
*Henry Pidcock.*

# GRAMMAR OF ENTOMOLOGY.

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A

FAMILIAR INTRODUCTION

TO THE

# HISTORY OF INSECTS;

BEING A NEW AND GREATLY IMPROVED EDITION OF

THE GRAMMAR OF ENTOMOLOGY.

BY

EDWARD NEWMAN, F.L.S., Z.S., &c.


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" My wish and judgment about the affair has always been this; that I should much prefer that some one of those, more skilful than myself, had undertaken it; but still that it is better even I should undertake it, than it be left undone."—*Cicero.*

THIS ILLUSTRATED EDITION

OF

AN INTRODUCTORY WORK ON INSECTS,

WRITTEN WITH A VIEW OF BLENDING

AMUSEMENT WITH INSTRUCTION,

IS INSCRIBED

To WILLIAM YARRELL, Esq.,

WHOSE LABOURS HAVE CONTRIBUTED SO GREATLY

TO RENDER NATURAL HISTORY A POPULAR PURSUIT,

WITHOUT IN ANY DEGREE LOWERING

ITS DIGNITY AS A SCIENCE.

# PREFACE.

TEACHERS in science are nearly equally divided into two classes;—those who know too much, and those who know too little. Those of the first class, overloaded with science, cannot admit the possibility of meeting with readers who have none; and, therefore, their essays and introductions are so worded that it requires a tolerable proficiency to understand them. The teachers of the second class fall into the opposite error; they curtail, garble, and popularize the writings of others without understanding them, forgetful that it requires a consummate knowledge of any science to abridge a work which treats of it ably and at large. The author submits, with much humility, that both classes are in error: he submits also that introductory works should be written *for* those who know nothing of the subject on which they read, and *by* those who possess, in themselves, some practical knowledge of the subject on which they write.

In accordance with these views the author has written the following pages; he supposes his reader utterly ignorant of Entomology, and endeavours to show him that it is the History of Insects, and the Art of Preserving Insects, and the Physiology of Insects, and the Classification of Insects: he does not address himself to the professed Entomologist; to such this work will be of little value.

The First Book, entitled History of Insects, is a complete compilation; a series of histories copied, in many instances *verbatim*, from the accounts of those authors who relate what themselves have witnessed. Objections will probably be raised to this plan, but the author thinks without reason. What good purpose would have been answered, had he so curtailed, transposed, and altered these histories, that their very authors should not have known them? On the contrary, is there not a good purpose answered in collecting together the most interesting observations of Huber, Smeathman, Rusticus, Kirby, Spence, Clark, Fries, and Bevan? No concealment is attempted: the authority for each history is given, except when dependent on the author's own observation, and thus the responsibility is removed from the compiler.

The Second Book, entitled Collection and Preservation of Insects, contains nothing worthy of comment; it will be useful to beginners, and thus the author's only object in writing it will be attained.

The Third Book, entitled Physiology or Anatomy of Insects, is the record of the author's own observations: he has given the names employed by other writers, when he could understand to what parts they referred, but in names alone has he availed himself of their labours; the facts, the descriptions, unless given as quotations, are entirely his own.

The Fourth Book, entitled Classification of Insects, may be charged with being too original: it may be said that the author should have given the views and arrangements of others in preference to his own. He would ask, whose system was he to select? That his own is the most simple and the most readily understood, no one will deny: that it is more perfect, or more accurate, or more philosophical, than any other, he does not presume to contend. As for a disquisition on system it would have been dangerous ground; pleasurable to the writer, but unprofitable to the reader: it would have doubled the size of the volume without adding a fraction to its value.

The want of an easy introduction to the Natural History of Insects has been felt by many. For the last two years, during which time it has been generally known that he has contemplated the task, the author has received numerous and pressing solicitations to proceed with it: he has at last made the attempt. He has done his best; whether successfully or not, others must decide.

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*Postscript, May*, 1841. — This little book was observed as a caterpillar in 1835; in 1837 it disappeared and remained concealed as a quiescent and lethargic *pupa*, until, roused by the genial influence of the present spring, it has burst its cere-cloths and assumed the ornamented wings of the gay and volatile butterfly. We need scarcely enquire the physical causes combining to induce this prolonged slumber: suffice it to know that the *imago* is at last on the wing, and perchance ere long may be flitting amid the live oaks of America and the Eucalypti of Australia: it will be sure to flutter about its native home, and many a fair finger will lightly touch its wings, and many a bright eye rest well pleased on its decorations: even the schoolboy will regard it as a thing to be desired, and if obtained will consider it a treasure.

