprotected with shells might naturally be supposed to be possessed of great sensibility, but such does not appear to be the case. "Baron Férussac, for example, states that he has seen the terrestrial Gasteropods or slugs allow their skins to be eaten by others, and, in spite of large wounds thus produced, show no sign of pain."* They possess, in a high degree, the power of repairing injuries and of reproducing lost parts. Many species, in their young state, can suspend themselves from any object by means of a thread emitted for the purpose, and in some this thread-producing power continues during life.† Those who have not examined the internal structure of these animals may perhaps be surprised to learn that in each there exists a small rudimental shell. If we are asked "what is the use of it?" we can only answer, "we cannot tell;" but, in many other animals, we can point to a rudimental structure apparently of no use in the organization of a certain species, yet, in others with which it is nearly allied, becoming, in its full development, of great importance to the economy and habits of the animal.

Thus, in the present case, though we find only a rudimental shell in the Slug (*Limax*), we meet with a conspicuous external covering of shell in the Snail (*Helix*). The species belonging to the latter family (*Helicidæ*) are very numerous,

* Quoted by Owen, page 306.

† Rev. B. J. Clarke, on the Irish species of the Genus *Limax*. Annals Nat. Hist. vol. xii. page 341.

no less than forty being known in Ireland alone.* In a little wooded glen, we have, in a couple of hours, collected more than a dozen of species, some of them, though minute, of great beauty when examined under the microscope. The larger species afford a plentiful supply of food to two of our favourite songsters, the blackbird and the thrush. Those with thin shells are, of course, the most in request, and are brought to some flat stone, and there broken to pieces. We recollect how tantalising, on one occasion, it seemed, when searching with a friend for a very elegant native species, which is found in wooded districts (*H. arbustorum*), while the shells we discovered were "few and far between," the recent fragments strewed plentifully about the stones, used by the thrushes for their demolition, showed that the birds were much more successful in their search than the naturalists.

About the sandy slopes and hillocks which extend for considerable distances along the coast, several creatures of this family may be found; and he who examines them critically will notice that, although the habitat appears of the same character, species will be abundant in one locality which are wanting in another, and their presence or absence does not seem to depend upon any law of geographical distribution. How constantly do the phenomena of nature make us feel the limited extent of our knowledge, and say, in a manner not to be misunderstood, "Be humble!" It is a general belief that these little snails are eaten, in vast numbers, by the sheep which graze upon the scanty pasturage of the sandy knolls, and that they form a very fattening kind of food.

The *Helices* are not, however, used only as food for birds, or for sheep and other quadrupeds, such as the hedgehog. There is a species, found in the southern and midland counties of England, which has been considered a delicacy by man himself (*H. Pomatia*). "From the time of the Romans, who fattened them as an article of food, they have been eaten by several European nations, dressed in various ways. Petronius Arbiter twice mentions them as served up at the feast of Trimalchio (Nero), first fried, and again grilled on a silver gridiron. At one time, it seems, they were admitted at our own tables; and Lister, in his *Historia Animalium Angliæ*, p. 111, tells us the manner in which they were cooked in his time. They are

* W. Thompson. Report of British Association, 1843.

boiled in spring-water, and when seasoned with oil, salt, and pepper, make a dainty dish."*

Fig. 169 represents a species belonging to a different order

Fig. 169.—VERMETUS.

(*Tubulibranchiata*). Such shells occur in groups, and are always found attached to other bodies. They bear some resemblance to the tubes of the serpulæ (*Fig.* 40), though the contained animals are widely different.

Of those which possess comb-shaped gills (*Pectinibranchiata*) the common Whelk, or, to use the term employed in the North of Ireland, the "Buckie" (*Buccinum undatum*) is perhaps the best known example. It is carnivorous in its habits, and is furnished with a singular kind of proboscis, well adapted for boring into the shells of other Mollusks. On some parts of the Irish coast it is taken in wicker baskets containing offal, and is then extensively employed by the fishermen as bait. From its abundance and its size, it is very frequently used by children in the manner described in the exquisite lines of Wordsworth:—

> ——————"I have seen
> A curious child applying to his ear
> The convolutions of a smooth-lipped shell,
> To which, in silence hushed, his very soul
> Listened intensely, and his countenance soon
> Brightened with joy; for murmuring from within
> Were heard sonorous cadences, whereby,
> To his belief, the monitor express'd
> Mysterious union with its native sea.
> Even such a shell the universe itself
> Is to the ear of faith, and doth impart
> Authentic tidings of invisible things;
> Of ebb and flow, and ever-during power;
> And central peace subsisting at the heart
> Of endless agitation."

