SCIENTIFIC ALPHABETS.

NATURAL HISTORY.

INSECTS.

"Natural History may be fundamental to the erecting and building of a true philosophy."

LORD BACON, *Sylvæ Sylvarum.*

ALPHABET OF INSECTS,

FOR

THE USE OF BEGINNERS.

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The Queen Butterfly in its various stages.

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CONTENTS.

PLAN OF THE WORK.

THIS little Work is intended for those who are desirous of beginning the delightful study of INSECTS, or who, having begun, find their progress interrupted by numerous difficulties. Among these, one of the most prominent is, the want of a plain and short outline of some of the leading subjects of inquiry, by way of a basis on which to proceed—a ground plan to work upon in rearing a superstructure of knowledge.

There is no English work answering to these views, and the French work of M. Audouin, though very excellent in its way, is too brief and too technical.* I have therefore sketched the following outline on a plan, which, I trust, will be found useful, taking M. Audouin's book as a sort of foundation, enlarging where I deemed it too brief, adding where I found any thing important omitted, and avoiding, as much as possible, the intermixing of theory and hypothesis with facts.

* Resumé d'Entomologie, 18mo, Paris, 1828.

In the three little volumes, published in the Library of Entertaining Knowledge, entitled INSECT ARCHITECTURE, INSECT TRANSFORMATIONS, and INSECT MISCELLANIES, I have introduced some of the most interesting details and discussions respecting Insects; but the plan of these works precluded my going into a regular elementary enumeration of parts and functions such as I have here given, and which may accordingly be considered introductory to these three volumes.

The general rule of style which I always adopt, is never to use a word derived from the Latin or Greek when I can readily find one of Saxon origin, not that it is possible to discard those derivative words altogether—the English language would be meagre indeed without such as have long been naturalized and are well understood; but as they are not the basis of our language, we ought, I think, to try to keep up our native words, and not hunt after foreign terms which we do not indispensably want. "Spotless," for example, I should generally prefer to *immaculate;* "across," for *transversely;* "horny," for *corneous;* "forked," for *furcate;* and so on. Of all vulgarities, pedantic vulgarity is the most offensive.

In giving names to things not previously named, the Greek language, from its facilities in compounding words, is usually resorted to, but this, I think, is in many cases done without necessity, as English, though not so easily compounded, may be often used with equal, if not greater, advantage. The French in these cases gallicize the Greek; but this, except in chemistry and a few other instances, appears to me in such bad taste, that I hope never to see the practice followed in England. "Whenever a Frenchman," says a shrewd writer, "can get hold of a rag of Greek, he instantly defiles it."* I have therefore admitted few, if any, terms not of English origin in the text, and have consigned the Latin and Greek terms to the notes.

The serious obstruction to knowledge caused by the rage for multiplying newly invented words is strikingly exemplified in the fact, that, of the "fifty-two pieces composing the thorax," (*corselet*,) "Mr. Kirby does not describe much more than twenty, and yet uses about forty different words for them in his nomenclature."† These are the very words of Mr. MacLeay, the author's most particular friend. Now, with a book having forty newly coined words for twenty things, how, I may justly ask, is it possible that a student can make progress in a science which has enough of difficulty arising from the minuteness of the objects, without thus taxing invention to increase them? "The doubts and difficulties," says Audouin, "which are experienced at every step, in trying to comprehend what pieces Mr. Kirby wishes to describe, suffici-

* Two Hundred and Nine Days, by T. J. Hogg, Esq. i. 226.
† Zoological Journal. v. 177.

ently prove (do they not?) the total deficiency of such a nomenclature, which is based on no philosophical rule." *(Annales des Sciences Nat. Fevr. 1832, p. 140, Note.)*

Another leading feature of this little work is the avoiding of the hypothetical theories which are successively following each other in Natural History, and which often vitiate the most valuable observations of talented men. It is not a little singular, that, while these theories are in a great measure banished from other sciences, they should now reign as paramount in this department as alchemy and astrology did in the dark ages. I have not here any room for details; but shall merely refer, for a proof of my position, to two works which have appeared within twelve months, one published under the patronage of Government, entitled "Zoology of North America," Part II., in the introduction to which it is gravely suggested that the doctrine of the Trinity may be corroborated by a Trinarian system of Animals!!!—the other, professing to relate to insects, entitled "Sphinx Vespiformis," 8vo., London, a tissue of the most incomprehensible fancies I ever looked into.

The standard works upon insects, for those who study philosophically, and look upon systems as only a convenient aid subordinate to their inquiries, are those of Aristotle, Redi, Malpighi, Valisnieri, Swammerdam, Réaumur, Lyonnet, Lesser, Ray, Gould, Bonnet, Leewenhoeck, De Ceer, the Hubers, Chabrier, Ramdohr, Audouin, Herold, Treviranus, Leon Dufour, Straus-Durckheim, and a few others, chiefly foreign, our English naturalists being almost exclusively engaged in the inferior departments of classing, inventing terms, and theorizing.

The illustrations have been taken from the best authorities — Audouin, Lyonnet, Straus-Durckheim, &c. Those of the parts of the corselet have been reduced from the Zoological Journal, No. 18, by the liberal permission of the publisher, G. B. Sowerby, F. L. S.

The next of this series connected with Zoology, will be the "ALPHABET OF BIRDS," comprising an outline of their comparative anatomy and physiology, to accompany "A CONSPECTUS OF BRITISH BIRDS."

Lee, Kent, June 10th, 1832.

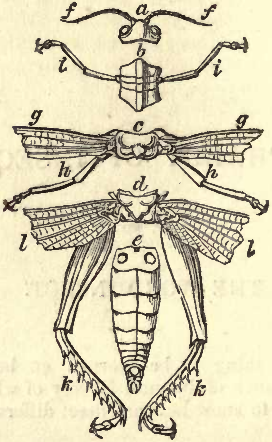
ALPHABET OF INSECTS.

THE WORD INSECT.

THE first thing to be learned on beginning to study the branch of Natural History of which I shall here treat, is to know how an insect differs from other animals.

The word *Insect* means "cut into," and every insect accordingly appears with divisions as if cuts had been made in the body; one just behind the head, and another behind the corselet, as may be seen in a bee or a fly; and the whole body besides is composed of rings, and it is on this account only that modern writers use the term insect.

These cuts divide the body of an insect into three parts, the head, the corselet, and the abdomen; and any animal in which these parts are not found distinct is not an insect. Consequently a spider, a woodlouse, a shrimp, or a crab, is not an insect, because none of these have more than two of the divisions; while the earthworm, the leach, the snail, the slug, and the oyster, are not insects, because they have none of these divisions distinct.



Parts of an insect shewn in the African cricket; *a*, the head carrying the ears, *f, f*, with the eyes at their base; *b, c, d*, the corselet separated into three pieces; the fore corselet, *b*, carrying the fore or first pair of legs, *i, i;* the mid corselet, *c*, carrying the second pair of legs, *h, h*, and the first pair of wings, *g, g;* the hind corselet, *d*, carrying the hind legs, *k, k;* and the second pair of wings, *l, l; e*, the abdomen.

Caterpillars, grubs, maggots, gentles, mauks, meal-worms, bloodworms, and wireworms, from being in a state of infancy or youth, do not in general possess the three divisions distinct, as they all do when arrived at their last state of full grown or adult insects.

With respect to other marks of distinction, it may be proper to mention that insects have no bones, no brain, no veins, no branched arteries, consequently no circulating blood; and do not breathe by the mouth, but through air-pipes in the sides. All insects have exactly six legs, though some butterflies have the first pair so short as not to be readily observed; and many caterpillars have, besides their six legs, as many as ten to sixteen members similar to legs, for the purpose of clinging and climbing.

THE SKIN, OR CRUST, OF INSECTS.

It seems indispensable to every plant and every animal to have a skin, to cover and protect the more sensible parts in the interior of the body. The skin in insects, however, appears still more important, from its having to fulfil, in some degree, the office of the bones in other animals.

The skin, therefore, is usually hard, like horn, or tough, like leather or parchment; though in some species, and also in the first stage of a very considerable number, it is thinner and softer than the human scarf skin.

In all cases, the skin furnishes a series of levers, or points of attachment and support to the muscles, by which every motion of the insect must be made. Unlike the skin of animals, therefore, that of insects is made up of various pieces, more or less closely jointed or joined like the various bones of animals. Each bone of other animals, moreover, is well known by a distinct name; but the pieces of the skin in insects have only been recently examined, and the few names already given to the pieces are not well determined, and still in much confusion.

A talented French naturalist, M. Audouin, thinks he has reason to conclude that there is always, from the moment of exclusion from the egg, a determinate number of pieces in every insect, probably thirteen, which are either distinct or two or more of them united; that various species differ in having some of the pieces large and others small, or altogether wanting; and that when any piece is found larger, other pieces near it will be proportionably smaller.

The human skin is formed of three layers, the scarf skin(1), the mucous net work(2), and the inner skin(3). In insects only two layers are usually obvious, the inner somewhat resembling the mucous net work of the human skin, and, like that, being the membrane of colour.

The colours of insects are exceedingly various; black prevails among beetles and flies; white among caterpillars, grubs, and maggots, which feed under cover; green among caterpillars which feed on leaves; grey and dusky among moths; while the colours of butterflies are usually bright white, yellow, blue, and red, in diversified shades and markings.

The terms usually given to the colours of insects in our modern English books pretending to science, often exhibit the most offensively pedantic taste, besides being frequently unintelligible. Thus we meet with *griseous*, for grey; *ochraceous*, for buff; *luteous*, for yellow; *miniatous*, for scarlet; *niveous*, for snow white; and numerous vulgar barbarisms of the same kind, which would not be tolerated in any other science.

In many insects pores may be detected in the skin, and probably these exist in all.

A considerable number of insects are clothed with hair or down, inserted, as in other animals, into the inner skin. It seems useful in keeping bees warm; in preventing the water from soaking into water-beetles; and may also possess electrical uses which we cannot trace.

COMPOSITION OF THE SKIN.

If the student of insects understand any thing of Chemistry (4), it may be useful to mention, that the

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(1) In Latin, *Epidermis*. (2) In Latin, *Rete mucosum*.
(3) In Latin, *Cutis vera*, or *Corium*.

(4) An "ALPHABET OF CHEMISTRY" will make one of this series of little books.

skin of insects is very complicated in its composition. M. Odier, on analysing the wing cases of the cockchafer, found—1. Albumen;—2. Extractive, soluble in water;—3. A brown substance, soluble in potass and insoluble in alcohol;—4. A coloured oil, soluble in alcohol;—5. Carbonate of potass, phosphate of lime, and phosphate of iron;—6. A particular principle, constituting one fourth of the weight of the wing cases: this principle he named *Chitine*.

It is chitine which in reality forms the outer frame or crust of insects. If an insect, such as a cockchafer or a dung beetle, be plunged into a solution of potass and exposed to heat, the crust of the insect is not dissolved and does not change its form. The only change it suffers is the loss of colour; all the muscles and intestines disappearing, the crust, consisting of chitine, alone remaining.

Chitine differs therefore from horn, hair, and the human scarf skin, which are soluble in potass. It is, besides, soluble in hot sulphuric acid, does not become yellow by the application of nitric acid, and burns without fusion or losing its form. It does not contain azote. It consequently resembles woody fibre more than any animal substance.

THE HEAD.

The head of insects, though it be represented as composed of three or four pieces, does not in general show the least trace of divisions or rings, like the rest of the body: but, because the rest of the body is composed of rings or pieces, it is conjectured by theory, that the head is also so composed, though we cannot perceive the divisions.

In the newly hatched insect, the head is often joined to the body, as in spiders, without any obvious division, which is always apparent in the adult insect;

but, even in the young state, it is usually harder, smoother, and of a different colour from the body.

In animals which have a bony skull the head is always more or less round; this being both the most capacious form, and the most difficult to injure by accidents,—circumstances so important in protecting the brain; but in insects which have no brain, the head, though in most cases round, is often of various shapes; as somewhat square and angular in the stag-beetle, flat and wedge-like in wasps and bees, and nearly triangular in some of the bugs. In the weevil and scorpion fly, again, it is long and pointed, while in some beetles and four-winged flies it tapers backwards into a long neck (1).

Minute naturalists are not yet agreed about the divisions of the head, and M. Audouin first says, "it can be demonstrated that it is composed of several segments;" and again he says, "it is composed of rather solid walls, most frequently presenting no trace of junction, so that it appears at first view quite simple, though an experienced eye soon discovers it to be the result of several segments—the number not yet determined,—united together." That is, as it appears to me, a theorist, accustomed to find that the bones of a skull can be separated, readily imagines junctions of pieces in the head of an insect, though he acknowledges them to be imperceptible.

The head of insects, like that of other animals, consists of the crown and forehead, (both of which M. Meckel objectionably calls the skull), and the face; but the extent of the cheeks is seldom very distinct. It is not so with the mask (2), as we may call it, a part which on the one side is jointed with the front or face, and on the other with the upper lip, which it covers;

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(1) In Latin, *Collum*.

(2) The mask is termed by the French, *Chaperon;* in Greek, ἐπιϛομα.

and when the upper lip is wanting, (as it is in some species), the mask performs its office.

In all insects, two horn-like members project from the forehead—very long, with many joints, in butterflies; very short in the house fly; and prettily feathered in male gnats, and in many male moths. These I shall venture to call ears (1), as it is most probable, though not distinctly proved, that they are the organs of hearing. In front, and at the root of the ears, are two eyes; but many insects have besides several other eyes on the forehead, as may be seen in bees, who have three of these frontal eyes. Insects have no organ similar to the nose in other animals, as they breathe entirely by the air-pipes in the sides. The mouth is, for the same reason, not employed either for breathing or for uttering sounds, but simply for feeding. It is very different in form and structure from the mouth of other animals.

The head is joined to the first ring of the corselet, either by a neck, by a simple membrane, or by means of a socket hollowed into the form of a funnel.

The natural position of the head is various. In grasshoppers and dragon flies, it is vertical; in most beetles, it is somewhat slanting, and almost horizontal. It is very moveable in the common fly and the dragon flies, so that it can be turned almost round, as on a pivot. In many other insects it is immoveable, as in the grasshoppers. In others, the head can be folded down, or drawn back, so as to remain concealed, or nearly so.

THE CORSELET.