To descend to prose — the first edition appeared in 1835. In 1837 a second edition was announced, from which circumstance it may fairly be concluded that the first was out of print; but notwithstanding this announcement, the second edition was delayed from month to month, until it was abandoned and almost forgotten: at length it was determined to reprint the work in its present illustrated and altered form.

The illustrations are almost entirely original: one is copied from Curtis, one or two from Shuckard and Spry, one or two from Westwood: two of the drawings, those at pages 27 and 96, are by the author's brother; the others by himself, and with the exceptions above specified, invariably from Nature: all the illustrations have been drawn and engraved expressly for this edition. The alterations are in every instance introduced with the view of making the work more easy to the beginner. The author would gladly have added to the number of pages, in fact, he had determined on doing so, he had prepared several most scientific and erudite passages, but

> "The best laid schemes o' mice an' men
> Gang aft a-gley."

On talking the matter over with his publisher — and what author ever presumed to decide for himself?—

it was deemed advisable to restrict the volume in its dimensions to three hundred pages, and in its character to a simple introduction,—a kind of "reading made easy" to the youthful butterfly-hunter.

The author cannot lay down his pen before he has acknowledged the gratification he feels from the liberal encouragement his literary labours have received: it would be false modesty to pretend blindness to the fact that the humble efforts of his pen and pencil have been unusually successful; and this knowledge raises in his heart a feeling of honest pride and gratitude he would fain express, yet knows not how.

Reader, should the author persuade thee, by a perusal of these pages, to follow in his footsteps, — to tread the paths which he has trodden, — to gaze with an enquiring and delighted eye on those things which he has gazed on,—it is enough. He bids thee, affectionately, farewell!

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THE

# GRAMMAR

OF

# ENTOMOLOGY.

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## BOOK I.

### ON THE HISTORY OR ECONOMY OF INSECTS.

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Here subterranean works and cities see,
There towns aerial on the waving tree;
Learn each small people's genius, policies,
The ants' republic and the realm of bees;
How those in common all their stores bestow,
And anarchy without confusion know;
And these for ever, though a monarch reign,
Their separate cells and properties maintain.

Pope.

## CHAPTER I.

### HISTORY OF INSECTS IN GENERAL.

THE history of an insect, like the history of a man, is an account of life from first to last, from birth to death. Insects are so constituted, that the history of an individual is the history of its race: climate, season or circumstance exercises but little power of creating differences among them; a bee is as essentially a bee, and a butterfly a butterfly, at the equator as at the poles; and in either situation performs the same acts. Insects of all kinds, and in all situations, resemble each other in the following particulars:—they proceed from the parent as eggs; the eggs are hatched and become grubs, in which state they eat, increase rapidly in size, and are invariably without wings; the grubs, when full grown, become for a time motionless; their skin opens, and from it comes forth the perfect insect, which has four wings, and does not increase in size. In a very great number of insects the grub changes its skin, and completely alters its form, when it becomes motionless; indeed, almost as great a transformation takes place as on its final change to a perfect insect; when this is the case, the animal, in its motionless state, is called a *chrysalis.* Thus we have four stages in the life of an insect,—four states which it is necessary thoroughly to understand; the egg (*ovum*), which is motionless, and apparently lifeless; the grub (*larva*), which is active, but without wings, voracious, and grows rapidly; the chrysalis (*pupa*), which is quite motionless, and does not occur in all insects; the perfect insect (*imago*), which is active, has wings, does not grow, and which, by laying eggs, perpetuates its kind. The names *egg, larva, pupa,* and *imago,* are the terms generally employed in descriptions; the three last answer equally well for Latin and English, but it must be borne in mind that the words, *grub, maggot* and *caterpillar,* are synonymous with the term *larva;* and *perfect insect, fly,* &c., are synonymous with the term *imago;* and the English and Latin words are used in English descriptions almost indifferently. These transformations, often spoken of as the *metamorphosis* of insects, are in reality nothing more than a continual casting of the outer skin; the larva often casts its skin four or five times, without any very remarkable change of form; every casting of the skin is a step towards arriving at ultimate perfection. In every insect the skin must be cast a certain number of times, and the last casting brings it to maturity.