Another shell, even more plentiful on our rocky shores, is the Dog-whelk (*Purpura lapillus*). It is remarkable for furnishing a purplish dye, which makes an indelible marking-ink. This is contained in a whitish or straw-coloured vein,

* Turton's Manual, edited by John Ed. Gray, pages 135, 136.

close to the head, and when applied to white linen when the sun is bright, is first green, then blue, changing to a reddish tint, and finally purple. It is not, however, to be supposed that this fluid is identical with that dye for which Tyre was so celebrated when its "merchants were princes, and its traffickers the honourable of the earth;" and which was reserved for the brilliant hangings of temples, or the costly robes of priests and kings. By what species of shell this dye was produced, and how it was extracted, have been questions respecting which much difference of opinion has prevailed. Our latest information on the subject is derived from Mr. Wilde,* who, when visiting the ruins of Tyre, in 1838, found on the shore "a number of round holes cut in the solid sandstone rock, varying in size from that of an ordinary metal pot to that of a large boiler." Within these, and on the adjacent beach, he found large quantities of shells broken, apparently by design, but subsequently agglutinated together. Hence he inferred, that the shells had been collected, in large masses, into these holes or mortars, to be pounded in the manner mentioned by Pliny, for the purpose of extracting the fluid which the animal contained. This opinion received confirmation from his finding that the broken shells of this conglomerate proved, on examination, to be the *Murex trunculus*, one of the species from which the Tyrian dye is known to have been obtained; and, also, that several of the recent shells, exactly agreeing with these, were found on the adjoining beach. The genus contains shells of great beauty (*Fig.* 170), some of which are furnished with long and delicate spines.

Fig. 170.—Murex.

* Narrative of a Voyage to Madeira, Teneriffe, &c. 2d edition, page 378; and Appendix to the same work, page 629.

III.—CEPHALOPODA, OR CUTTLE-FISH.

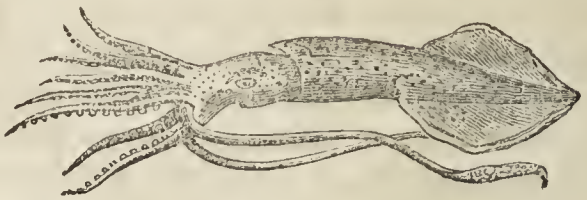

Fig. 171.—CALAMARY.

IF we look at a Cuttle-fish (*Fig.* 171), we notice that the head is surrounded by a number of appendages; and this peculiarity is implied in the term "*Cephalopoda.*"* It is restricted to the third division of the encephalous Mollusca; to that class which is the most elevated in organization. Its superiority is manifested in the muscular, the respiratory, and the nervous systems, and also in the existence of a true internal skeleton of a peculiar structure, the first approach towards the most obvious characteristic of the vertebrate animals.

Though the shell of the Pearly Nautilus (*Nautilus Pompilius, Fig.* 172) is common in museums, the capture of the