THE middle portion of the body in insects, always obviously distinct from the head before, and from the

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(1) In Latin, these organs are termed *Antennæ*.

abdomen behind, I shall term the corselet (1). Unlike the head, this part is composed of several distinct rings and pieces, which have but recently received names, and been studied. Most of the names invented by our English authors are confused, inappropriate, and bad. In following M. Audouin, I shall endeavour to be as plain and simple as I can.

The most natural division of the corselet is into three rings or segments, though these are sometimes very distinct, and sometimes intimately united. These three rings, beginning from the neck, may be termed the fore-corselet, the mid-corselet, and the hind-corselet(2), which three being united, form the corselet. It will be convenient to consider, that the whole corselet, as well as its three rings, has a breast, two sides, and a back.

The student must be warned, that, among the numerous species of insects, these several parts are found to be very variable in size; and, agreeable to the interesting law, that as one part is enlarged, another is proportionally diminished, it is not unusual for a particular part to be exceedingly minute, or wholly wanting, if a contiguous part be comparatively very large.

Taking the whole corselet, and beginning at the breast, we find a piece which may be appropriately termed the breast-plate(3), and is found in all insects, forming sometimes a large, sometimes a small piece, in some species very distinct, as in several water-beetles, but in others so intimately united to the contiguous pieces, that the joining is imperceptible. The breast-plate forms the middle of the breast in all the three rings of the corselet, and for the sake of more minute distinction, it may be considered as divided

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(1) In Latin, *Thorax*.

(2) In Latin, *Prothorax*, *Mesathorax*, *Metathorax*.

(3) In Latin, *Sternum*, which is inaccurate.

into the fore breast-plate, the mid breast-plate, and the hind breast-plate (1).

On the inside of the breast-plate, in the interior of the breast, is another singular piece, usually jointed with the hinder and inner end of the breast-plate. It varies much in form, but frequently resembles a Y, and is hence called the prop, or Y piece, by the French naturalists (2). This is always present in each of the three rings, and, like the breast-plate, may be considered as the fore breast-prop, the mid breast-prop, and the hind breast-prop (3). It extends in some cases within the head, and in others, as in the tree-hoppers, within the abdomen, and was then termed by Réaumur the scaly triangle.

The chief use of the breast-prop, seems to be to afford an attachment and lever to the muscles which move the fore legs; very evident in the singular breast-prop of the mole cricket: and, according to Audouin and Marcel de Serres, to protect the nerves, by separating them from the gullet, stomach, and heart. The hind breast-prop has often attracted attention from its singular trident-like form.

The fore corselet, under side; *a, b,* the breast-plate; *c, c,* the under flanks.

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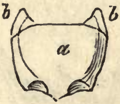
1) In Latin *Prosternum, Mesosternum,* and *Metasternum,* all bad.
(2) In Latin *Furca,* or *Entothorax.*
(3) In Latin *Antefurca, Profurca,* and *Postfurca.*

The side pieces, which may be called the flanks, consist of one on each side, in each of the three rings of the corselet, joined to the breast-plate,—in all three pairs, which we may call the under flanks (1); and other three pairs, usually united to the former, above and behind, sometimes even resting on the breast-plate itself, may be called the upper flanks (2). These have always a constant relation with the haunches (3) of the ring to which they belong, and sometimes share in forming the circumference of their socket, being jointed with them by means of another small piece, which M. Audouin calls *Trochantine*.



The mid breast-plate; *a*, the breast-plate; *b*, *b*, the mid under flanks.

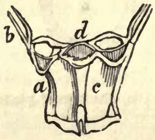
Besides these six pairs of flanks, there is generally, though not always, a very small piece, in relation with the wings and the under flank, always resting on the latter, sometimes going along its fore border, but sometimes, becoming free, it passes either before or above the wing. It may be termed the wing scale(4).

Along the fore border of the under flank, sometimes of the breast-plate itself, and even of the upper part of the body, the opening of an air-pipe or spiracle may often be observed surrounded by a small piece,

(1) In Latin *Episterna*.
(2) In Latin *Epimera*.
(3) In Latin *Coxæ*.
(4) In Græco-Latin *Parapteron*.

often of a horny texture, which may be called the horn scale (1). It is not always present, for the spiracle itself is often closed; but when it is found it is important, as a good guide in the comparison of the other parts.

It is proper here to remind the student, that, when he examines an insect, he ought to look for all these pieces, just as, in examining a rat, he ought to look for the gall bladder; but he must not be disappointed if he do not find all the pieces, as some may be wanting, as the gall bladder is in the rat; and the accounting for such variations opens a fine field of philosophical research.

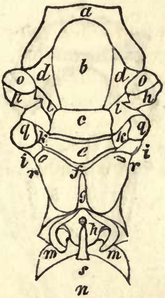


The hind breast-plate; *a*, its upper flank; *b*, its under flank; *c*, the plate itself; *d*, the breast prop.

Having thus gone over the various pieces which compose the breast and the sides of the corselet, we may next turn to the upper part of it, which may be termed the back plate (2), extending from the neck to the abdomen. In reference also to the division into three rings, and beginning at the head, we may call

(1) In Latin *Peritrema.*
(2) In Latin *Tergum thoracis.*

the first, the fore back plate; the second, the mid back plate; and the third, the hind back plate (1).

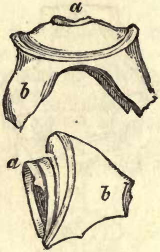


The back of the whole corselet in a wasp (*Polistes Billardieri*). *a*, the fore back plate; *b*, *c*, the mid back plates; *c*, the mid back scale; *e*, *g*, the hind back plate; *e*, the first piece; *f*, the second piece; *g*, the hind back scale; *d*, *d*, the sides of the mid back plate; *h*, the fourth piece of the hind back plate; *i*, *i*, the under flanks; *k*, *k*, the wing scales of the second pair; *l*, *l*, the wing scales of the first pair; *m*, *m*, haunches of the hind legs; *n*, part of the abdomen; *o*, *o*, *p*, *p*, *q*, *q*, the sockets of the two pair of wings; *r*, *r*, the spiracles for breathing; *s*, the cord for the pulley.

Each of these, in many instances, is composed of four pieces. The fore back plate is thus found to consist of four pieces in locusts and crickets, being in these insects large, and the breast small, according to the law of proportion. In beetles, and most winged insects, however, only two pieces can be readily dis-

(1) In Latin *Tergum prothoracis*, *Tergum-mesothoracis*, and *Tergum metathoracis*.

tinguished, on account of the intimate junction. The fore part (1) is generally concealed within the body.

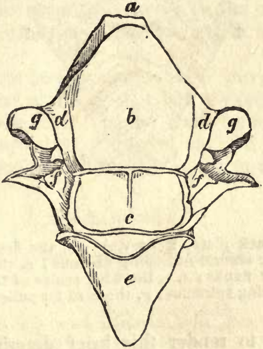


The fore back plate, front and side views; *a*, the first piece, or collar; *b*, the second piece.

The mid back plate is, in like manner, composed of four pieces. The second of these (2) is important, from its always jointing, by means of side pieces, (very distinct in the ruby tail fly), with the wings. The third is what may be called the back scale (3), and is usually somewhat triangular in form. In some of the plant bugs, this part extends over the wings, wing cases, and the border of the abdomen. Another piece of the mid back plate is usually quite concealed in the body, or sometimes so intimately joined to the former, as scarcely

(1) In Latin *Præscutum*. (2) In Latin *Scutum*.
(3) In Latin *Scutellum*.

to be distinguishable. Sometimes it is distinct and free. It has been termed the bridle (1).



The mid back plate, front view. *a,* the fore part; *b,* the second piece; *c,* the third piece; *d, d,* the supposed side pieces of the second piece; *e,* the internal third piece; *f, f,* the wing scales of the first pair; *g, g,* joint bones of the first pair of wings above the sockets.

The hind back plate is also composed of three pieces, the first being often concealed within the body, but obvious in bees and wasps. The second is occasionally composed of two pieces, as in some water beetles, but these are intimately united in the stag beetle. The third piece is divided by a channel lengthwise, which has led to the mistake of considering it as two separate pieces. The fourth piece is very conspicuous in the common fly, and also in the cockchafer; but in obe-

(1) In Latin *Frænum.*

dience to the law of proportion, it is exceedingly small in crickets, grasshoppers, and locusts.

The hind back plate, front view; *a*, the first piece; *b*, the third piece, the second not being obvious; *c*, the fourth piece; *d*, *d*, the under flanks; *e*, *e*, the wing scales of the second pair; *f*, *f*, the breathing spiracles; *g*, the cord for pulley.

In order to render this brief description of the corselet complete, it may be necessary to mention that, on the inner surface of the plates, there are certain remarkable inequalities of surface, and even some distinct parts observable, besides those already described. Amongst these are occasional horny ridges, (1) always formed by the junction of two contiguous pieces; and, when they can be detected, they are excellent guides for discovering the boundaries of two pieces, which cannot be distinguished on the outside. They serve for the attachment of muscles. When these ridges are on the outside, (2) they often assist in the mechanism of a joint, such as those of the wings.

Other small pieces are found in the inside of the corselet, sometimes in the form of flat plates raised upon

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(1) In Latin *Apodemæ insertionis.*
(2) In Latin *Apodemæ articulationis.*

a foot stalk, and wide at top, like certain mushrooms, such as those which Réaumur found in the abdomen of the treehopper, and termed cartilaginous plates. Like the former, they either serve for the attachment of muscles (1), or assist in the mechanism of the wing joints (2).

It is farther to be remarked, that if the corselet, as well as the head and abdomen, be cut exactly in half, lengthwise, each of the pieces and organs on each side will correspond as exactly as our own two hands, or our two nostrils; a very remarkable fact.

Recapitulation.

The corselet, then, according to this statement, consists of

FORE CORSELET	Fore breast plate, Fore breast prop, Two under flanks, Two upper flanks, Fore back plate, four pieces.
MID CORSELET	Mid breast plate, Mid breast prop, Two under flanks, Two upper flanks, Two wing scales, Mid back plate, four pieces.
HIND CORSELET	Hind breast plate, Hind breast prop, Two under flanks, Two upper flanks, Two wing scales, Hind back plate, four pieces.

In all thirty-six pieces; or, if considered as divided lengthwise in the middle, there will be fifty-two pieces.

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(1) In Latin, *Epidemæ insertionis.*
(2) In Latin, *Epidemæ articulationis.*

THE ABDOMEN IN INSECTS.

We are obliged to use this very objectionable term for the third and last division of the body, which is more or less closely united to the corselet. The abdomen may be described to be that part of the body which succeeds the corselet, consisting in most cases of a certain number of rings, without any jointed members for locomotion, and uniformly enclosing a portion, sometimes a very small one, of the intestines.

It is formed by a series of very short hollow cylinders or rings, united with each other by a joint, by a membrane, and sometimes by an intimate junction, the exact line of which is not obvious. Sometimes the rings slide into one another like the tubes of a telescope.

Each of these cylinders is called a ring or segment (1), and is sometimes composed of a single piece, sometimes of two half cylinders, whose two borders usually come into contact. In other cases they do not touch at this point, but remain free, and one more or less overlaps the other, as in bees.

Each ring is virtually composed of two principal portions, which, when they can be distinguished, (this is not always possible) take the name of arches (2). The upper, is called the arch of the back (3); the under, the arch of the belly (4).

In the flea, the bed bug, and other insects without wings, as well as in grubs and caterpillars, where the joining of the corselet with the abdomen is not so obvious, the latter may always be known by the legs never being jointed with it.

When the back of the abdomen is covered, as in

(1) In Latin, *Segmentum*. (2) In Latin, *Arcus*.
(3) In Latin, *Arcus tergi*. (4) In Latin, *Arcus ventris*.

beetles, by the wing-cases, it is softer and more flexible than the belly; in other cases the reverse.

In beetles, and some other insects, the abdomen is joined to the corselet without any joint to permit motion; while in bees, wasps, and most two-winged flies, there is a very obvious joint, consisting of a hinge, scooped out in the first ring for the purpose of receiving a projecting part of the fourth piece of the hind-back plate of the corselet, arising from between the thigh sockets of the third pair of legs.

The termination of the hind back plate; *a*, joint of the abdomen; *b*, *b*, sockets of the thighs of the hind legs.

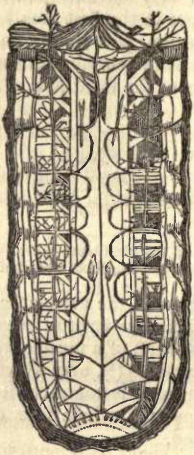
There is besides, in the corselet, a distinct opening or hole, (of a triangular form in bees), to give passage to the broad tendon (1) of a muscle from the abdomen, and to serve as a pulley (2), over which it may play. In proportion as this muscle contracts, it accordingly pulls the abdomen upwards, which falls downwards again when it is relaxed.

Wasps, bees, earwigs, and many other species, have the power of moving the abdomen in various directions, as a whole, and of bending and curving it as a dog does his tail, all of which motions are performed by means of muscles attached to the inner surface of the rings.

The muscles or cords by which every motion is performed are very numerous, as may be seen from

(1) In Latin, *Funiculus*.
(2) In Latin, *Trochlea*.

those of the caterpillar of the goat moth, traced with incredible skill, patience, and accuracy by M. Lyonnet, to whom I am indebted for this figure.



Muscles of the caterpillar of the goat moth (*Cossus ligniperda*); with the two main air-pipes running along each side, and the heart with its six pairs of pyramidæ wings in the middle.

MEMBERS OF INSECTS.

The word member has been chosen here from its involving no theoretical fancy, as the term *Appendage*, used in modern books, always seems to do. I apply the term member to any part of an insect, either jointed upon the body, or not appearing to make a portion of its surface, such as the legs, wings, and ears, as well as the eyes; and, by slightly extending the term, it may also include the tail-fork of the earwig, and the sting of the bee.

In describing the members, I shall follow, in the same order as before, the head, corselet, and abdomen.

MEMBERS OF THE HEAD.

It will be most convenient to consider the several members of the head, in the order in which they appear most conspicuous to the eye, beginning with the ears, and proceeding to the eyes, the feelers, the lips, and the jaws.

The Ears of Insects.

The members which I here venture to call the ears (1), though not quite proved to be the organ of hearing, are uniformly two in number, standing out from the head, upon which they are jointed and moveable in a socket (2), by means of a ball or pivot (3).