On account of their small size, it is difficult to find common examples of the *eggs* of insects; those laid on meat by the blue-bottle fly must be known to many; the silk-worm's eggs again are not unknown; but the generality of insects' eggs are so concealed, and so little conspicuous, that they are found with difficulty. Examples of *larvæ* are numerous; the maggots found in wasps' nests and used in fishing, —the maggots in apples and nuts,—the maggots in cheese, and in decaying substances,—and the caterpillars which devour our cabbages, and those which spin webs on our apple, pear, and plum trees,—are familiar to us all: these are insects in the larva state. The *pupa* state is more difficult to find, because insects generally crawl away into crevices or hide themselves underground, before changing to this state; an angular pupa, of a green colour, with small black spots, which produces a common white butterfly, may, however, be frequently seen on palings and garden walls, and the smooth brown pupæ of moths are continually dug up in gardens. The *imago*, or perfect state, is exemplified in butterflies, moths, gnats, flies, wasps, bees, ants, beetles, grasshoppers, earwigs, cockroaches, bugs, fleas, may-flies, and dragon-flies. All descriptions of insects in scientific works relate to the imago state, unless the contrary is distinctly expressed.

The mode in which the life of an insect is passed, differs very widely in the various states of its existence: it often happens that the larva inhabits the water and the imago the air; sometimes the larva inhabits the water, the pupa inhabits the earth, and the imago returns to the water. The following brief histories will in some degree exemplify this.

*History of the Simulia.**—The eggs of the *Simulia* or *sandfly* (sometimes also called the *mosquito*), appear to be at present unknown; there is, however, little doubt, that like those of other gnats, they are deposited on the surface

* Authority;—M. Fries, in 'Entomologisches Archives.'

of the water, and in that situation are hatched by the warmth of the sun combined with the moisture of the water. The larva is found on the stems of water-plants (*Phellandrium*, &c.), on those portions which are always covered by the water: it is long, cylindrical, considerably thickened posteriorly, and nearly transparent; its head is distinctly separated from the body, and is of an oblong form; it has four jaws moving horizontally, each bifid at the tip, and two little horns in the usual place of antennæ, inserted in the front of the head, rather towards each side; each of these is composed of two joints, the first or basal joint stout, the second or apical one, divided into many rays, which fold back on the first joint: there are two very small eyes on each side of the head. The body of the larva is divided into twelve segments, besides the head; of these, the second is incrassated, and furnished below with a retractile conical foot; the last segment is very minute, and furnished with two small prehensile feet: the air-tubes, so very plainly seen in other aquatic larvæ, are totally wanting; neither is there the least appearance of spiracles or breathing-holes in the sides.

The motion of the larva in the water is tolerably brisk; but on any object coming in contact with it, it instantly becomes motionless, attaches itself by the anterior prehensile foot, and remains for a long time perfectly still and immovable. When it moves from one place to another, its progression is undulating, somewhat like that of a leech, being performed in this manner:—the anterior foot is firmly attached to some object, then the posterior pair of feet are brought up to it, the back arching up during the operation; the anterior foot then releases its hold; the body is again elongated, the foot attached further on, and the posterior feet again brought up to it. The food of the larva is unknown: when full grown, it spins a little silken sheath, in shape like a watch-pocket, which is attached to the plant frequented by the larva, and in this it shortly changes to a pupa in an upright position: the case being always open at top, the head and shoulders of the pupa are seen projecting above it. The pupa much resembles that of a moth: it is perfectly motionless, of a brown colour, and exhibits very distinctly the parts of the perfect insect through its skin: from the back of its head arise, on each side, four hair-like appendages; these are tubular, and appear to be designed for breathing. About the sixth of July the little creature bursts from its sheath; the case of the chrysalis opens in a right line down the back, and the perfect insect emerges through the opening, surrounded by a bubble of air, and slowly begins to unfold its wings under the water; finally, its skin being cast, and maturity attained, the imago disengages itself from its former habitation, and mounts within its bubble to the surface of the water, when the bubble bursts, and the creature, with its new organs, has acquired a new element. The imago is a small black fly, with two large transparent wings, which, when at rest, repose horizontally on its back; moderately long legs, and short stout antennæ: it flies with ease, and somewhat sportively, rising and falling. In this country it is found in the damp parts of woods, and other similar situations; but, happily, in very limited numbers.

There is scarcely any creature more annoying to men and animals, than this little fly: its attacks are made in innumerable multitudes, and it is troublesome, not only from the pain and inflammation caused by its bite, but also from the intolerable itching occasioned by its crawling over the skin. In the woody and marshy parts of Lapland, these flies swarm in the months of July and August; nay, even the summits of the highest mountains, though capped with perpetual snow, impose no obstacle to their progress.