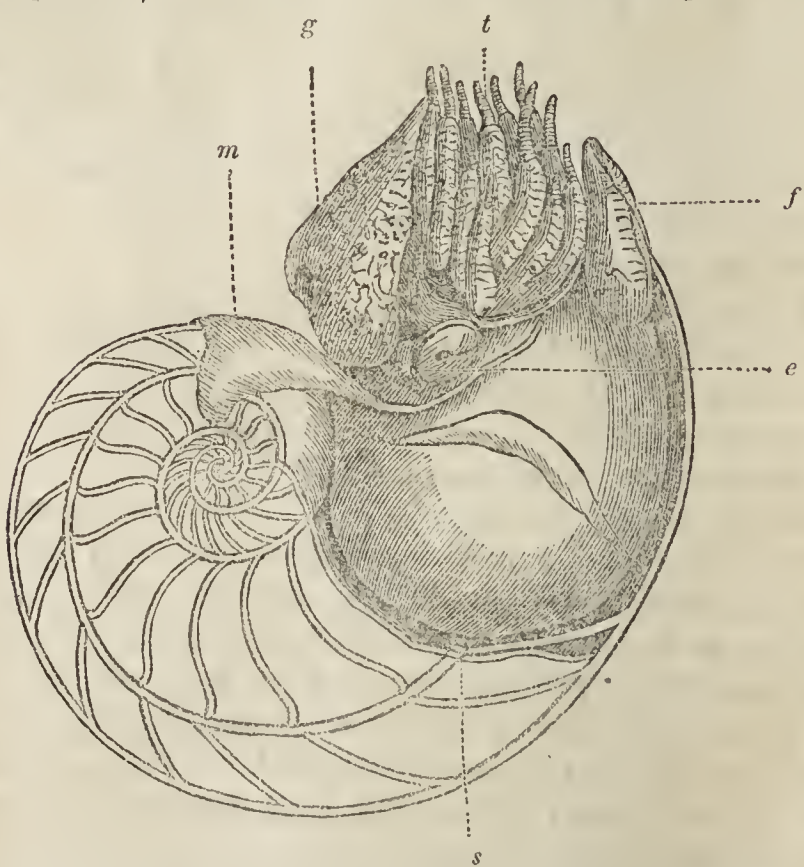

Fig. 172.—PEARLY NAUTILUS, WITH THE SHELL LAID OPEN.

Fig. 172—*t*, Tentacula.—*f*, Funnel.—*g*, Foot.—*m*, Part of mantle.—*e*, Eye.—*s*, Siphon.

* From two Greek words, signifying *head-feet.*

living animal is of rare occurrence. One was taken, when floating in the South Seas, and being presented to the College of Surgeons, London, was there dissected by Professor Owen, who published an elaborate memoir on its structure, and its relations to other families, both recent and extinct. We learn from this source that it has four gills (*Tetrabranchiata*), in which respect it differs from all other existing species of Cuttle-fish, that it occupies the outer chamber of its shell, and that it can rise to the surface or descend at pleasure. Similar in structure and in powers were the ammonites (*Figs.* 173, 174), which, at former periods of the earth's history,

Fig. 173.

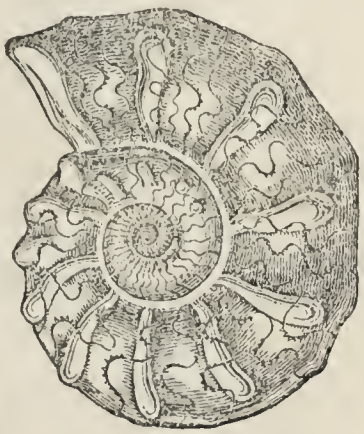

Fig. 174.

Ammonites.

must have been living in its seas, though now known only as fossil; and alike in general organization, though different in form, are those large tapering chambered fossils (*Orthoceratites*) which, in some parts of Ireland, are so abundant in the limestone quarries.

The other Cuttle-fishes (*Dibranchiata*) abound in all seas, and are arranged in two divisions, according as they have eight or ten arms. To the latter group belongs the Loligo or Calamary (*Fig.* 171)—the common Sepia or Cuttle-fish—and the Loligopsis (*Fig.* 175), so remarkable for the great length of one pair of its arms. All possess a shell or internal skeleton differing in form and structure in different species; all are furnished with a powerful horny beak for tearing up their prey, and with an ink-bag, from which, at pleasure, they can emit a fluid which darkens the water and favours their escape from their enemies.

Fig. 176.
Belemnite.