Supposing the head to be composed of a ring made up of determinate pieces, similar to the corselet, the

(1) In Latin, *Antennae*, which means placed *before*, and was applied by the Romans to the sail-yard of a ship.

(2) In Latin, *Torulus*.

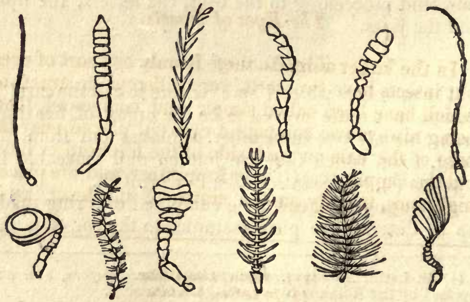
(3) In Latin, *Bulbus*.

ears would be found to arise like the wings, from the junction of the upper flanks with the back or rather crown plates.

The ears are composed of minute cylinders or rings successively added to each other, to the number of thirty in some butterflies; and thus forming a tube, which encloses nerves for sensations and muscles for moving, as well as air-pipes and cells.

As to their insertion or connexion, they are always, according to M. Audouin, placed near the eyes, before, behind, above, below, between, or even apparently within these. Sometimes their bases are near together, or united, and sometimes considerably distant.

As to their direction, they are stiff or flexible, straight or nodding, parallel or diverging, spiral or not spiral; and they are in some species carried always forward, in others backward, or towards the sides, and sometimes folded up or drawn into a sheath.



Various forms of the ears.

As to length, they are very long compared with the length of the body, in some moths and beetles, and very short in the house fly; but their length does not depend on the number of the joints, for they may be long, when composed of only three or four pieces, and short, when composed of ten or more pieces.

As to form, they are either cylindrical, conical, bristle-shaped, awl-shaped, spindle-shaped, forked, branched, feathered, tiled, beaded, (like a neck-lace), pectinated, (like a comb), serrated, (like a saw), prism-shaped, downy, hairy, or bristly. Their tips again are either pointed, knobbed, clubbed, hooked, triangular, leaved (1), (as in the dung beetle), forked, blunt, awned (2), abrupt, or perforated.

In the males of moths, gnats, and some other insects, the ears are in all or most cases more ornamented with feathers, hairs, or sculpture, than in the female, in which the ears are plain.

The Eyes of Insects.

In the larger animals, there is only one sort of eyes, but insects have two sorts, very different in structure, which have been called simple and compound, there being always two compound eyes (3), placed near the base of the ears on each side of the forehead or face; but the simple eyes (4) vary in number, and are placed higher up, usually on the crown of the head, as in

(1) In Latin, *Lamellatæ.*
(2) In Latin, *Aristatæ.*
(3) In Latin, *Oculi compositi.*
(4) In Latin, *Ocelli*, or, very objectionably, *Stemmata.*

the bee, where the simple eyes are three in number, and placed in a triangle.

The upper portion of a bee, showing the two compound eyes with their facettes at the base of the jointed ears: together with the three simple eyes in form of a triangle on the crown.

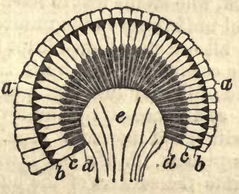
We do not meet with simple eyes in all insects, but no adult insect is without compound eyes. The number of simple eyes is usually three. Each is composed of, 1. an outer membrane, hard, transparent, and formed of a single piece (1); 2. a layer of a viscous or clammy substance (2), immediately behind the first, which determines the colour of the eye, being black in bees, white in crickets and grasshoppers, and red, yellow, or green in some caterpillars; 3. a rather thick membrane (3), seemingly composed of a tissue of net-work, whose meshes are very closely set; and 4. a nerve from the ganglion of the head, very small, which penetrates to the inside of the outer membrane, where it spreads out.

Compound, composite, shagreened, or facetted eyes, are so named from being made up of a great

(3) In Latin, *Cornea*. (2) In Latin, *Pigmentum*.
(3) In Latin, *Choroides*.

number of minute eyelets, not unlike the six-sided facettes of crystals. They are always immoveable, differing in this from the eyes of larger animals. Each of the little eyelets or facettes is very similar in structure to one of the simple eyes already described. According to Professor Müller, of Bonn, the composite eye of the dragon fly may be divided into two parts; one above and behind of a reddish colour, with the eyelets twice as broad as those of the other in front and below, which is greyish.

When the whole composite eye is cut into, we find, 1. the outer transparent membrane (*a*); 2. the larger or clammy-coloured matter (*b*); 3. a broad belt, orange-coloured before, and black in front (*c*); 4. a second belt within the first, deep black (*d*); 5. the ganglion of the nerve, which, when slightly pressed, is seen to be composed of rays of fibres, or threadlets (*e*), one of which probably passes to each eyelet.



The cellular tissue, and the clammy-coloured substance, are found wanting in some species of night insects; and, according to Treviranus, there is in the cockroach, (a night insect), behind the outer membrane, a mass of a dark violet colour, composed of numerous little pyramids, upon which the nerve is spread in the form of fibres.

The Mouth in Insects.

Following the generalizing views of M. Audouin, in considering the head composed of similar parts to one of the three divisions of the corselet, the mouth will occupy the place of the breast-plate and the two under flanks; and taking each of these three as composed of two pieces, there would be in the mouth, by supposition, six pieces; and this in fact is the number of pieces found in a great number of species, though not in all; for, by the law of proportion, when a part is much enlarged, a contiguous part is either very small, or altogether wanting.

Notwithstanding the mouths of insects are thus composed of a determinate number of pieces, their structure both appears to be, and is, very different,—for example, in a bug, a butterfly, a bee, and a beetle,—owing to the difference of form, as well as to the difference of junction in the several pieces.

M. Lamarck, who seems first to have had a glimpse of the general uniformity in the number of pieces in the mouth of all insects, at once leapt to the singular and untenable conclusion, that bugs, through process of time, got rid of the joinings that made their mouths into a tube, and successively improved themselves into beetles with good moveable jaws. M. Savigny, reversing this process, thinks the jaws of the beetle degenerated into the suckers of the butterfly and the bee.

Many of our English naturalists, from being far behind in logic and generalizing, and therefore incompetent to take advantage of Continental researches, so admirable when they are stript of theory, forthwith conclude, that all insects, without free, moveable jaws, or having any of the six pieces wanting, have imperfect mouths. One English naturalist in particular, by a gross misconception of Savigny's meaning, represents the mouths of sucking insects as "totally useless;" and thence concludes, "they can do no injury to agriculture," a conclusion as false as the former is impious.

I have stated this in order to prevent misconception, which, from the imperfection of terms, is but too apt to mislead a genuine field observer, and is certain to mystify and bewilder a compiler or a cabinet naturalist.

Comparing the jaws of an insect with those of man, or with the bill of a bird, we find that while the motion of the latter is upwards and downwards, the motion of the former is forward from the sides. According to M. Audouin, who follows M. Savigny, the mouth of an insect consists of the upper lip, a pair of upper jaws, a pair of under jaws, and an under lip.

1. The upper lip (1) is a flat, usually horny, plate, joined horizontally to the lower part of the face, and closing the mouth.

2. The upper jaws (2), one on the right and another on the left, resemble, in eating insects, a large horny tooth, more or less curved, often indented, and jointed into the sides of the head immediately below the upper lip, being moveable, and without any pieces attached to them, as is the case with the under jaws. In some moths the upper jaws are exceedingly small, with a part as if scooped out in each.

3. The under jaws (3) are also two in number, and are jointed into the right and left of the inner cavity of the mouth, immediately below the upper jaws; they resemble the upper jaws in moving from the sides forward; but are seldom so strong, being rather membranous than horny, particularly at the tips; they also differ in being jointed, while the upper jaws are solid.

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(1) In Latin, *Labrum*. (2) In Latin, *Mandibulæ*.
(3) In Latin, *Maxillæ*.

Usually, at the place where the horny texture ends, and the membranous begins, there is, on each of the under jaws, a remarkable little member, in form of a thread, composed of from four to six joints, commonly tipt with a part less horny than the rest, jointed upon a stem or footstalk that supports it, and furnished with hairs. These jointed members are called feelers ([1]), though the term is objectionable, because their use is not well ascertained.

Sometimes the inner front of the lower jaw forms a sort of acute lobe, or even a large scale, furnished at the tip with a hook, and resembling the upper jaws. In that case, the outer division of the upper jaw takes sometimes the form of a case or arched shield ([2]); sometimes it constitutes a second feeler which is short, and inserted within it. These are called inner feelers ([3]), to distinguish them from the outer, and longer feelers([4]), described above.

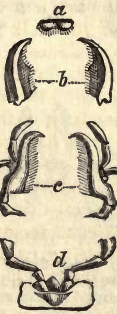
The only organs in other animals similar to these feelers are the whiskers in the cat, the mouse, the seal, the night-jar, and other birds which feed on insects; and the beardlets in the cod, the barbel, and other fish.

4. The under lip ([5]), which closes the mouth below, is not unlike a second pair of upper jaws united, on their inner side, and covered in the greater part by a horny projection called the chin ([6]).

Each of the halves of the under lip carries a feeler smaller than those of the under jaws, and composed of four or more joints. The projection beyond the chin is called the tonguelet ([7]). In many insects there is found a small piece ([8]) on each side, arising in the

(1) In Latin, *Palpi*.
(2) In Latin, *Galea*.
(3) In Latin, *Palpi interni*.
(4) In Latin, *Palpi externi*.
(5) In Latin, *Labium*.
(6) In Latin, *Mentum*.
(7) In Latin, *Lingula*.
(8) In Latin, *Paraglossa*.

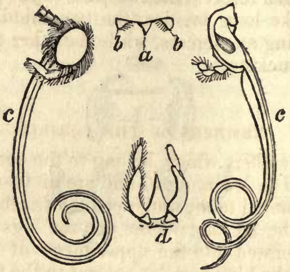
fauces, resting upon the tonguelet, with a tip like a small ear.



Parts of the mouth in a beetle. *a*, the upper lip; *b*, the upper jaws; *c*, the under jaws, with two pairs of jointed feelers; *d*, the under lip, with the short tongue in the middle, the chin below this, and a pair of jointed feelers.

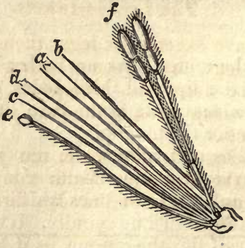
In bees, the under jaws are rather long, encasing the sides of the lip, and these, being united, form a sort of sucker, moveable at the base. Cuvier mistook the under lip for the tongue.

In butterflies and moths, the upper jaws and the upper lip are very minute, the under jaws immoveable at the base, and form two lines which are united and form a long tube rolled up spirally. It would be no less incorrect to call this the tongue, as it has been called by Fabricius, Latreille, and Cuvier, than it would be to represent it as an imperfect mouth, as has been done by our English naturalists from gross blundering and fatuity.



Parts of the mouth in a day flying moth (*Zygæna*). *a*, the upper lip; *b*, *b*, the upper jaws; *c*, *c*, the under jaws in form of a sucker carrying the jointed feelers at their base; *d*, the under lip with the tonguelet in the middle, and the jointed feelers on each side.

In two-winged flies and gnats, the upper lip forms a case, the two pairs of jaws are in form of bristles, and were mistaken by Latreille for feelers, while the under lip forms a tube.



Parts of the mouth in a gnat. *a*, *b*, the upper lip and upper jaws carrying the jointed feelers; *f*, *c*, *d*, the under jaws and tonguelet; *e*, the under lip.

In bugs, the under lip forms a long sheath; the edges, bending downwards, are shaped into a hollow canal, which receives the two pairs of jaws, in this case formed like long bristles, the two middle ones probably acting as piercers, while the other two probably assist in sucking.

MEMBERS OF THE CORSELET.

THE members which belong to the corselet are appropriated to locomotion, and are of two sorts. One sort are jointed to the under pieces of each of the three rings of the corselet; these are the legs (1): another sort are jointed into the upper pieces of the mid corselet and the hind corselet—never to the fore corselet; these are the wings (2).

Here the law of proportion is observed to regulate, as it always does, the relative size of the members, and the pieces on which they are jointed. When the legs, or a pair of them accordingly are very short, the corresponding pieces of the corselet are very small; and when the wings are small or wanting, the corresponding pieces are small or undivided.

The Legs in Insects.

Insects have exactly six legs, though the first pair or the fore legs, are in some butterflies so small as scarely to be detected. Millepedes, centipedes, and wood-lice, which have more than six legs, are not strictly insects.

The fore legs, or first pair, are jointed into the joinings of the breast-plate with the under flanks in the fore corselet, and are always directed forwards.

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(1) In Latin, *Pedes*. (2) In Latin, *Alæ*.

The mid legs, or second pair, are jointed with the same pieces in the hind corselet.

Each leg may be considered as made up of four principal pieces—the haunch, the thigh, the shank, and the foot—enclosed in a horny or membranous skin, containing the necessary muscles for moving the joints.

The haunch (1) is various in form, being short and small in most beetles, while it is large in wasps and grasshoppers. In lady-birds it is round; in cockroaches it is flat. It is made up of three pieces (2), two next the corselet working in the socket (3), and the third (4) jointed to the thigh, but apparently without independent motion.

The thigh (5) is the second principal piece, and is always comparatively long and generally bulged, but flat. It can only be moved backwards and forwards and not sideways. In leaping insects, and in those which dig and burrow, the thigh is always long, strong, and muscular.

The shank (6) is the third principal piece of the leg, and is generally flat and about the same length as the thigh, but more slender. In the hind legs of swimming insects, the shank is often fringed. Upon the upper end and sometimes the middle, moveable spurs (7) are frequently jointed or fixed.

The foot (8) is the fourth principal piece, with which the leg ends. It is composed of five smaller pieces in a great number of species, but in some cases only from one to four, and in others, the number varies in the several pairs of legs on the same insect. Two muscles, one above and one below, have been detected in each of these pieces.

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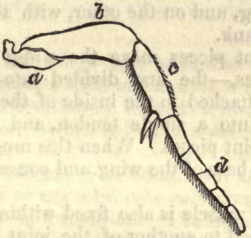
(1) In Latin, *Coxa*.
(2) In Latin, *Trochantina* and *Rotula*.
(3) In Latin, *Acetabulum*. (4) In Latin, *Trochanter*.
(5) In Latin, *Femur*. (6) In Latin, *Tibia*.
(7) In Latin, *Calcaria*. (8) In Latin, *Tarsus*.