Among the numerous gnats and flies which feed on blood, these are the most to be feared; impelled by an insatiable thirst they make their attack, and will have blood; nothing can repel or deter them. Whenever the garment of a traveller has accidentally slipped aside, and discovered a portion of his skin, however small, that exposed portion is instantly streaming with blood: in the southern parts of Lapland they are less troublesome than in the northern, although clouds of them occasionally appear, performing their evolutions in the air.

The *Simulia* seems to have adopted the world for its country: no known land appears to be without it; all temperatures suit it—the polar snows and the blaze of tropical sands. Yet all the flies of which travellers complain as so dreadfully annoying, are not *Simuliæ*;—many of our commonest gnats have a similar taste for blood. Although from what is related, there can be no doubt that the blood of man is an acceptable food to the *Simulia*, yet it is remarkable that the greatest multitudes of these creatures inhabit those bleak, inhospitable, and almost inaccessible regions where the foot of man seldom treads, and where other warm-blooded animals are scarcely known to exist. It is clearly ascertained that the female *Simuliæ* alone suck the blood of man; the males spend their lives among the leaves of trees, or settle on flowers, from which they appear to derive nutriment; it is therefore far from impossible that, on the failure of animal, the females also may have recourse to vegetable food.

*History of the Ichneumon.*—There are many butterflies and moths which increase so rapidly, that, without a check, their caterpillars would, in two or three years at the utmost, devour every green leaf on the face of the earth, and render it incapable of supporting its present inhabitants. The ichneumons are evidently created to act as a check to this devastation: they are generally small insects, with slender bodies, and have four transparent wings: they are very active, running about the stems and leaves of plants in search of caterpillars, and fly very readily. The ichneumons are of many kinds: more than a thousand species have been described by naturalists; and it is probable that every butterfly, and every moth, indeed, almost every insect, has one peculiar to itself: the history of them all is nearly similar.

The caterpillar of the tiger-moth is one of the most destructive; it devours, indiscriminately, lettuces, radishes, beans, peas and every other early production of our gardens, and is most abundant in the spring, when these plants are being reared: it is a very rough, hairy caterpillar, black above, with a red fringe on each side, and is preyed on by several ichneumons. The largest ichneumon (*Pimpla Instigator*) of the tiger-moth (*Arctia caia*) is often about an inch long, but varies much in size; it has a black body and red legs, and emits a remarkably strong smell, something like burning pitch. In the spring, this ichneumon may be seen coursing over the leaves of lettuces, nettles and currant-bushes, on strawberry-beds, &c., hunting for the object of its attack. When it has found a caterpillar, it seizes it behind the head with its jaws; at this operation the caterpillar loosens its hold of the plant on which it was feeding, rolls itself suddenly into a ring, erects its bristles as stiffly as possible, and falls to the ground: if the fall is great and among twigs, the ichneumon is sometimes dislodged, but this rarely happens.

The female ichneumon has three bristles at its tail; the middle one of these appears to be a tube for conveying its eggs into the body of the caterpillar, and is called an ovipositor, the outer ones seem to serve as protectors to this ovipositor, and not to be used for piercing the caterpillar. When the caterpillar can fall no farther, is frequently unfolds itself, and writhes about to dislodge its enemy; but its struggles are useless: the ichneumon elevates its body

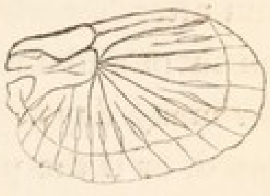
into a kind of arch, bending the ovipositor forward beneath it nearly to its mouth; it then steadies the ovipositor by its hind legs, and, with a slight jerk, drives it into the skin of the caterpillar behind the head; the egg is instantly deposited, the ovipositor withdrawn and the ichneumon flies away. The caterpillar, immediately on the conclusion of this operation, remounts the plant on which it had previously been, and begins feeding eagerly, as before; no difference whatever is to be discovered in its manner, in the quantity of food it consumes, or in the rapidity of its growth.