To this division belonged the Belemnite (*Fig.* 176), whose remains are abundant in the white limestone of the County

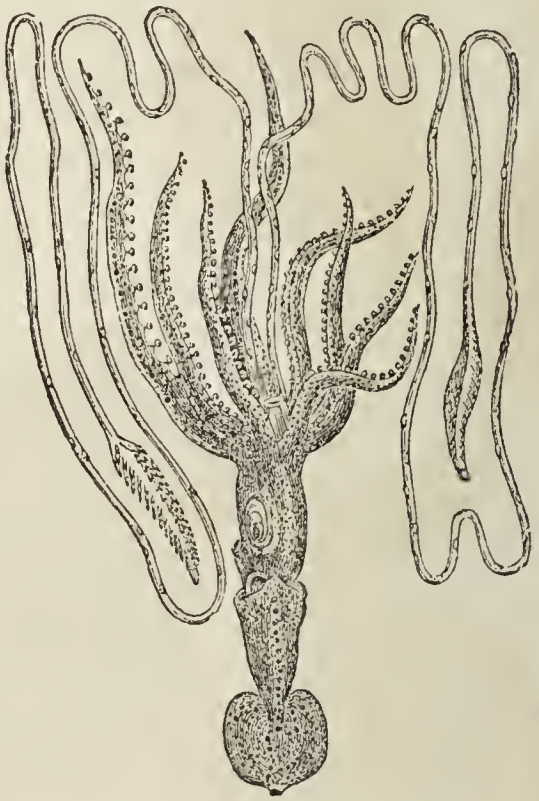

Fig. 175.—Loligopsis.

Antrim. The flinty conical body we now behold constituted part of the internal skeleton of the living animal. The remains of a Belemnite have been found in England in such a state of preservation as to show the head, the arms, the ink-bag, and the internal shell.* From a careful examination of its structure, Mr. Owen is of opinion that it possessed the power of swimming backward and forward with great vigour and precision, could rise swiftly and stealthily to infix its claws into the belly of a fish, and then perhaps as swiftly dart down, drag its prey to the bottom, and devour it. How strange it is to gaze upon that fossil entombed in masses of limestone, and, in imagination, picture that flinty structure gifted with life, and forming part of a carnivorous animal, who, in the primæval seas, ere these lands were upheaved from the bed of ocean, carried on his career of rapine, the voracious destroyer of the weaker inhabitants of the deep!

* Owen, pages 337, 339.