The most remarkable part of the foot, is the tip piece termed the claw [1], which is wanting in the fore-legs of some butterflies and other species. Each foot has usually two claws, but in some insects there is only one, and in others, there are four and even six on one foot. The claws are very various in form according to the uses intended.

In the two-winged flies there are, between the claws, from two to three thin plates [2], outwardly convex and toothed like a comb, and used for cleaning the body and wings. At the base also are suckers, or, as Mr. Blackwall thinks, spunges, containing a sort of glue, which enable flies and other insects to walk up glass against gravity.



The leg of an insect. *a*, the haunch; *b*, the thigh; *c*, the shank, with a forked spur; *d*, the foot, with five joints.

The Wings in Insects.

The wings in insects are four, sometimes two, in number, and are uniformly jointed upon the upper

(1) In Latin, *Unguis*. (2) In Latin, *Pectines*.

flanks, and the back plate of the corselet,—one pair uniformly on the mid corselet, and the other uniformly on the hind corselet.

The upper or fore wings(1), which may be also called the greater or first pair, are always jointed upon the two upper flanks, and the back plate on each side of the mid-corselet, and of course near the centre of gravity, being balanced on the one side by the head and fore corselet, and on the other by the abdomen and hind corselet.

Somewhat like the human wrist, which is composed of a number of little bones, the wing joint in insects has small horny joint pieces (2), to the number of seven in the first pair, of various size and figure, but all united by a membrane, and jointed on the one side with the wing, and on the other, with the back plate and upper flank.

These joint pieces move the wings by means of three muscles,—the first divided into two portions where it is attached to the inside of the corselet; but these unite into a single tendon, and are fixed into one of the joint pieces. When this muscle contracts, it lowers the base of the wing and consequently raises the tip.

A second muscle is also fixed within the corselet, and is attached to another of the joint pieces. This muscle lowers the inner edge of the wing and gives it a sort of pendulum-like motion.

A third muscle is similarly placed, and acts in concert with the two first.

The preceding description applies to the wings of bees and wasps; while in two-winged flies there are two sets of muscles: one set placed lengthwise for

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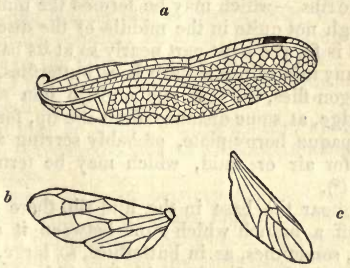
(1) In Latin, *Alæ anteriores.*
(2) In Latin, *Epidemæ.*

lowering the wings, and another placed aslant and across these for raising the wings.



a, wing of dragon fly; *b*, wing of bee; *c*, wing of a house fly.

In general, the wings may be said to be composed of two membranes united together by means of horny lines, which are variously termed veins, nervures(1), and wing bones, though not quite correctly. I prefer the term rib (2).

The wing rib is not to be considered as a bone, but as a horny and nearly solid tube enclosing air-pipes (3) for the purpose of expansion. The number and disposition of these ribs, which may be reckoned about seven, varies greatly in different groups of insects.

In bees, wasps, two-winged flies, and butterflies, beginning at the upper edge of the wing, we find it formed by a strong rib which may be termed the fore-rib(4), rendered remarkable in some butterflies for a hook at its base which serves as a pulley for the tendon of a muscle.

At some distance, often about the middle of the

(1) In Latin, *Neuræ*. (2) In Latin, *Costa*.
(3) In Latin, *Tracheæ*.
(4) In Latin, *Costa anterior* or *Radius*.

wing, and somewhat parallel to the fore rib, runs another also usually strong, sometimes the strongest of all the ribs,—which may be termed the mid rib (1), for though not quite in the middle of the disc of the wing, it is for the most part nearly so at its base.

In many insects, particularly bees, butterflies, moths, and dragon-flies, the fore and mid rib join near the upper edge, at some distance from the tip, forming a small opaque horny plate, probably serving as a reservoir for air or fluid, which may be termed the rib-spot (2).

From near the base in the mid rib, there is often given off a branch which runs between it and the fore rib, sometimes, as in butterflies, so large, that it may be mistaken for the mid rib itself. It may be termed the mid rib branch (3). It is wanting in bees.

On the lower side of the mid rib several branchlets are given off, which go to unite with other branchlets. These branchlets may, if necessary, be numbered 1, 2, 3. &c., or lettered *a*, *b*, *c*, &c.

The next leading rib in the wing may be termed the inner rib (4), and is usually divided near the base into two, sometimes three or four, branches. In butterflies, the division takes place about the middle of the wing.

Near the under edge of the wing is another rib, which may be termed the lower rib (5), between which and the edge, are in some groups, one or more small ribs (6).

These several ribs and their branches, (in some groups so numerous as to give the whole wing the appearance of lace or net work), by inclosing portions of the wing, form what may be termed areas (7), and as

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(1) In Latin, *Costa media* or *Cubitus*.
(2) In Latin, *Stigma*. (3) In Latin, *Costa mediastina*.
(4) In Latin, *Costa interna*. (5) In Latin, *Costa inferior*.
(6) In Latin, *Costulæ marginales*. (7) In Latin, *Areæ*.

it is of some use to attend to these, in describing the wings, I shall point out the principal areas, premising that a wing may be said to have a base [1], where it is joined to the corselet; an upper edge [2] running from the base to the fore tip [3], an outer edge [4] running from the fore to the hind tip [5], and a lower edge [6] from the hind tip to the base.

What may be termed the upper area [7] is the space inclosed between the mid rib with its branches and the upper edge.

The space inclosed between the mid rib and the inner rib, with its branches, may be termed the mid area. In butterflies [8], this space is somewhat oblong and triangular, without any cross ribs.

The space inclosed between the mid rib and the lower rib, or between the lower rib and the under edge, may be termed the lower area [9].

The irregular space, occupying the outer edge; all the wing, indeed, not included in the three other areas, may be termed the outer area [10].

These several areas are further divided into smaller areas, or, as they may well be called, meshes, which form beautiful lace-work in the dragon flies and others of the same group.

According as they are in the base, the middle, or the outer edge, these may be termed base meshes [11], mid meshes [12], and outer meshes [13].

The other parts of a wing necessary to be attended to in descriptions, are chiefly coloured markings, particularly on the wings of butterflies, such as

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(1) In Latin, *Basis*. (2) In Latin, *Margo anterior*.
(3) In Latin, *Apex anterior*. (4) In Latin, *Margo exterior*.
(5) In Latin, *Apex inferior*. (6) In Latin, *Margo inferior*.
(7) In Latin, *Area superior*. (8) In Latin, *Area media*.
(9) In Latin, *Area inferior*. (10) In Latin, *Area exterior*.
(11) In Latin *Cellulæ basilares*. (12) In Latin, *Cellulæ mediæ*.
(13) In Latin, *Cellulæ exteriores*.

a streak(1), a band(2), a spot(3), an eyelet(4), a sprinkling (5), &c. The outer and lower edges, are, in butterflies, moths, and some other insects, furnished with fringes(6), and sometimes with a tail(7).

Markings of the wings of butterflies and moths.

With respect to texture, the first pair of wings in beetles are so horny and stiff, that they have no close resemblance to what are called wings in other insects. They are indeed less adapted to flight than to cover the second pair in a state of repose, and to balance the body, perhaps, by their weight in flying. Sometimes indeed these horny wings, usually called wing cases(8), cannot be separated on the back, in which case the second pair of wings is either very small or

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(1) In Latin, *Striga*. (2) In Latin, *Fascia*.
(3) In Latin, *Macula*. (4) In Latin, *Ocellus*.
(5) In Latin, *Irroratia*. (6) In Latin, *Ciliæ*.
(7) In Latin, *Cauda*. (8) In Latin, *Elytra*.

wanting. The term wing cases is quite appropriate, so far as function is considered; but it is important to know that these wing cases in beetles occupy the same place, and are jointed in the same manner, as the first pair of wings in bees.

The leathery wings of locusts, crickets, and grasshoppers, and the half leathery wings of tree bugs, and some other insects, are also similar in their relative situation to the first pair of wings in bees.

In the base of this first pair of wings, there are found in the common fly, some beetles, and other insects, a pair of small scaly members, dependent on the larger wings, and appropriately termed winglets(1). It is a mistake to consider these apart from the wings, for they are always jointed into the back plate of the mid corselet, never into the hind corselet, and united at the base to the wing; and often the separation of one of them from the wing cannot be traced. It is sometimes double, that is, two to each wing, like a bivalve shell. It does not, as has been supposed, produce the buzzing of flies.

The second pair of wings(2) are always, like the first pair, jointed with the back plate and upper flanks of the hind corselet. They are in most respects similar to the first pair, as in the joint pieces, which are only six instead of seven, the ribs, the areas, and the parts of the circumference.

It is worthy of remark that, except in dragon flies, earwigs, some beetles, and a few other insects, they are commonly much smaller than the first pair, but in all cases, following the law of proportional relation, to the parts of the corselet upon which they are jointed.

In the common fly, and others similarly constructed, there arises exactly from the same part of the hind

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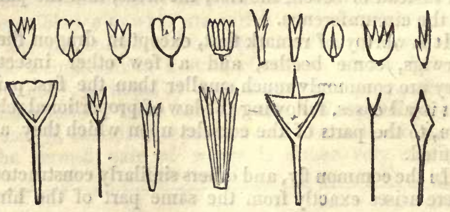
(1) In Latin, *Alulæ*. (2) In Latin, *Alæ posteriores*.

corselet as the second pair of wings, a pair of small members, shaped somewhat like a drum-stick, and protected above by the winglet. These have been called poisers (1), or balancers, and are supposed by some to aid in balancing the body, by others to produce buzzing, by beating on the winglets, neither of which opinions is proved. The law of proportion proves them, as M. Audouin thinks, to be the second pair of wings, which he proves by the fact of the poisers only occurring in insects having no second pair of wings.

In moths, the second pair of wings are each furnished near the base with a sort of slender, but stiff, horny hook, somewhat curved, which is fixed into a projection of the first pair, by way of bridle (2).

In wasps and bees the second pair are bridled to the first pair by minute hooks, in form of an S along the upper edge.

The wings of some insects are clothed with hair, and others, as butterflies and moths, with a sort of feathery scales (3), which appear in the microscope of very various forms. These scale feathers are placed over each other like the tiles of a house, are the coloured part of the wing, and easily come off on being touched, in the form of dust.



The feathery scales from the wings of butterflies and moths, magnified to shew their various forms,—from Reaumur.

(1) In Latin, *Halteres*. (2) In Latin, *Frenum*. (3) In Latin, *Plumulæ*.

MEMBERS OF THE ABDOMEN.

THE only members in this portion of an insect's body, are situated upon the two last rings, and are very various in form and use. Insects, having no spine, like animals furnished with bones, have no tail, at least similar in structure to that of the dog or the horse; but in many moths there is a hairy brush, which is termed the tail (1), on the last ring. Its use is not apparent in the males, while in the females the hair is plucked out to cover their eggs, by an instrument similar to a pair of tweezers, also placed on the last ring of the abdomen. In the scorpion fly the tail is jointed.

In earwigs there is a forked member (2) on the last ring, the blades of which are moveable, and which are said to be used for folding up (rather, I should think, for unfolding) the wings, which are for the most part concealed under the short wing cases. A somewhat similar member, but the blades crossing each other as scissors, is found in the male snake fly. In the rove beetles are long, narrow, stiff members; and the dragon-flies, leaf-like members on the last ring, absurdly called a sting, but whose use is not well ascertained, any more than the use of the long bristles jointed into the last ring in the day fly, and shorter ones in the cockroach, and some crickets and grasshoppers.

In other instances, there are long members in the last ring, somewhat similar to a brad-awl, and used for the purpose of boring holes to deposit the eggs. These are peculiar to females, and are termed

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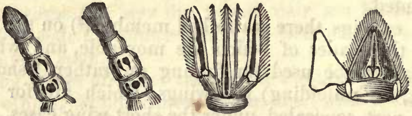
(1) In Latin, *Cauda*. (2) In Latin, *Forceps*.

ovipositors (1). They are sometimes hollowed into a tube for the egg to pass along, and sometimes solid.

In bees, wasps, and some other insects, there is a weapon used for attack and defence, termed the sting (2), which can be drawn within the abdomen when it is not used. It is composed of a sheath, darts (3) barbed at the point, and a poison bag at the base for poisoning the wound which it makes.

In the grub of the glow-worm, I discovered a singular instrument on the last ring, composed of gristle-like rays, in form of a funnel, covered with a clammy adhesive substance, and capable of being extended and contracted. The grub employs it to clean every part of the body.



a, **The last ring of the abdomen of a bee opened, shewing the sting in its sheath ;** ***b,*** **the sting of a bee magnified to show the barbed darts ;** ***e,*** **cleaning instrument of the grub of the glow worm open ;** ***d,*** **the same shut.**

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(1) In Latin, *Ovipositores*.
(2) In Latin, *Aculeus*. (3) In Latin, *Spicula*.

INTERNAL ORGANS OF INSECTS.

Having thus taken a brief, but, I trust, an intelligible survey of the outside of the body in insects, the student may be supposed to be partly prepared to examine the various organs within the body. It will be convenient, for this purpose, to begin with the organs employed in the digestion of the food, and then pass on to those employed in breathing, sensation, and reproduction.

ORGANS OF DIGESTION.

It is remarkable that the length of the organs of digestion in insects, measuring from the mouth to the vent, is, as in the larger animals, proportioned to the sort of food. Vegetable food, being more crude, or not so like the properties of the animal body, requires more preparation to turn it into nourishment; and hence, insects, and other animals which feed on vegetables, have their organs of digestion of great length, much longer, indeed, than the body, in which they wind in many folds. Animal food requiring less preparation, the insects which feed on it have their organs of digestion short, and of the same length as the body. In all cases they consist of three layers, the outer membranous, the middle muscular, and the inner mucous.

When the food has been taken into the mouth and bruised, or chewed by the jaws when those are moveable, or sucked up when they form a sucking tube, it passes on to the haus or entrance (1) of the gullet, and thence to the stomach and intestines as in the larger animals.