When the caterpillar has attained its full size, it spins a web among leaves, on the ground, in a bush or against palings, intermixing a considerable quantity of its own hairs; and in this web it changes to a chrysalis. The egg of the ichneumon is very soon hatched and becomes a white maggot, without feet, and with very little appearance of head; it begins eating that part of the flesh of the caterpillar which is immediately in its neighbourhood, and continues its course towards the tail, devouring all the fat and muscular parts not absolutely essential to motion and life; and, by the time the caterpillar of the moth is full grown, and becomes a chrysalis, the maggot of the ichneumon is full grown also, and occupies more than half of its interior. It is worthy of remark that this maggot, thus inhabiting for weeks the body of a caterpillar, and devouring its flesh, always avoids those parts which are essential to life; as though aware that the cessation of life in the caterpillar would ensure its own death, as it could not subsist on the putrifying carcass. After lying quiescent for some weeks, and frequently through the entire winter, the skin of the maggot is thrown off, and it becomes a chrysalis, exhibiting very nearly the shape and appearance of the future fly; the antennæ and legs being placed before it, the wings small and folded by its side, and the ovipositor being turned up a little over its back. The chrysalis is without motion, and much resembles that of the bee: in both instances the limbs are quite distinct from the body, and not united with it in a hard crustaceous cover as is the case in the chrysalis of the silk-worm: this kind of chrysalis is said to be necromorphous, because its limbs are rigid, formally arranged and perfectly motionless, as in death.

The chrysalis state lasts but a few days, and the perfect insect emerges from it; after this first escape, it has to penetrate the shell of the chrysalis of the tiger-moth, in which it is still imprisoned, and which is rendered much harder by the drying of the portions of animal matter left unconsumed by the maggot of the ichneumon. The ichneumon overcomes this difficulty by gnawing a hole, with its sharp and strong jaws, generally in that thin portion of the shell which covers the wing of the future insect: almost immediately on emerging, the ichneumon vibrates its wings, and flies away.

The caterpillar of the tiger-moth is preyed on in a similar manner by the maggot of a two-winged fly; and this maggot, while thus devouring the interior of the caterpillar, is itself a prey to a minute kind of ichneumon, twenty of which sometimes feed in the maggot of a single fly. The manner in which the egg of this little ichneumon is introduced into the maggot of the fly, is at present unknown; but as the fly fastens its egg exteriorly on the skin of the caterpillar, and does not perforate the skin to deposit it inside, as in the case of the great ichneumon before described, it is supposed the small ichneumon's egg is laid in the egg of the fly, while the latter is adhering to the skin of the caterpillar. The egg of the fly, which is placed on the neck of the caterpillar, the only part from which the caterpillar could not remove it, is very conspicuous to an observer: in this situation we cannot be surprised, then, that the ichneumon should discover it; nor does it appear an improbable supposition that the little creature seizes this opportunity of piercing the shell with her oviduct, and depositing her eggs amidst its contents. The maggot of the fly, as soon as it is hatched, pierces the skin of the caterpillar, and commences devouring, carrying within it a horde of insidious parasites, which, though they interfere not with the due performance of its appointed work of destruction, yet, in the end, so weaken it that it never arrives at perfection. Very ingenious experiments and calculations have proved, that four out of every five eggs that are laid, are prevented from arriving at maturity by parasites attacking them in one or other of their stages; a fact which proves the immense importance of this seemingly insignificant tribe of animals.

*History of the Earwig.*—The earwig is one of our most common insects; it is well known to every one, and is very generally an object of unconquerable dislike; the forceps at its tail, and the threatening manner in which these are turned over its back, to pinch anything of which it is afraid, render it peculiarly disgusting. The fore wings of the earwig are square, short, leathery pieces, which cover but a very small portion of the body: the insect is incapable of bending or folding them in any direction, or of using them as organs of flight. The hind wings are quite different from the fore wings: they are folded into a very small compass, and covered by the fore wings, except a small portion which protrudes from beneath them; and, when examined in this position, appear totally useless as organs of flight. When unfolded, the hind wings are remarkably beautiful; they are of ample size, perfectly transparent, displaying prismatic colours when moved in the light; and are intersected by veins, which radiate from near the centre to the margin.—The shape of these wings, when fully opened, is nearly that of the human ear; and from this circumstance it seems highly probable that the original name of this insect was ear*wing*.



Earwigs subsist principally on the leaves and flowers of plants, and on fruit; and they are entirely nocturnal insects, retiring by day into dark crevices and corners, where they are screened from observation. The rapidity with which they devour the petals of a flower is remarkable; they clasp the edge of a petal in their fore legs, and then, stretching out their head as far as possible, bite out a mouthful; then another mouthful nearer, and so on till the head is brought to the fore legs. This mode of eating is exactly that which is practised by the caterpillars of butterflies and moths; the part of a leaf or petal is eaten out in a semicircular form, and the head is thrust out to the extreme part, after every series of mouthfuls. Pinks, carnations, and dahlias, very frequently lose all their beauty from the voracity of these insects. When the time of breeding has arrived, which is generally in the autumn, the female retires for protection to the cracks in the bark of old trees, or the interstices of weather-boarding, or under heavy stones on the ground: here she commences laying her eggs. The eggs are usually from twenty to fifty in number: when the female has finished laying them, she does not forsake them as is the habit of other insects, but sits on them in the manner of a hen, until they are hatched.