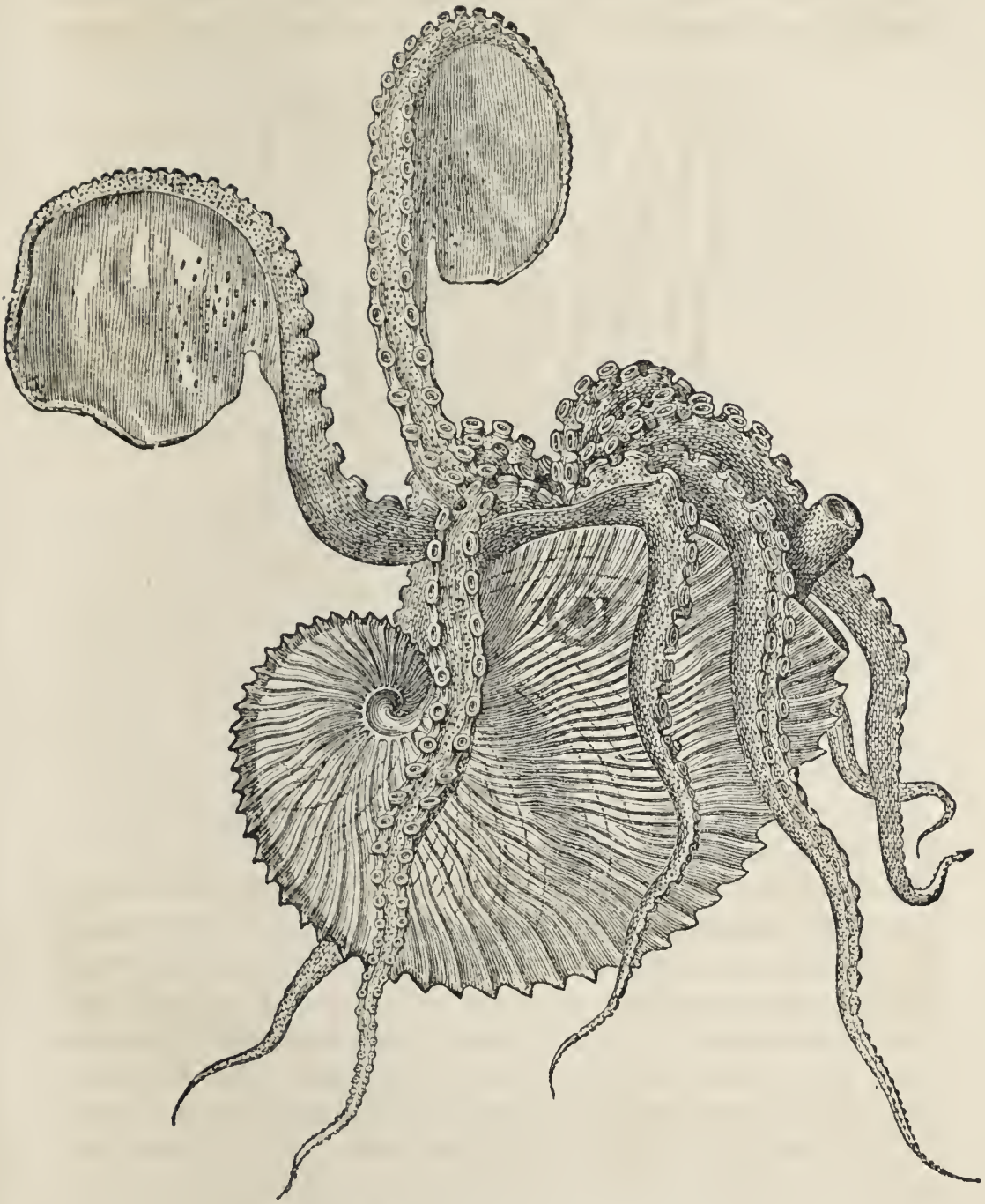

Fig. 177.—Argonaut, or Paper Nautilus.

Of the eight-armed division, the most interesting species is the Argonaut or Paper Nautilus, regarded as giving to man the first example of the art of navigation. It has been usually represented, as in the annexed figure (*Fig.* 177), with six arms extended over the sides of its little vessel to act as oars, and two others upraised as sails. Such being the universal belief among naturalists, it is to be expected that

poets would not fail to celebrate its nautical capabilities.* Thus, Pope bid us

> "Learn of the little Nautilus to sail,
> Spread the thin oar and catch the driving gale."

And Montgomery, in his "Pelican Island," gives a picture so exquisitely finished, that even the naturalist can scarcely bring himself to wish that it were different:—

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

It is now ascertained that the Nautilus never moves in the manner here described. The account, though so universally accredited, is altogether fabulous. It moves backwards through the water by the action of its arms, like other Cuttle-fish. It can creep along the bottom, and, like many other Mollusks, it can rise to the surface; but there the arms are never employed as oars; and those which have the broad expanded membranous disc are never used as sails. Their true function, as ascertained by M. Rang, and confirmed by the experiments of Madame Power, is the secretion of the substance of the shell. They are stretched tensely over its surface, and, when accidental injuries arise, they deposit for its repair the needful quantity of shelly matter. To do this, and to supply what is wanted for the enlargement of the shell with the growth of the animal, is their appointed duty; one similar to that of the mantle of the bivalve shells.

* Byron's well-known description is too beautiful to be omitted:—

> "The tender Nautilus who steers his prow,
> The sea-born sailor of his shell canoe,
> The ocean Mab, the fairy of the sea,
> Seems far less fragile, and, alas! more free.
> He, when the lightning-wing'd tornados sweep
> The surge, is safe—his port is in the deep—
> And triumphs o'er the armadas of mankind,
> Which shake the world, yet crumble in the wind."
>
> THE ISLAND.