In man, the food is mixed, during the process of chewing, with a peculiar fluid supplied from several glands or fountains situated near the mouth. In insects, similar fountains (2) have been described by Ramdohr, Leon Dufour, and others. They are most obvious in sucking insects, and when a fly cannot suck a bit of dry sugar, it has been observed to moisten it with this fluid.

The organs (3) which furnish the silk, spun by the silk-worm and other caterpillars, are similarly situated with the preceding, and perhaps are the same organs.

The most complicated organs of digestion, (found, of course, in insects feeding on vegetable matter,) may be described under six divisions, the gullet, the crop, the gizzard, the stomach, the intestines, and the vent.

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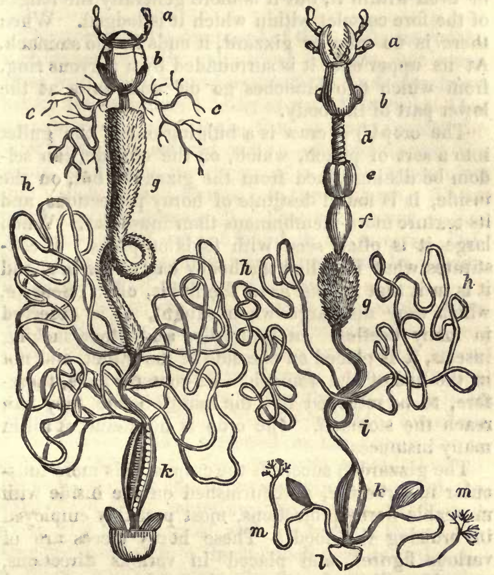
(1) In Latin, *Fauces* or *Pharynx*; in Scotch *Haus*.
(2) In Latin, *Sialisteria*. (3) In Latin, *Sericteria*.



The organs of digestion in two different beetles. Fig. 1, a garden beetle (*Carabus*). Fig. 2, a churchyard beetle (*Blaps*). *a*, the jaws and feelers; *b*, the head; *c*, *c*, the saliva vessels; *d*, the gullet, very short in Fig. 1; *e*, the crop, wanting in Fig. 1; *f*, the gizzard, wanting in Fig. 1; *g*, the stomach, large and convoluted in Fig. 1; *h*, *h*, *h*, the bile vessels long, and numerous; *i*, the small intestine; *k*, the blind gut; *l*, the vent; *m*, *m*, the excrementary vessels.

The gullet([1]) varies much in length, being sometimes very short, and sometimes reaching to the abdomen, or even within it, but it is more generally the length of the fore corselet within which it is lodged. When there is no crop or gizzard, it ends in the stomach. At its upper end, it is surrounded by a nervous ring, from which two branches go off and unite at the lower part of the body.

The crop ([2]) or craw is a bulging out of the gullet into a sort of pouch, which, on the outside, can seldom be distinguished from the gizzard; but, on the inside, it is found destitute of horny projections, and its texture more membranous than muscular. When large, it is often seen with folds or plaits. It constitutes what is called the honey bag of the bee, and it is in it that insects have the fluids, often offensive, which they discharge when caught, as is observed in many beetles. In butterflies and other sucking insects, it is placed on one side of the gullet, and not in the line of the stomach. Its contents have, therefore, to be returned into the mouth before they can reach the stomach. The crop is not found at all in many instances.

The gizzard([3]) succeeds the crop, and is more muscular in structure, and furnished on the inside with moveable horny projections, most probably employed in bruising the food. These horny pieces are of various figures, and placed in various directions, sometimes like a brush, sometimes like a comb; and just above the entrance of the stomach they nearly close the passage, forming a sort of valve, which will only permit minute portions of the food to pass. Swammerdam and Cuvier are mistaken in thinking insects which have a gizzard, such as grasshoppers,

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(1) In Latin, *Œsophagus*.

(2) In Latin, *Ingluvies;* in German, *Speisesack*.

(3) In Latin, *Ventriculus callosus*.

chew the cud. The chewing motion which deceived them, I have found to be the process of cleaning the feet and the ears. The gizzard is not found in all insects.

The stomach[1] is composed of thin, soft, extensible, membranes, usually cylindrical in form, but sometimes with bulgings and contractions, and sometimes forked, the entrance[2] being at one of the forks. One remarkable circumstance is, that, in many insects, the outer surface is covered with a number of teat-like points, similar to the finger of a glove, containing fluid which they discharge into the stomach. These may be termed vessels [3]. They vary much in size and number, and are not found in all insects. Different opinions are held respecting them by Cuvier, Marcel de Serres, and Leon Dufour.

In all insects, we believe, there are vessels called bile vessels[4], consisting of several membranous tubes, filled with a peculiar fluid, bitter, and usually brown or yellow, but sometimes limpid, supposed to be similar to bile, though we find nothing like the liver for preparing this bile, which is probably, therefore, as M. Gaëde thinks, prepared in the vessels themselves. These vessels float in many convulutions in the abdomen, one end being sometimes free and the other fixed, and sometimes both ends fixed, and giving rise to a sort of arch or curve. Sometimes these are inserted into the stomach near its outlet[5]; in others, one end goes into the stomach, and the other into the blind gut. Their number varies from two, which are found in the rose-chafer, to four, found in beetles and common flies; to six, found in butterflies, and to even one hundred and fifty (pro-

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(1) In Latin, *Ventriculus chylificus*, or *Duodenum*.
(2) In Latin, *Cardia*. (3) In Latin, *Villi*.
(4) In Latin, *Vesiculi biliarii*. (5) In Latin, *Pylorus*.

bably mere branches of two fundamental ones), found in bees, wasps, and dragon-flies.

It is in the stomach that the food is converted, by means of the digestive fluid, from the gastric vessels and the bile, into a pulpy mass, called chyle, if we may follow the analogy of other animals.

The outlet (1) of the stomach is in insects furnished with a valve to prevent the too rapid passage of the chyle into the intestines.

The intestines (2) form an extended portion of the organs of digestion, which may be divided into four parts, the chyle gut, the small gut, the blind gut, and the vent gut.

The chyle gut(3), which is always found in large animals, is seldom, in insects, different from the small gut. When it is distinguishable, as in the glow-worm, it is very smooth. It receives the chyle from the stomach.

The small gut (4) is usually strait, smooth, and of equal size through its whole length, though there are bulgings in some species; and, for the most part, it has many convolutions. The chyle, in passing along, has its nutritive portions taken up by the inner membrane of this intestine, through which it passes into the cavity of the abdomen, and not, as in other animals, into lacteals, in order to be converted into red blood, which is not found in insects.

The blind gut (5) consists usually of an egg-shaped cavity, formed by the bulging out of the lower end of the small intestine. It is often covered with plaits orbands; sometimes the bile vessels open into it, and it always contains the crude parts of the chyle rejected by the small gut as unfit for nourishment.

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(1) In Latin, *Pylorus*. (2) In Latin, *Intestina*.
(3) In Latin, *Duodenum*. (4) In Latin, *Inestinum tenue*.
(5) In Latin *Cœcum*.

Insects have no gut precisely similar to the colon of other animals.

The vent gut (1) is very muscular, and usually short. It ends in the vent (2), through which the crude parts (3) of the chyle, collected in the blind gut, are thrown out of the body.

The singular discharges of offensive matter, such as the poison of the bee, and the vapour of the bombardier beetle, are prepared near the vent gut by a particular apparatus, and stored up in a sort of bladder, from which they are discharged.

In the abdomen of a certain class of bees in the common hive, called wax workers, are cells between the rings, in which wax appears to be prepared by secretion from the food within, and not collected, as is supposed, directly from flowers; as the pollen is well known to be upon the thighs for the purposes of food. This opinion, however, which I have not myself verified by observation, is contrary to that popularly held. It was first started by Hornbostel, a clergyman at Hamburgh, in 1744, and republished as his own discovery, by Reim, in 1769. Mr. John Hunter, evidently without being aware of these, published it as his own discovery in 1792; and Huber, assisted by the clever daughter of Professor Jurine, made experiments and dissections, all confirmatory of the same view. Recently G. R. Treviranus, one of the best living experimental physiologists, has repeated the investigations, and has come to the same conclusion. I think these high authorities must outweigh that of Mr. Huish, who decides that they are all wrong, and that the popular notion is right.

The nutritive part of the chyle, which is (if the term may be used) filtered through the sides of the small gut, is not then received into any vessel, as has

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(1) In Latin, *Rectum*. (2) In Latin, *Anus*.
(3) In Latin, *Excrementa*, or, *Fæces*.

already been said, but spreads about through the interior of the body, taking the form of an irregular mass of soft pulpy fat, greenish or whitish in colour, which surrounds the organs of digestion, and fills up every vacant place in the body, particularly in caterpillars, of which it forms a very large proportion of the whole bulk.

The more fluid portions appear to be taken up through the membranes of the several organs, probably in a similar way to that by which they previously passed through the membranes of the small intestine. On this subject, however, we are still very much in the dark: though it is certain the fat is employed for the purposes of nutrition; for it is always stored up in great quantity before an insect passes into the state of chrysalis, when it ceases to eat, and often remains torpid for many months; and is also found similarly stored up in the female before the eggs are laid, but after this disappears.

The nutritive matter, whether it be fat or fluid, not being carried through the body in arteries and veins as the blood is in other animals, to nourish the several parts, lies around and upon the parts to be nourished, which absorb the peculiar portions they require, rejecting the rest; and this may be required by other parts for a different purpose.

The more solid portions may be required by the muscles, the layers of the intestines, the horny skin, and perhaps by the nerves; while the more fluid portion may be taken up by the gastric vessels, the bile vessels, and the peculiar vessel, which is the only organ found in insects in the least resembling a heart.

ORGANS OF CIRCULATION.

The organ or vessel in question was called a heart by Malpighi and Swammerdam, and the older naturalists; but though it is now commonly called the dorsal vessel (1) by modern writers, I shall use the term heart, which, besides being again introduced by Meckel, Herold, and Straus, is less repulsive to a beginner; and I shall endeavour to describe is so as to prevent misconception.

The chief resemblance which the heart in insects bears to that of other animals, is its containing a fluid, and its regular beating, as may readily be observed in smooth caterpillars, in which it is of large size. Lyonnet counted twenty to one hundred beats in the minute in the goat caterpillar, caused, it has been said, by the alternate contraction of a number of muscles ranged along its sides. It differs most essentially from the heart in other animals, in having no visible inlet or outlet in the form of veins or arteries. Consequently, there is not, and cannot be, any real or direct circulation of blood in insects, though a claim to the discovery of such a circulation has been lately made, upon very slight and vague grounds, by Professor Carus, of Dresden, and too hastily admitted by Mr. Spence, though the claim is not new, having been made by Comparetti, on the faith of minute dissections.

The heart lies along the whole extent of the back, from the head to the vent, immediately under the skin and muscles. It is in form of a cylinder contracted at the two ends, but usually narrower towards the head, and wider towards the vent.

It is composed of two membranes; an outer of cellular texture interlaced with numerous airpipes(2), and an inner of muscular texture.

Within it is filled with a fluid, transparent, coagulable, readily drying, and, when dry, having the look of gum, its colour being sometimes strong and sometimes greenish, orange yellow, or dull brown. Without,

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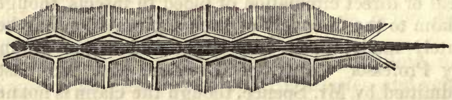
(1) Latin, *Vesicula dorsalis.* (2) In Latin, *Tracheæ.*

the masses of fatty matter which sometimes surround it in considerable quantity, are of the same tint as the fluid within, and it may be, the fluid derives its colour from them, though M. Audouin seems to think the reverse is the case.

Meckel and Herold, considering the organ a heart, think that its beatings, or alternate contraction and dilatation, which affect its whole extent, are for the purpose of agitating, not of circulating, the fluid it contains, as they admit no outlet or inlet by means of vessels for that purpose. Herold thinks that the dilatation, or diastole, is produced by the triangular muscles which attach it to the back; while the contraction, or systole, is produced by the muscular fibres of the inner membrane.



The heart of a carnivorous grasshopper, with its valves, chambers, and artery, from M. Audouin.

"The dorsal vessel," says M Straus-Durckheim, a naturalist of high talent, "is in reality the heart of insects, being in them, as in higher animals, the mover of the blood, which in them, instead of being contained in blood vessels, is diffused through the cavity of the body. The heart occupies the whole of the back of the abdomen, and ends at the fore part of the organ in a single artery(1) without branches, which carries the blood into the head where it is poured out, whence it flows back into the abdomen, in consequence solely of its accumulation in the head, in order to enter anew into

(1) This was anticipated in part by Lyonnet, page 412.

the heart. To this alone is reduced the whole circulation in insects, which accordingly have but one artery without branches, and no veins.

"The wings of the heart are not muscular, as Herold pretends; they are simple fibrous ligaments for retaining the heart in its place.

"The heart is divided within into eight successive chambers, in the cockchafer, separated from each other by converging valves, which allow the blood to pass forwards from one to another as far as the artery that conducts it into the head, but oppose its movement backwards. Each chamber is furnished at its fore part on the sides with two openings in form of cross chinks, which communicate with the cavity of the abdomen, and through these the blood contained in the latter can enter into the heart. Each of these openings has within it a little valve, in the form of a half circle, which shuts up the passage during every contraction.

"From this brief detail, it may be conceived, that when the chamber nearest the vent is dilated, the blood in the cavity of the abdomen will enter through the two openings (1) above described. When this chamber contracts, the blood which it contains, not being able to return into the cavity of the abdomen, shuts the valve(2), and passes into the second chamber. This dilates for the reception of the blood, and at the same time it receives a certain quantity of blood by its proper openings. Then, by the contraction of this second chamber, the blood passes in the same manner into the third, which receives it equally by the side openings. In this way the blood is propelled from one chamber to another, till it reaches the artery; and it is the successive contractions of the several

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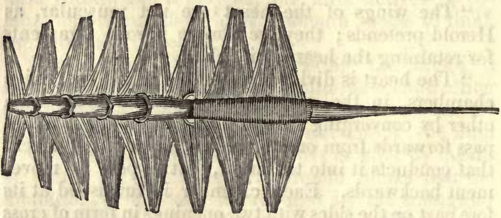
(1) In Latin, *Auriculo-ventriculariæ.*
(2) In Latin, *Valvula interventricularia.*

chambers of the heart which are observable through the skin in the backs of caterpillars."



The heart of the cockchafer, with its valves, chambers, and artery, from M. Straus Durckheim.