When the little ones leave the shell, they are instantly very perceptibly larger than the eggs which contained them. They precisely resemble the parent in structure and habit, except that they are without wings; they also differ in colour, being perfectly white. The care of the mother does not cease with the hatching of the eggs: the young ones run after her wherever she moves, and she continues to sit on them and brood over them with the greatest affection for many days. If the young ones are disturbed or scattered, or if the parent is taken away from them, she will, on the first opportunity, collect them again, and brood over them as carefully as before, allowing them to push her about, and cautiously moving one foot after another, for fear of hurting them. How the young ones are fed until the mother's care for them has ceased, does not appear to have been ascertained; for it is not until they are nearly half grown that they are seen feeding on vegetables with the rest.

*History of the Locust.** — The locust, from the remotest ages, has had a greater power to injure man, than any other living creature. Its course is almost invariably accompanied by famine and pestilence: man is armed with no power to resist it. The locust was sent as a plague to the Egyptians, especially to punish them for their detention and oppression of the Israelites: the whole face of the country was covered by their multitudes. Afterwards, about the date 200 B.C., we have it on record, that locusts again swarmed in the same part of Africa. St. Augustin mentions another enormous swarm in the same region, which devoured every green leaf, and, eventually reaching the sea, perished by drowning: the mass of their corrupted bodies created so great a stench, that a pestilence ensued which carried off nearly a million human beings. We are told by Mouffet, that in

* Authority: — Kirby and Spence's 'Introduction to Entomology.'

the year 591 a swarm of locusts visited Italy; they pursued their destructive course, devouring every thing, until they reached the sea, in which they perished. The pestilence arising from the stench, carried off men and beasts to the number of more than a million. In 1478 the Venetian territory was visited by a swarm of locusts, which so completely destroyed the crops as to cause a famine, wherein more than thirty thousand persons died of starvation. In 1650, a swarm of locusts entered Russia. As they passed, the air was darkened by their numbers; they covered the face of the earth; the trees bent with their weight; and in some places the mass of their dead bodies was four feet in depth. In 1748 a swarm of locusts visited the Austrian dominions: at Vienna the breadth of the swarm exceeded three miles, and so darkened the air, that one person could not see another at the distance of twenty paces. Major Moor witnessed in the Mahrattas, the ravages of a swarm of locusts that was five hundred miles in length, and so compact as completely to hide the sun, and occasion darkness. Mr. Barrow relates that in Southern Africa, in the years 1784 and 1797, a swarm of locusts covered an area of nearly two thousand square miles. When driven by a north-west wind into the sea, they formed upon the shore, for fifty miles, a bank three or four feet high: the stench from their putrifying bodies was perceptible at the distance of one hundred and fifty miles. In 1778 and 1780, a swarm of locusts visited Morocco; every green thing was eaten, and a dreadful famine ensuing, such vast numbers of people died of hunger in the streets of the towns, that their bodies lay unburied.

The egg of the locust is deposited in the ground; when it is hatched, the larva has all the appearance of a locust in miniature, except that it is without wings. Its work of destruction immediately commences; it devours every blade of grass—every green leaf it can obtain. In the autumn it assumes the winged state, and then myriads assemble, and having stripped the earth of its mantle of green, rise in the air, and are driven by the wind, carrying with them destruction, famine, and pestilence. The shape and appearance of the locust is that of our commonest grasshopper, but it greatly exceeds that insect in size; it leaps with ease and agility, but, except in its migrations, does not readily fly. The jaws of the locust are excessively hard and strong, capable of devouring not only the leaves, but, when these fail, the bark and even the solid wood of trees. The sound of their feeding, when in swarms, is as the rushing of flames driven by the wind. Happily, in this country, the locust is very rare; it has occasionally been driven over by winds, but has never been known to breed here. In the year 1748, a considerable number were observed, but not enough to do any serious injury.