The species of Octopus (*O. vulgaris*, *Fig.* 178) found on the British shores, and known as the common *Poulpe*, is of rare occurrence on the Irish coast.* Its strange figure and staring eyes cannot fail to excite astonishment when seen for the first time, more especially when its twisting arms are

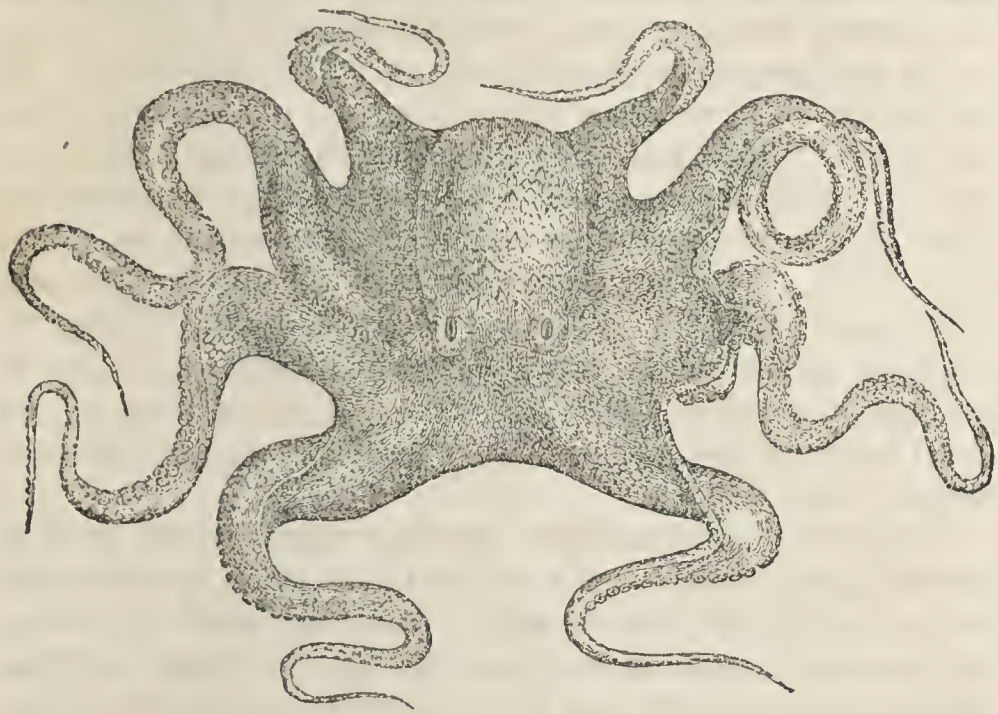

Fig. 178.—Octopus or Poulpe.

employed in the act of walking, or in that of swimming, by means of the contractions of their connecting membrane. These arms have, however, another office, for which they are elaborately adapted; and as the description given of them by Professor Jones is equally applicable to other Cephalopods, we shall adopt the language of that eloquent writer:—

"The feet or tentacula appended to the head are not, however, exclusively destined to effect locomotion; they are used, if required, as agents in seizing prey, and of so terrible a character, that armed with these formidable organs, the Poulpe becomes one of the most destructive inhabitants of the sea; for neither superior strength nor activity, nor even defensive armour, is sufficient to save its victims from the ruthless ferocity of such a foe. A hundred and twenty pair of suckers, more perfect and efficacious than the cupping-glasses of human contrivance, crowd the lower surface of every one of the eight flexible arms. If the Poulpe but touch its prey, it is enough;

* Another species (*Eledone ventricosa*) takes its place, and often its name.—R. Ball.

once a few of these tenacious suckers get firm hold, the swiftness of the fish is unavailing, as it is soon trammelled on all sides by the firmly-holding tentacula, and dragged to the mouth of its destroyer. The shell of the lobster or crab is a vain protection, for the hard and crooked beak of the Cephalopod easily breaks to pieces the frail armour." *