This is both very rational, intelligible, and supported by minute and careful observation. It at once destroys numerous fancies on the subject, proposed by Cuvier and Marcel de Serres.

The blood then appears to be partly prepared by transmission through the coats of the intestine, and again probably undergoes changes in its passage to, and its course through, the heart; and being diffused through the cavity of the body without being confined in blood vessels, it is probably distributed whither it is wanted by the muscular movements of the animal, and assimilated by what is termed imbibition.

Organs of Breathing.

In the larger animals, the blood, by means of lungs, is exposed to fresh air, taken in by the mouth and nostrils, and through the windpipe passing into the lungs, where it gives off oxygen to the blood, and carries off carbonic matter from the blood. In insects there are no lungs, and consequently no air is taken in by the mouth (there are no nostrils) by breathing.

Fresh air, however, is as essential to insects as to other animals, though it enters their bodies in a different manner; since, instead of one, two, or three openings for breathing, there are usually eighteen, generally very obvious in the larger caterpillars; their function being demonstrable by stopping them up with oil or grease, when the animal is soon suffocated and dies.

These openings are termed spiracles (1), and are of two sorts, simple and composite.

A spiracle magnified to show the lips open to inhale the air in breathing.

The simple spiracles (2) are usually situated on the sides of the abdomen, a pair (one on the right and one on the left) to each ring, at the junction between the back arch and the belly arch. Like the nostrils in man and other animals, these spiracles are often beset with hairs, crossing and meeting, for the purpose of preventing the entrance of what might prove injurious, while the air may pass pure.

The position assigned them, as well as their number, varies considerably, to suit the habits of the insect. In the maggots of some flies, for instance, which feed on greasy substances, or live in water, there is only one spiracle at the end of the last ring which can be stretched out like a telescope into the air, while the body is enveloped.

The second and third rings of the body of caterpillars answering to the mid and hind corselet, having no spiracles in caterpillars, and the exact parts where

(1) In Latin, *Spiracula,* improperly *Stigmata.*
(2) In Latin, *Spiracula simplicia.*

they might be looked for being the place where the four wings are afterwards jointed, M. Blainville inferred that the wings, when expanded, in the moth and butterfly, were nothing more than spiracles. In this singular opinion, M. Audouin would have agreed, had it not occurred to him, that if the wings were to be considered spiracles, there would not be both wings and spiracles in the same insect at these four points, which upon examination he actually found, as in the cockroach and the mole cricket; and of course M. Blainville's fancy is thence annihilated.

The opening of these spiracles is surrounded by a ring, more or less circular, and somewhat elevated, which being contractile, may be considered as similar to the lips of the mouth.

The composite spiracles (1) are never placed in the abdomen, but exclusively in the fore corselet, and are (so far as is at present known) only two in number. These are very obvious in grasshoppers. They are composed of two horny pieces, which move outwards and inwards in the process of breathing, like a pair of folding doors, their movements being produced by two muscles.

The spiracles convey the air which they inspire from without to a corresponding number of air pipes, to be carried into the body, as the air inspired by man is carried into the windpipe and the lungs. The several air pipes which go from the spiracles end in a common pipe on each side, and these two common pipes may be termed the main air pipes (2). They run lengthways from the head towards the vent, and send off innumerable small branches to convey the air to the different parts of the body, somewhat like the branches of certain shrubs; the branchlets (3) interlace

(1) In Latin, *Tremaëræ* or *Spiracula composita*,
(2) In Latin, *Tracheæ*. (3) In Latin, *Ramuli*.

the membranes, penetrate the muscles, and extend through the legs and the wings.

Two sorts of these air organs have been distinguished, the one tubular or pipe-like, as those we have just described, and another vesicular or cell-like.

The first sort, or air pipes (1), are composed of three distinct membranes, the outer and inner of which are thick, extensible, and of a cellular texture, while the middle one is formed of a gristly thread rolled spirally round in the manner of a corkscrew, and very similar to the spiral air pipes of plants. This gristly spiral thread is very elastic, in consequence of which the pipe is kept uniformly open, for even when it is compressed by the muscles, it immediately expands again. There is a similar mechanism of gristle in the human wind pipe.

These air pipes have also been distinguished, from their situations, into arterial and pulmonary, the arterial being those which come directly from the spiracles; and the pulmonary, the two large pipes on each side of the body, (not always traceable), from which other arterial pipes branch off. The structure of both these is similar.

The second sort, or air-cells (2), are without the spiral gristle, being composed only of an outer and inner membrane. Consequently, those air cells, when not filled with air, must become flaccid by their sides collapsing. They are not in the form of pipes, but like cells or pouches, mutually communicating with each other through very short and simple canals. They never communicate directly with the spiracles, but receive their air from the air tubes. They are not found in all insects; but, when they occur, they appear to serve the purpose of reservoirs for air.

They vary also in number and in size. In the rose

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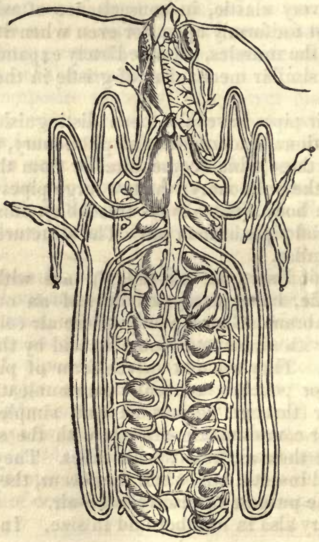
(1) In Latin, *Tracheæ tubulariæ.*
(2) In Latin, *Tracheæ vesiculariæ.*

chafer, for example, they are very small and very numerous; but comparatively large in grasshoppers and crickets. In these insects, the air cells can be easily counted. It would be a difficult matter to inflate them with air, had there not been an ingenious contrivance to facilitate this, in a sort of ribs with which their sides are provided, discovered by Marcel de Serres, and consisting of small projections from the edge of each ring of the belly, and not distinct jointed members.



The breathing apparatus in the Praying Mantis, showing the numerous air tubes and air cells on each side.

The air then is breathed by means of these various organs, and acts on the blood, or the fluid similar to blood, somewhat, it may be presumed, in the same way as it acts on the human blood, in the lungs, oxygen being abstracted, and carbonaceous matter carried off (1).

The insects which live under water constantly or partially, have peculiar organs for decomposing the water or the air it contains in order to procure oxygen, which appears to be indispensable to life. Some of these water insects, indeed, come ever and anon to the surface, in the same manner as the water eft and the whale, to breathe the air. Others remain always under water.

ORGANS OF SENSATION.

It is well known that in man, the brain and spinal cord, with the nerves proceeding from them or connected with them, are the organs of feeling or sensation, the brain being encased in the strong bones of the scull, and the spinal cord in the no less strong and peculiarly-jointed bones of the back. The nerves in insects differ much from those of man, and particularly in there being no peculiar structure like the skull, and the bones of the spine, to encase what may be termed the main stem, whether that be considered the origin or the receiver of the branches. This main stem in insects, however, which lies along the breast and belly, from the head to the vent, is protected by the inner breast-plate from being compressed by the gullet, as has been already noticed.

In man, the brain is distinguished into two parts, the spinal cord being a third; but besides these there is a system of numerous and extensive nerves, which

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(1) This will be fully explained in the "ALPHABET OF PHYSIOLOGY."

is only connected with the three parts just mentioned by very small twigs, and is therefore considered as being partly independent of them. This partially independent system of nerves in man is termed the ganglionic system, and it is sometimes also called the great sympathetic nerve, or the intercostal nerve.

Now it is generally maintained by naturalists, that insects possess only this ganglionic system of nerves, and have no brain or spinal cord like that of the larger animals.

It maybe well, before proceeding farther, to describe a ganglion, which is a knot or mass of nervous substance, at a point where two or more nerves meet, and appears to consist of two substances similar to those of the brain, while it differs from a nerve in being firmer in texture, redder in colour from a greater supply of blood, and covered with a membrane of closer texture. The fibres or threads of the nerves which join such a nerve-knot or ganglion, become twisted within it, as Scarpa says, into a bundle, and threads from the several joined nerves unite to form a new nerve, which is always larger than any of those whence it has been formed. This constitutes a ganglion in man.

Instead of a brain, then, insects have generally in the head a double nerve-knot or ganglion, contained in a horny cavity larger than itself. This, for the sake of distinction, may be called the ganglionic brain (1); inasmuch as it differs from the ganglionic system in man by sending nerves to the eyes, the ears, and the mouth, while the former appears (so far as is yet understood) to supply nerves only to the heart, stomach, intestines, and other organs, whose motions are involuntary. The ganglionic brain also differs from the brain in man by being surrounded with

(1) In Latin, *Cerebrum ganglionicum.*

powerful muscles which move different portions of it, whereas, there are no muscles to move the human brain. Besides the nerves to the eyes, the ears, the mouth, from the fore part of the ganglionic brain in insects, and two nervous films behind, difficult to detect, and probably running to the heart,—two thick nerves go off from the base, and after forming by their separation a sort of ring or collar, which, dipping down, embraces the gullet, they re-unite at what may be called the second nerve-knot or ganglion (1), below the gullet, whereas the brain is above the gullet.

In the same way, two nerves go off from the lower part of this second nerve-knot or ganglion, and re-unite at a third (2).

Two nerves go off from the third in a similar way, and thus, at intervals, a chain of nerve-knots or ganglia, united by double nervous cords, is formed along the belly of the insect to the vent.

The number of nerve-knots or ganglia varies in different species. Sometimes there is one for each ring of the body, and in other cases, not so many as this. The louse has only three, while the mole-cricket has nine, and the green field cricket has ten.

When one of these nerve-knots is carefully observed, it is found to be usually spherical or pear shaped, sometimes flat, (in the gipsy-moth, the third is heart-shaped) consisting, like the ganglionic brain, of two lobes, not always of the same form, even in the same insect.

Besides the two main nerves, or double nervous chord which unites the several nerve-knots into a chain, there goes off from each, on both sides, small nervous branches, and these again divide into branchlets smaller and smaller, which are distributed to the gullet,

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(1) In Latin, *Ganglion secundum.*
(2) In Latin, *Ganglion tertium.*

the stomach, the air-pipes, and the muscles throughout the body.

Lyonnet counted forty-five pairs of these nerves, and two single ones in the goat caterpillar, making in all ninety-two, which is fourteen more than are found in man.

The double nervous chords uniting the ganglia are tubular, and composed of two substances, the membrane forming the tube, and a sort of marrowy substance with which this is filled. It is probable, that the smaller branches are similar in structure.

The nervous system in a garden beetle (*Carabus*). *a*, the first nerve-knot or ganglion, with a large nerve on each side going off to the eyes; *b*, the second nerve-knot; *c*, the third, nerve-knot; *d*, *e*, *f*, *g*, *h*, the other nerve-knots or ganglia.

It is not improbable that each nerve-knot may form the centre of feeling to the parts with which its nerves communicate; and if this be so, it will afford some explanation of the fact, which is no less singular than it is ascertained beyond question, that insects obviously do not feel so much pain from wounds and injuries as larger animals. Hence it appears to be, that the abdomen of a wasp or a bee will continue to live, and thrust out the sting, long after it is severed from the body; and the head of a dragon-fly will eat as voraciously after it is cut off, as if it had to supply an insatiable stomach. The circumstances seem to disprove, in the most decided manner, the humane, though mistaken, opinion of the poet, so often quoted, that

> "The poor beetle which we tread upon
> In corporal sufferance feels a pang as great
> As when a giant dies."

No giant could kick if his body was cut asunder, yet the bee stings in such circumstances; no giant could eat voraciously like the dragon-fly when his head is cut off, nor walk about without his head, as a common fly will readily do; nor after his bowels have been scooped out, as cockchafers often do.

May it not be that Providence has endowed insects with less acute feelings, in order to lessen their sufferings when preyed upon by birds and other animals, for whose food they appear to be mainly intended? I throw this out as a plausible conjecture.

I have already briefly described the external appearance of the eyes, and what seem to be the ears; but it may be useful here to advert again to these and the other organs of the senses.

The sense of *Touch* has been by many supposed to reside in the organs I have ventured to call the ears, which have thence been termed feelers, but the evidence on which this rests is slight and unsatisfactory;

for the bending the ears forward, and moving them in walking, seem to be for the purpose of listening.

I think that the numerous joints in the foot permitting it to bend round objects, and more particularly the soft-cushioned feet of some beetles and flies, and also the feelers on the under jaws, and the under lip, may be more plausibly considered the organs of touch; while the hairs, and long bristles, and spines, of some caterpillars, are evidently connected with the sense of touch.

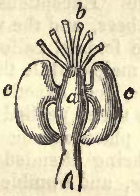
There can be no doubt that insects possess the sense of *Taste*, several species being most delicately fastidious respecting their food; rejecting some leaves and choosing others, when no difference is perceptible to us. It is not well ascertained in what part of an insect's mouth the organs of taste are situated, though I think it more plausible to consider the tongue as such than the feelers, or the haus, as has been done by some authors.

Most insects possess an exquisite sense of *Smell*, but as they do not breathe through nostrils and do not possess them, we are naturally led to suppose the organ of smell to be in the spiracles,—most probably in the pair of spiracles on the fore corselet, which are, it may be recollected, of different structure from the other spiracles; or, if M. Huber be correct, in a small spiracle at the root of the tongue. Dumeril appears to think that the whole lining of the air-pipes throughout the body is the organ of smell—evidently a gratuitous assumption highly improbable.

For the brief reasons assigned under touch, and for others deduced from dissection and experiment, I have ventured to call the *Ears*, two horn-like organs, always situated near the eyes, to which various incongruous functions have been assigned. As I have little doubt these organs will one day be proved to be ears, I think it will direct attention more decidedly to them by at once terming them ears, than by leaving them open to all sorts of crude fancies, so easy to form, but so detrimental to correct inquiry.

The *Vision* of insects is much better understood than that of the other senses. As I have already described the simple and compound eyes of insects, so far as their outward structure is concerned, I shall now call attention to the nerves of the eyes. (1)

In insects which have large eyes, these nerves are exceedingly large, bulging out after they go off from the ganglionic brain into considerable knobs. In the stag-beetle, in which these are pear-shaped, so many minute branchlets go off to the eye, (one probably to each facette,) that it is not possible to count them. In the hive bee the knobs of these nerves are kidney-shaped, and so much larger than the brain itself, that they might lead an indifferent observer to suppose they were actually the brain.