*History of the Ant-lion.** —The ant-lion is a native of Portugal, Spain, France, Italy, and Turkey, and probably of most of the tropical countries: it is a large fly with four long wings, beautifully reticulated, like those of a common dragon-fly. The egg is laid by this fly either upon the surface of the ground or just below it, in sandy and loose soils; the heat of the sun soon causes it to hatch and pro-

duce a larva. The larva, in shape, has a slight resemblance to a wood-louse; but the outline of its body is more oval, and the anterior part often considerably wider than the posterior: it has six legs, and the mouth is furnished with a pair of forceps, consisting of two incurved jaws, which give it a formidable appearance. Its food consists solely of the juices of other insects, particularly ants; at first view it seems scarcely possible that it should ever procure a

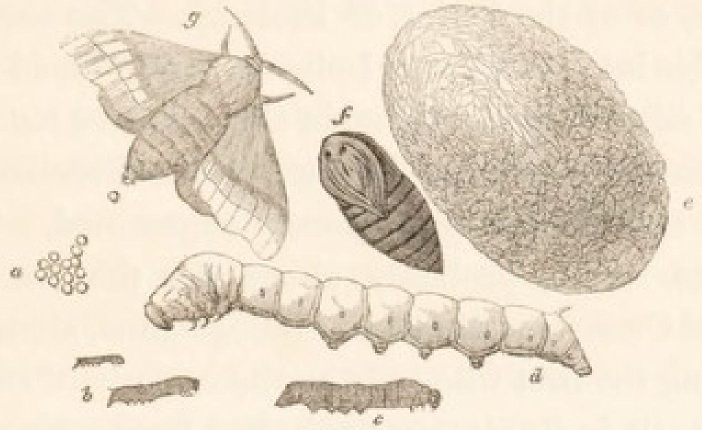
* Authority: —Kirby and Spence's 'Introduction to Entomology.'

single meal: not only is its pace slow, but it can walk in no other direction than backwards; its grim aspect, combined with this awkwardness in progression, appears to offer insuperable obstacles to the capture of its prey.

The first step of the larva is to trace in the sand a circle, the destined boundary of its future abode: this being done, it proceeds to excavate the cavity by throwing out the sand by a process not less singular than effective. Placing itself in the inside of the circle which it had traced, it thrusts the hinder part of its body into the sand, and, with one of its fore legs, serving as a shovel, it charges its flat and square head with a load, which it immediately throws over the outside of the circle, with a jerk sufficiently strong to carry it many inches. Walking backwards, and constantly repeating the process, it soon arrives at the part of the circle from which it set out: it then traces a new circle within the first, and excavates a second furrow; then a third within this, and so on, until, by a repetition of these operations, it arrives at the centre. It never loads its head with the sand lying on the outside of the circle, although it would be as easy to do this with the outer leg, as to remove the sand within the circle with the inner leg; but it knows that it is the sand within the circle that is to be excavated, and it therefore constantly uses the leg next the centre.

After the first series of circles is completed, a second, of less diameter, and deeper, is commenced within it; and so on with others, until the hole assumes the shape of the impression of an inverted cone, when the work is finished.— As the constant use of one leg during the whole of this operation, would necessarily exhaust the animal so much that it would be compelled to waste much time in recovering its strength, it adopts a plan which prevents this: the first circle is excavated with one foot; it then turns completely round, so that the second is excavated with the opposite foot; and this alternation proceeds regularly through the whole work. Small stones are jerked out by its head, in the same manner as the sand; but such as are too large and heavy to be jerked out, the ant-lion poises on its back, and keeping them steady by the motion of the segments of its body, carefully walks up the ascent with its burden and deposits it beyond the margin. Sometimes the stone will slip from the back of the labourer, and roll down the side of the hole; as often as this may happen the patient creature renews its task, and never fails to accomplish it at last: but if it meet with a large or immovable stone, the work is abandoned, and another hole commenced in a more suitable spot. The hole is rather more than two inches deep; the length of the ant-lion is about half an inch: the animal buries itself in the sand at the bottom of the hole, its jaws alone being visible, and thus awaits the arrival of its prey.

When an ant or any other insect steps on the margin of the pit, the sand slides from under its feet, its struggles but hasten its descent, and it falls headlong into the jaws of the enemy. Sometimes, especially after rain, when the particles of sand adhere to each other, the intruder is able to arrest its downward progress, and begins to scramble up again; no sooner does the ant-lion perceive this, than he shovels loads of sand on its head, and throws them with such skill that the poor insect is soon overcome, and carried to the bottom. When the body has been emptied of its juices, the shell is jerked out of the pit to a considerable distance, as if to avoid giving any cause of alarm to new comers.—After a period of nearly two years, the larva having attained its full growth, it retires deeper into the sand, spins a silken cocoon, and changes into a chrysalis, in which state it remains about three weeks, when the perfect insect emerges.