An instance of its powers, both of attack and escape, fell under the observation of Mr. Broderip, of London. He attempted, "with a hand-net, to catch an Octopus that was floating within sight, with its long and flexible arms entwined round a fish, which it was tearing to pieces with its sharp hawk's-bill. The Cephalopod allowed the net to approach within a short distance of it before it relinquished its prey, when, in an instant, it relaxed its thousand suckers, exploded its inky ammunition, and rapidly retreated, under cover of the cloud which it had occasioned, by rapid and vigorous strokes of its circular web." †

Besides the power of thus escaping when pursued, it also possesses, in common with others of its class, a protection against being discovered, which, conjoined with the other, surpasses the cloak of darkness in the fairy tale. It can change its colour to that of the adjacent objects; so that, like the Ptarmigan in the snow, it becomes comparatively inconspicuous. Mr. Owen remarks, that "the power which the Cephalopods possess of changing their colour, and of harmonizing it with that of the surface on which they rest, is at least as striking and extensive as in the Chameleon, in which it seems, from the latest observations, to be produced by a similar property and arrangement of pigmental cells." ‡

The prepared ink of the Cuttle-fish is capable of being made into a pigment, and, even after being entombed for centuries, preserves its powers. Dr. Buckland supplied some of this fossil ink to an eminent painter, who immediately inquired from what colour-man such excellent sepia might be procured. The internal bone is used in making erasures, and is manufactured into the article known as "pounce" in the shops. The flesh, especially that of the arms, is considered very nutritious. It was highly prized by the ancients, and, though not used in these countries, is still much sought for in other

* Outline of the Animal Kingdom, page 431.
† Owen, page 346. ‡ Page 343.

parts of the world, and occasionally exposed for sale in the market at Naples and elsewhere. Our most common species (*Loligo vulgaris*) forms the bait with which one-half of the cod taken at Newfoundland is caught.* During violent gales of wind, hundreds of tons of them are thrown up there on the beach. Other species appear elsewhere to be no less numerous. Mr. Bennett† describes them as forming a dense shoal on the surface of the water, extending several hundred yards on each side of the ship he was in; and also gives an animated description of the flights of the flying squid, a name given to another species because of their manner of leaping from the water.

Stories are told of gigantic Cuttle-fish throwing their arms over luckless vessels, the thickness of each arm being equal to that of the mizen-mast. But it is the business of science to dispel these exaggerations, and patiently and laboriously to seek out the truth, hailing with joy each new light which may shine on the subject of inquiry. In the College of Surgeons, London, are preserved portions of the largest specimen of Cuttle-fish which any of our museums contain. The carcass was found during Captain Cook's first voyage, floating on the sea, surrounded by aquatic birds, who were feeding on its remains. "Comparing the size of this animal, from the parts existing, with that of the smaller perfect animals, its body must have been at least four feet long, which, added to the tentacula, would make it seven feet in length."‡ We have, in these countries, no positive evidence of the existence of any Cuttle-fish of larger dimensions, but the general prevalence of such belief inclines naturalists at present not to deny the possibility of their occurrence.

The ova of the Cuttle-fish are contained in vesicles, which, in some cases, are clustered together, and known as "sea-grapes." On one occasion, our dredge brought up a large mass of them, so mature that, in the act of throwing it into a vessel of sea-water, many of the ovisacs burst, and, to our astonishment, we beheld the fluid swarming with minute Cuttle-fish, whose dark eyes were singularly conspicuous. In April, 1845, we found, on a sandy bank, in Belfast bay, a number of detached vesicles, which had been left uncovered

* Dr. Johnston in Mag. Nat. Hist. vol. iii. page 153.

† Narrative of a Whaling Voyage round the Globe. London, 1840.

‡ Owen, vid. Athenæum, 1840, page 676.

by the retiring tide. Each had a thread-like extremity, buried in the sand to the depth of two or three inches, and highly elastic. We have been unable to ascertain to what kind of Cuttle-fish they belonged.* Mr. R. Ball has recorded, as occurring in the Irish seas, twelve species of Cephalopoda, three of which were previously undescribed.†

The remains of animals of this family have been found along with the undigested portions of the food of the gigantic saurian reptiles of remote ages; and thus, in the words of Dr. Buckland, "the general law of nature, which bids to eat and be eaten in their turn, is shown to have been co-extensive with animal existence on our globe; the *carnivora* in each period of the world's history fulfilling their destined office, to check excess in the progress of life, and maintain the balance of creation."