The head nerves in the bee. *a*, the first nerve knot or ganglion, with its forked division below; *b*, the small nerves of the head; *c*, *c*, the two large nerves of the eyes.

It is remarkable that the eyes of insects are supplied with large air pipes, arising from the main air pipe in the head; one rather large, surrounding the eye, and many others going off from this and dividing into

(1) In Latin, *Nervi optici*.

equal angled triangles, as has been minutely described by Marcel de Serres.

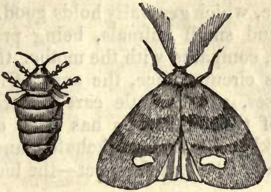
I have proved by experiment that M. Latreille was mistaken in supposing a small black ant, common in France, to be blind: I found it on the contrary very impatient of light.

ORGANS OF REPRODUCTION.

UNLIKE snails and worms, among which there is no distinction between the males and females, insects have the two sexes as distinct as the larger animals, and in many respects are similar to birds, so far as pairing is concerned,—that is, a single male associates with a single female. Exceptions to this general rule occur among hive bees, and the white ants of warm countries; a single female, called the queen, being attended by many males, while the young are nursed by a peculiar class, (not exactly females, but more like these than like males,) called nursers, or workers. The reverse takes place among poultry and black cattle, one male being attended by many females. Among ants, wasps, and humble bees, several individual females in the same hive are attended by several males.

Insects differ from birds and many other animals, in the male taking no share whatever in providing for the young, either before or after pairing.

The male is generally smaller than the female, sometimes, but not always, brighter or differently coloured; is distinguished in moths and gnats by the ears being feathered or ornamented, while those of the female are plain; and in grasshoppers and cuckoo-flies by wanting the ovipositor. In some insects the male has ample wings, when the female has none, or very minute ones, not adapted for flying.



The Vapourer moth, the female with plain ears and with very short wings; the male with feathered ears and large wings.

The male insects are, in most cases, more restless and wandering than the females, and of course more frequently seen, differing in this from spiders, the males of which are seldom or rarely seen.

All female insects have eggs, which, in a few cases, are hatched within the body, but are generally laid in such places as the young may readily find food when hatched; the mother, in most instances, dying soon after the laying, and of course the young have from the first to shift for themselves.

These are ascertained facts which cannot be questioned, though they do not accord with the popular error of insects being generated by putrefaction, and by blighting fogs or winds, much less the so-called philosophical theory of their being generated by some sort of mysterious chemistry.

This theory was supposed to be unanswerably supported by the multiplication of microscopic animalcules in water, which could not, on account of their minuteness, be traced to their parents. This, however, though apparently impossible, has recently been done by Professor Ehrenberg of Berlin, who, by putting the animalcules in coloured fluids, succeeded not only in discovering their eggs and the hatching of these but in tracing them before they were laid in the egg-organ of the mother ([1]).

M. Ehrenberg was no doubt assisted in this by the circumstance, which generally holds good, of the eggs of insects and small animals, being proportionably much larger, compared with the mother, than in birds.

From this circumstance, the eggs of insects may, in many cases, with a little care, be traced in the egg-organ of the mother, as has been done by M. Straus-Durckheim in the cockchafer, and by Swammerdam in a much smaller insect—the louse.

Egg organ in the louse magnified; *a*, the right branch converging; *b*, the left branch diverging; *c*, an egg in the egg tube ready to be excluded; *d*, *d*, the fountain which furnishes the glue.

Male reproductive organs in the blister beetle.

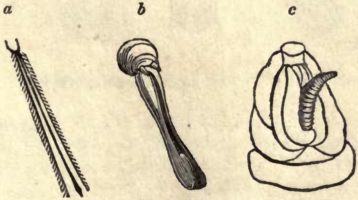
([1]) In Latin, *Ovarium*.

When an egg is laid by an insect, it is, except in a very few cases, glued to the place where it is laid by a sticky fluid provided for that purpose, and discharged along with the egg, or immediately after it; the vessel producing which fluid in the louse may be seen in the figure. The louse glues its eggs to hairs; moths and butterflies glue theirs on the bark or leaves of plants and trees, where they usually remain through the winter, to be hatched the following spring.

It is thence obvious that the eggs of insects, thus firmly glued, cannot, as has been fancied by the unlearned, as well as by philosophers, float about in the air, than which, indeed, they are always much heavier.

Several species of insects, instead of gluing their eggs in this manner, place them in nests, as is done by the bees and wasps, appropriately called miners, masons, carpenters, or upholsterers, according to the processes they pursue in building their nests.

Other species dig holes in the ground, or cut out grooves in wood, in which to lay their eggs, and are provided with curiously-constructed instruments for that purpose, such as the grasshopper, whose digging instrument is like a scymitar; the saw-flies, whose instrument is like a double saw; and the gall-flies, whose instrument is like an awl.



Instruments for depositing eggs; *a*, that of a cuckoo fly; *b*, that of a grasshopper; *c*, that of a saw fly.

Several species, well termed cuckoo-flies, thrust their eggs into the nests or the bodies of other insects, or animals, and have appropriate boring instruments for this purpose.

This is indeed one of the most singular circumstances in the economy of insects, and frequently leads to no little disappointment, when collectors feed caterpillars for the purpose of breeding moths from them; for instead of the expected moth, a brood of cuckoo-flies, whose maggots had been feasting on the body of the caterpillar, make their appearance, and immediately pair and set out upon excursions for the discovery of other caterpillars, into which they may thrust their eggs.

GROWTH OF INSECTS.

I HAVE here selected the word "growth" in preference to *development*, both because it is shorter, more English-like, and less startling to beginners, and because *development* has recently become one of the catch words of an absurd theory, and has been twisted from its true meaning, by applying it comparatively to two or more animals, instead of confining it, as it always should be, to an individual. *Metamorphosis* is still more objectionable, where similarly applied, and I have elsewhere used "Transformations," as somewhat less so.

EGGS OF INSECTS.

INSECTS' eggs are not all of an oval form like those of birds, but some are like a pear, some like an orange, some like a pyramid, and some like a flask.

Various shaped eggs of insects magnified.

The eggs of the gnat, for instance, may be compared, in shape, to that of a powder flask, and the mother gnat lays about three hundred at a time. Now each egg, by itself, would sink to the bottom of the water; yet the gnat puts the whole three hundred together in the form of a little boat, and in such a way, that they will all swim on the surface of the water; and a very curious way she has of managing this.

Like other insects, the gnat has six legs. Four of these (the four fore-legs) she fastens to a floating leaf, or to the side of a bucket, if she is on the water contained in one. Her body is thus held level with the water, except the last ring of her abdomen, which is a little raised. This being done, she begins to make use of her other two legs, (or hind legs) and crosses them in the shape of the letter X. The open part of this X, next to her tail, serves as a kind of scaffolding, to support the eggs she lays, until the boat is formed. Each egg, when laid, is covered with a kind of glue; and the gnat holds the first laid egg in the angle of the X until the second egg is laid by its side, and glued to it; she then glues another egg to its other side. All these stick together thus $*_*{*}$, making a kind of triangle, or figure of three, and this is the beginning of the boat. Thus she goes on, piling egg upon egg, always keeping the boat in proper shape by her useful hind-legs. As the boat grows in size she pushes it from her by degrees, still adding to the unfinished end next to her body. When the boat is half-built, her hind-legs are stretched out thus =, the X or cross form is no longer wanted, and she holds up the boat as cleverly as if it was done with two out-stretched arms.

The boat is at length completed, and an excellent boat it is, quite water tight. For though it is very small and delicate, yet no tossing of the waves will sink it; and nothing can fill it with water, or turn it upside down. In fact, the glue with which it is covered prevents it from ever being wet. Even if the boat be pushed down to the bottom of the water, up it comes again quite dry: so that it is better than the best life-boat that has ever yet been invented (1).

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(1) Working Man's Companion, Cottage Evenings, p. 54.

The eggs of insects are not, like those of birds, always smooth; but are sometimes ribbed, and sometimes tiled, or otherwise sculptured or carved on the outside.

The shell of an insect's egg is rarely or ever brittle like that of a bird, but composed of a tough membrane which, in some instances, can be stretched out, as appears from the eggs of ants and some other insects growing considerably larger in the process of hatching.

The mother insects, usually dying before their eggs are hatched, do not sit upon them like birds, except in the singular instance of the earwig, which, from the proceedings of one kept by me in a glass, in March, 1832, appears to attend more to shifting the eggs about to places where they may receive moisture, than any thing like hatching by covering them. Ants shift their eggs according to the changes of the day and night, and also of the weather, placing them near the surface of their nests when it is warm and dry, and deep down when it is cold or wet.

In consequence of being exposed to the same temperature, all the eggs of any particular species, in any given district, are hatched exactly at the same time, or at most within a few days; and when such eggs are numerous, an immense number of caterpillars make their appearance all at once on plants and bushes, and give rise to the notion that they are brought by winds, or generated by what is called *blighting* weather, though this is as absurd as to say the wind could bring a flock of cattle, or that the *blight* could generate a flight of sparrows or rooks without eggs to hatch them from.

By looking carefully on the bark of rose or currant bushes, or on the back ribs of gooseberry leaves, the eggs may be found sometimes in patches, sometimes in rows, whence the caterpillars are hatched that creep into the buds, or stream over the leaves and devour them.

INFANCY OF INSECTS.

THERE is no single English word which will apply to every insect just after it is hatched, and while it remains in what may be called its state of infancy; but there are several English words which apply to this state in different sorts of insects, as I shall now explain.

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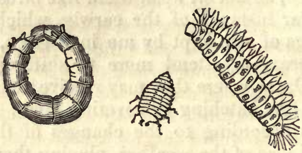

Insects in the infant state; *a*, caterpillar of a saw fly; *b*, grub of a ladybird; *c*, maggot of a cheese fly magnified.

The word "CATERPILLAR" (1) is applied to the creatures which are, with a few exceptions, shaped like an earth-worm, and of various colours, but most commonly green, sometimes smooth, sometimes studded with short or with long hair, and sometimes with a sort of thorns, and having exactly six legs always placed on the corselet and furnished with claws, while they have from two to sixteen clinging feet (2) without claws, always situated on the rings of the abdomen. All caterpillars are hatched either from the eggs of butterflies, moths, or saw flies, with four wings, and, when full grown, they become butterflies, moths, or saw flies, like their parents.

Among the caterpillars best known and most destructive are gooseberry and willow caterpillars, which

(1) In Latin, *Eruca*.
(2) In Latin, *Prehensores*, objectionably *Propedes*.

become saw flies, as does the small caterpillar, erroneously called the turnip fly (1). Other well known caterpillars are the large caterpillars which feed on cabbage, and become white butterflies, and small gregarious caterpillars which destroy hedges and fruit trees, afterwards becoming moths, as do those which roll up the leaves which they eat, or creep into buds, constituting the well known "worm i' the bud." Other caterpillars, which become small moths, devour grain in granaries, the wood of currant and willow or other trees, garments of woollen or silk and furs, and insects and other animals kept in cabinets.

The word "GRUB" is not quite so definite as caterpillar, and is often applied popularly, but erroneously, to both caterpillars and maggots. In precise language, a grub is a creature hatched from the egg of some sort of beetle or weevil (which is a beetle with a longish snout). A grub has always exactly six feet on the corselet, and never any clinging feet on the abdomen like caterpillars. The body of a grub is also, with a few exceptions, more clumsy than that of a caterpillar, the general colour being white, yellow, or brown, never, I believe, green; and the head usually some darker colour, as blackish or dark brown.

The best known grubs are those of the cockchafer, which takes three years to arrive at its full growth, and devours the roots of grass; those of the corn weevil, which do great injury in granaries; and those of the weevils that feed on nuts, and on the buds of apple and other fruit trees, as well as on the roots of cabbages and turnips, producing knobs on them. The meal-worm and the wire-worm are also grubs, as well as those which worm-hole furniture, gnaw bacon, and destroy the bark of trees. One of the pests, called the turnip fly, is the grub of a weevil. All these become

(1) There is a beetle grub also called the turnip fly.

beetles in their adult state, which in turn produce a fresh laying of eggs from which other grubs are hatched.

The term "MAGGOT" is more precise than grub, though some maggots are erroneously called grubs. Maggots are never produced from the eggs of butterflies, moths, saw flies, beetles, or weevils, but always from the eggs of two-winged flies, or from bees or wasps. A maggot differs from a caterpillar or a grub in having no feet, and from an earthworm in never being of a dull red or dingy green colour, but usually white, greyish, often transparent, so as to show the intestines, and, in the case of the water maggots, called blood-worms, of a bright blood red.

The best known maggots are those of the blow-fly, which live on meat, either fresh or putrid; those of the bot fly, producing the disorder called bots in horses; those of the cheese-fly, called jumpers, or hoppers, and sometimes erroneously mites, (mites not being insects at all, but ranking with spiders); and those of the crane flies, which destroy grass and corn fields, often improperly called the grub. The wheat fly, as it is called, and the Hessian fly, which have proved so destructive, are both grubs of small flies, not unlike gnats.

Maggots are popularly called mawks in the North, and gentles in the South, and very often worms.

These three sorts—caterpillars, grubs, and maggots—are, by modern naturalists, called by a Latin word, which means a mask or a phantom (1) because Linnæus took a fancy to suppose them only insects in a mask, which when they had thrown off, they were, of course, unmasked. I think the term objectionable and improper, though it is often convenient for want of a better.

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(1) This Latin word is *Larva*.

These infant insects, indeed, often throw off their skins, or moult, as it may be termed, during their growth, the old skin partly splitting and sloughing off; but this old skin is no more a mask than the feathers of a bird, which are moulted once or twice a year, can be called a mask.

Like most young animals, all caterpillars, grubs, and maggots, eat voraciously, as it is necessary to supply nutriment for their increasing growth.

ADOLESCENCE OF INSECTS.

Adolescent insects; *a*, the peacock butterfly; *b*, the blue-bottle fly; *c*, the cockchafer; *d*, the dragon-fly.

THE English word adolescence, though derived, like infancy, from the Latin, is well understood as applied to the period of life between infancy and full growth. Except this, there is no term which occurs to me as applicable to the stage of insects succeeding the one just described. I have only adopted it here, however, not because I think it good, but because I cannot find one more suitable.

In this stage, insects differ more remarkably from the larger animals than almost in any other particular; for while the latter remain active and continue, as before, to eat and grow, the former in few instances do neither, but remain in a very singular state of torpor.

Preparatory to going into this state, many insects make a sort of nest, called cocoon ([1]), to lie in; others hang themselves up by the tail, by a very ingenious process; and some remain active and move about, as in the case of bugs, locusts, grasshoppers, crickets, and dragon-flies.

Besides the insects which make a cocoon, many of those which do not, upon moulting their last skin in the caterpillar, grub, or maggot state, acquire a covering, in some cases horny and tough, in others thinner and more transparent. In this envelope they remain, till the soft juices accumulated in their previous state become duly assimilated to their proper organs or members, and form the horny skin of the body, together with the legs and wings.

In butterflies, such as the peacock and the alderman, this covering appears shining, as if gilt, and a Latin ([2]), and also a Greek ([3]) word, implying gilding, was given to butterflies in this state, and thence these words were extended to instances in which there was no gilding, and the terms, from frequent use, may now be considered half naturalized as English words, particularly the term chrysalis.

Those with gilt coverings, as is the case with most butterflies, are in this state of a longish form, with several projecting corners and angles, with no appearance of feet or wings. Moths, again, in this state, are usually longish and tapering, with distinct rings and spiracles for breathing along the sides. Two-winged flies are in form of an egg, except being equal in thickness at each end. Most beetles and gall-flies have no case-covering, but remain with their legs folded closely over their breast. It has been already mentioned that bugs, crickets, grasshoppers, and dragon flies are

(1) In Latin, *Incunabulum.*
(2) The Latin word is *Aurelia.*
(3) The Greek word is *Chrysalis.*

not thus laid up in case coverings, nor do they rest with their legs folded, but walk actively about.

Insects, when laid up in these case coverings, were fancied by Linnæus to resemble infants bewrapt in swaddling bands, once common all over Europe, and a Latin word (1), indicating this, was thence applied; and to those not laid up, but remaining active, the fanciful term, *nymph*. The latter is objectionable, because it can only be applied to female insects, while it has been indiscriminately used for both male and female. The former, though almost naturalized in English, is liable to the same objection, and ought, therefore, to be in the neuter gender. So far as this term means an infant, it is incorrect, but the Romans used it both for a baby, a doll, and a girl before arriving at womanhood, and in this latter sense it may be used, if no better term occur.

ADULT STAGE OF LIFE IN INSECTS.

In the same vein with the fanciful resemblance of a caterpillar to a masked insect, and of an adolescent insect to an infant wrapt in swaddling bands, Linnæus fancied that the adult insect, now unmasked and unswaddled, resembled a picture, image, effigy, copy, pattern, or representation of an insect, and thence adopted a Latin word (2) implying this, which is still used by modern writers, though evidently both far-fetched and incorrect, as it plainly means, not the insect itself, but a statue or spectre of it. The disciples of Linnæus, however, accustomed to the art of inventing fanciful meanings for words, and of mystifying the plainest facts, will, no doubt, maintain that *Imago* does not mean an image, but the insect itself; in the same way as those of the modern schools will

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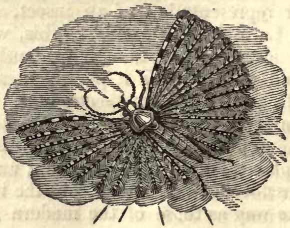
(1) The Latin word is *Pupa*, better *Pupum*.
(2) The Latin word is *Imago*, whence our English word *Image*.

maintain that what they fancifully call *types*, are not like any other known "types," the moulds, models, or dies struck for the purpose of forming figures, nor are they figurative representations, but the very animals themselves. It is thus that fancy and inaccuracy take the place of facts, and do incalculable injury to genuine knowledge.

I would have had less objection to adopt, as I have elsewhere done, the term *perfect*, as applied to adult insects, had it not been in recent times grossly abused in theoretical comparisons of one animal with another,—a beetle, for instance, being termed *perfect*, because several pieces of its mouth are moveable; and a gnat or a butterfly imperfect, because the pieces of the mouth are joined into the form of a sucking pipe. The distinction of the two forms is certain and undeniable; the terms employed are no less impious than insulting to common sense.

After remaining in the adolescent stage for a due length of time, in some instances only a week or two,—very commonly for several months, particularly the winter months,—the case covering, when there is one, or, when there is none, the outer skin, is thrown off, and the insect emerges in its adult or full grown state.



The Twenty-plumed Moth magnified.

For a few hours after its emergence, it is usually somewhat moist, the wings being unexpanded, and, as it were, crumpled up, and the body not so distinct in its outline as it afterwards becomes. In some beetles also, such as ladybirds, the colours are pale, and the first pair of wings, which form the wing cases, are soft, and of a pale uniform colour, without the spot afterwards seen on them.

It is now that the air tubes distributed through the body, and particularly through the wings, perform the important office of inflation; and if a main wing-rib be then cut across near the root, the part of the wing to which it goes ever after remains shrivelled.

Those who are little acquainted with insects, are exceedingly apt to think they grow like other animals, and from this cause commit many mistakes, not perhaps of great moment, but which it may be proper to rectify by examples. The most common British butterflies are those which are white, and all are usually looked upon as of the same species, differing in nothing, except, perhaps, in the size, the latter being erroneously ascribed to difference of age. But the fact is, that there are a considerable number of species of our white butterflies, and probably more varieties even of these than have yet been ascertained or described. It is certain indeed that butterflies do not, like the larger animals, increase in size as they grow older; for every individual, from the moment it becomes a butterfly, continues invariably of the same size until its death. Butterflies, indeed, seldom live longer than a few days, or, at most, a few weeks, and during this time they eat nothing except a sip of honey: and since this is so, it would be absurd to expect that they could increase in size. It must not however, be understood from this, that the same species will always measure or weigh precisely the same; for though this will hold as a general rule, there are many exceptions, arising from the accidents the caterpillar may have suffered, from which an individual butterfly originated. It is only during the caterpillar state that the insect eats voraciously, and grows in proportion; and if it is, during this stage of its existence, thrown upon short allowance, it cannot acquire the standard magnitude, and the butterfly will be dwarfed from the first. The same remarks with respect to growth, apply to insects of every kind; and the fact cannot be better exemplified than in the uniformity of the house-fly, among which scarcely an individual in a thousand, will be found to differ a hair's breadth in dimensions from its fellows. The smaller flies that sometimes mingle with the common house-fly, are those that come from the maggots in cheese.

Few insects, after arriving at the adult state, live more than a few days, or at most a few weeks: some live for a few months, but this is an exception to the general rule.

SYSTEMATIC ARRANGEMENT OF INSECTS.

The only use of a systematic arrangement of insects or other natural productions, appears to me to be its convenience of bringing things together in some logical order, both to aid the memory in remembering, and the judgment in comparing and deciding upon agreements and differences. A system, in this point of view, is similar to the frame work of a cabinet, into the partitions of which many little facts may be stored and dove-tailed, that would otherwise be scattered through the memory at random at the great hazard of being lost.

Such systems, however, since the time of Linnæus, who set the baneful example, have been considered the sole end and aim of study, and are even preposterously represented as a high branch of philosophy, though, viewed in this light, they appear to me no higher nor more important than the play pebbles, which a child may be seen to amuse itself in classing in rows or circles, according to size, form, or colour.

Nay,—viewed in the light of a philosophical study, they are worse than trifling,—they are decidedly injurious, by leading to serious errors, such as that of sucking insects, having "jaws totally useless, can do no injury to the agriculturist," which has been asserted and published within the last two years, by a fanciful theorist, with the ravages of the hop-fly and the bean dolphin staring him with flat contradiction in the face.(1)

(1) The same theorist has since proposed to prove the doctrine of the TRINITY, by what he calls a Trinarian System of Animals.

In Botany again, what is preposterously lauded as the *Natural* system, is asserted to lead at once to a knowledge of the qualities of a plant by merely ascertaining what is called its *natural* order; in the face of the glaring facts of the wholesome potatoe with the poisonous deadly night-shade, and tobacco, being found in one of these so-called *natural* orders; and the wholesome bread-fruit tree, the fig, and the mulberry, with the most poisonous known vegetable, the upas, in another of these *natural* orders. ([1])

Confining ourselves to insects, all sorts of blunders are committed by those who undertake to display what they term the natural system. Moths, for example, are said to be distinguished from butterflies by flying only during the night, though there are numerous examples of day-flying moths; and even groups are actually termed diurnal by the very theorists, who set out by telling us they are nocturnal. A nocturnal-diurnal moth, can only, I should think, be imagined to be of pure Hibernian origin.

There is no system indeed without some such striking error either of omission or commission, and hence we must be contented to make the best we can of their imperfections.

I am most particularly disposed to object to the very fanciful and theoretical terms *Kingdom*, *Tribe*, *Family*, and the like, not only as being founded on no obvious ground, there being no proper king, chief, nor head, in the divisions so termed, but actually involving serious hypothetical errors, contradicted by well-known facts. The terms "Class," "Order," "Rank," "Group," "Species," "Variety," from having some basis to go upon, are much less objectionable; though it is not always necessary to employ

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(1) This will be more fully explained in the "ALPHABET OF BOTANY," now in preparation.

any particular term—numbers being in most cases more simple and less liable to mislead.

Rejecting then the more recent and partially fashionable systems as hypothetical, that of Fabricius as complex and unnecessarily difficult, and that of Linnæus as wanting the grand requisite of distinctness, I think I cannot propose a better than that of the distinguished Swedish naturalist, Baron De Geer, from whose magnificent work on insects, perused with avidity in my younger days, I derived that taste for the study which increases with every coming year. In giving an outline of this system, I shall use the liberty of making a few slight alterations, which I think will render it more easy in assisting beginners to arrange the insects which they may collect, or may wish to study.

OUTLINE OF A SYSTEMATIC ARRANGEMENT OF INSECTS.

INSECTS.

Animals with exactly six feet, and three divisions of the body, more or less distinct.

Divided into

A. Winged Insects. B. Wingless Insects.

A.—WINGED INSECTS.

Divided into

I.—Four Winged Insects, with Membranous Wings; II. Four Winged Insects, with the first pair more or less thick or hard; III. Two Winged Insects.

I. FOUR WINGED INSECTS, ALL THE WINGS MEMBRANOUS.

Divided into

1. Those with powdery wings and a spiral sucker. *Butterflies and Moths.*(1)

2. Those with the wing-ribs hairy. *Caddis Flies* or *Water Flies.*(2)

3. Those with unequal wings, the first and second pair hooked together. *Saw-Flies*, *Cuckoo-Flies*, *Wasps*, *Bees*, *Ants*, (male and female, the workers having no wings) *Ruby Tails*, and *Bee Parasites.*(3)

4. Those with the wing-ribs netted like lace. *Scorpion Flies*, *Day Flies*, *Dragon Flies*, *White Ants*. *Timber Lice*, (some of which have no wings) *Pearl Flies*, and *Ant Flies.*(4)

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(1) In Latin, *Lepidoptera* (LINNÆUS).
(2) In Latin, *Trichoptera*, (LEACH).
(3) In Latin, *Hymenoptera*, (LINNÆUS).
(4) In Latin, *Neuroptera*, (LINNÆUS).

5. Those with a sucker bent under the breast. *Tree-hoppers*, *Lantern Flies*, *Frog-hoppers*, *Plant Lice* or *Aphides*, and *Cochineal Insects* or *Cocci* (1).

II.—FOUR WINGED INSECTS WITH THE FIRST PAIR MORE OR LESS THICK OR HARD.

Divided into

1. Those with the first pair of wings leathery at the base, and over-lapping the second pair cross-ways, and having a sucker bent under the breast. *Tree* and *Plant Bugs* (the bed bug has no wings), *Water Bugs*, and *Water-measurers* (2).

2. Those with the first pair of wings leathery throughout, overlapping at the edges only, and covering the second pair, which are folded lengthwise. *Locusts*, *Grasshoppers*, *Crickets*, *Mole-crickets*, and *Cockroaches* (3).

3. Those with the first pair more or less horny, forming cases, sometimes long, sometimes short, for the second pair folded up when at rest beneath them. *Beetles*, *Chafers*, *Weevils*, *Earwigs* (4).

III.—TWO WINGED INSECTS.

Divided into

1. Those with poisers in place of the second pair of wings and a sucker. *Gnats*, *Mosquitoes*, *Crane Flies*, *Midges*, *Gadflies*, *Dung-flies*, *Bee-flies*, and *Common House-flies* (5).

2. Those with only two wings, in some cases none, and longish jaws. *Bird-flies*, *Bat-flies*, *Sheep-flies*, *Forest-flies* (6).

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(1) In Latin, *Homoptera*, (LEACH).
(2) In Latin, *Hemiptera*, (LEACH).
(3) In Latin, *Orthoptera*, (OLIVIER).
(4) In Latin, *Coleoptera*, (ARISTOTLE).
(5) In Latin, *Diptera*, (ARISTOTLE.)
(6) In Latin, *Homaloptera*, (LEACH).

B.—WINGLESS INSECTS.

[N.B. Bugs, timber-lice, ants, white ants, and some female moths, do not rank in this division, though they have no wings. We cannot make nature bend to our systems.]

Divided into

1. Those with the hind legs formed for leaping. *Bed-fleas*, *Bird-fleas*, *Dog-fleas* (1).

2. Those with tail bristles formed for leaping. *Spring-tails* (2).

3. Those with no members formed for leaping. *Head-lice*, *Body-lice*, *Crab-lice*, *Sheep-ticks*, *Dog-ticks*, *Bird-lice*.

The drawers of a cabinet may be ticketted either with the above letters and numbers, or with the Latin names in the notes, and the insects collected may be arranged accordingly.

In order to class and name individual species, there is little aid at present, except through the medium of very expensive books. This will be partly obviated by my little "CONSPECTUS OF BRITISH BUTTERFLIES AND MOTHS," and I hope soon to be able to get through the rest of our British Insects in the same way, progress having been already made with the "CONSPECTUS OF TWO WINGED FLIES," according to Meigen, Fallen, and other high Continental authorities; and the "CONSPECTUS OF SPIDERS AND MITES," according to Lister, Clerck, and Walckenaer, which will be accompanied by "THE ALPHABET OF SPIDERS AND MITES."

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(1) In Latin, *Thysanura*, (LEACH).
(2) In Latin, *Anoplura*, (LEACH).

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