The brief space devoted to the Mollusca cannot be closed without adverting to their great importance in a geological point of view. Their shells, which, in a fossil state, are found in the secondary rocks, are different from those of any animals of the same tribes now existing. They may belong to the same families, in some cases to the same genera, but *invariably the species is extinct.* In the older tertiary rocks, we meet, for the first time, with shells in a fossil state, which are specifically identical with some now living. But the number of such is so small, that it has been estimated at only three and a half per cent. of the entire. As we approach the more recent strata, the number of shells of species still living continues to increase, until, in those tertiary rocks which are the most recent, it constitutes nine-tenths of the entire number. Hence shells have, with great propriety, been termed "the medals principally employed by Nature in recording the chronology of past events." ‡

An aid in the detection of generic resemblances between different fossil shells, and also between recent and fossil, has

* They have so much resemblance to the ovisacs contained in the ovary of *Rossia palpetrosa*, figured by Professor Owen in the appendix to Ross's voyage, that we are inclined to surmise they must have been those of some species of the same genus—a conjecture the more probable as to this genus belong two species, added to our Fauna by Mr. Ball. Ovisacs described to us as similar to what we have noticed were found by Miss Ball on Clontarf strand.

† Proceedings Royal Irish Academy, 10th Jan. 1842.

‡ Lyell's Principles of Geology, vol. i. page 283.

of late been afforded by the microscopic investigation of their structure by Dr. Carpenter, an investigation which is still in progress. That gentleman observes, "that marked differences in the structure of shell go along with marked difference in general characters, and that a close correspondence in the structure of the shell may be held to indicate a tolerably close natural affinity."* And he enumerates certain genera "which may be at once distinguished from each other, and from all other shells, by the characters supplied by a fragment of shell which a pin's head would cover." Should more extended observations warrant the broad inferences to which such inquiries at present point, and be found applicable to the Crustacea and Echinodermata, no less than to the Testacea, how clear is the light which they will cast into "the palpable obscure," which sometimes baffles the most anxious and persevering efforts of the geologist!

Another series of observations, of a nature totally unlike these, has given additional importance to the shells of stratified rocks, by teaching us better to understand the circumstances under which they have been originally deposited. These investigations were carried on by Professor Edward Forbes,† in the Ægean Sea, on board H. M. S. *Beacon*, Captain Graves, and continued for eighteen months. By means of the dredge, the Mollusca and Radiata of that region were explored, at all depths of water between the surface and 230 fathoms. Nearly 700 species were thus found, and, in different regions of depth, they were associated in such a manner that each of these regions presented its own peculiar and characteristic association of species, just as on lofty mountains the character of the vegetation changes in proportion to the altitude. Those species which had the widest range of geographical distribution, had also the most extensive range with regard to regions of depth; and some were discovered living, which had previously been known only as fossil. Both with regard to vegetable and animal life, species were found to attain, at certain depths, a maximum size, then gradually to diminish, and finally to disappear, their places being supplied by similar forms, specifically distinct. Genera, in like manner, were found to be replaced by corresponding genera. So that the

* Annals Nat. Hist. December, 1843.

† Report to British Association. Cork meeting, 1843.

exploration of this sea exhibited, in regard to depth, a series of phenomena similar to what had been already observed by geologists with regard to successive periods of time, or to degrees of latitude in geographical distribution; thus showing that the study of the characters which Nature now exhibits furnishes the key to that series of ciphers in which she has written the history of the past.

It will be seen, therefore, that, in the study of the Testacea, the naturalist rises from the determination of species to inductions which lead him to examine the structure, habits, and distribution of extensive groups; to investigate the conditions under which they are found to exist; and, uniting in one series the past and the present, to aim at generalizations sufficient to task, to their utmost capability, the limited powers with which man, in his present state of existence, has been endowed.

END OF PART I.

INDEX TO PART I.