*a*, Eggs of the silkworm. *b*, *c*, caterpillars in a young state. *d*, the same full grown. *e*, cocoon of silk. *f*, chrysalis. *g*, perfect moth.

# CHAPTER II.

## HISTORY OF THE SILK-WORM.*

FROM time immemorial silk has been a valuable article of commerce, and a favorite material for dress; the archives of China speak of its existence five thousand years ago, but we are unable to discover the precise period of its earliest appropriation to the uses of man. The Chinese are supposed to have discovered the art of preparing it 2700 years before the Christian era, when the empress Si-ling-chi is said to have observed the labours of the silk-worms on wild mulberry-trees, and applied their silk to use. From China the art passed to Persia, India, Arabia, and the whole of

* Principal authority:—'Cabinet Cyclopædia,' No. 22, Silk Manufacture. Also 'British Cyclopædia,' Article "Silkworm."

Asia. According to Latreille the city of Turfan, in Little Bucharia, was for a long period the rendezvous of the caravans coming from the east, and the chief depôt for the silk trade of China. It was the metropolis of Seres in Upper Asia, or of the Serica of Ptolemy. The expedition of Alexander into Persia and India first introduced the knowledge of silk to the Grecians, in the year 350 B.C., and with the increase of wealth and luxury in the Grecian court the demand for silk was prodigiously augmented. Thence it passed to Rome, probably about the time of Julius or Augustus Cæsar, the Emperor Heliogabalus, about the year 220, being the first who wore a robe entirely of silk. Until A.D. 550, silk in its raw state only had been sent out of China, the exportation of insects being prohibited on pain of death, and up to this period the real nature of the material was unknown. Its introduction into Europe is said to have been accomplished in the following manner.

Two Persian monks having been employed as missionaries in some of the christian churches, which, according to Cosmas, were already established in different parts of India, had penetrated into China. There, amidst their pious occupations, they viewed with a curious eye the common dress of the Chinese, the manufacture of silk, and the myriads of silk-worms, whose education, either on trees or in houses, had once been considered the labour of queens. They soon discovered that it was impracticable to transplant the short-lived insect, but that in the eggs a numerous progeny might be preserved, and multiplied in a distant climate. They observed with interest the labours of the little creature, and strove to make themselves acquainted with the manual arts employed in working up its productions into so great a variety of fabrics. On their return to the West, instead of communicating the knowledge thus acquired to their own countrymen, they proceeded on to Constantinople. The prospect of gain, or, as some have asserted, an indignant zeal excited by seeing a lucrative branch of commerce engrossed by unbelieving nations, prompted them to impart to the emperor the secret, hitherto so well preserved by the Chinese, that silk was produced by a species of worm; and to acquaint him with their belief that the eggs might be successfully transported, and the insects propagated in his dominions. They likewise explained to Justinian the modes of preparing and manufacturing the slender filament, mysteries hitherto either altogether unknown or but imperfectly understood in Europe. By the promise of a great reward the monks were induced to return to China, and there, with much difficulty eluding the vigilant jealousy of the Chinese, they succeeded in obtaining a quantity of silkworms' eggs. These they concealed in a hollow cane, and at length, in the year 552, conveyed them in safety to Constantinople. The eggs were hatched at the proper season by the warmth of manure, and the worms were fed with the leaves of the wild mulberry-tree. These worms, in due time, spun their silk, and propagated, under the careful tendance of the monks; who also instructed the Romans in the whole process of manufacturing their production.

For a period of more than six hundred years, the production of silk appears to have been confined to the eastern empire, until Roger I., king of Sicily, on returning from his invasion of the East, introduced it into his kingdom, where it soon became an important occupation, and the manufacture of silk speedily attained a decided excellence. From Sicily we trace its progress over the greater part of Italy and Spain; and thence, under Francis I., into France.

James I. of England, stimulated by the success attending the production of silk in France during the reigns of Henry IV. and Louis XIII., made great efforts to accomplish its introduction into England. A second attempt was made in the reign of Charles I., a third in that of George I., and a fourth very recently (1825), both in England and Ireland; but all these have proved unsuccessful, and it is now generally believed that our climate is not suited for the purpose. Although the production of silk in England is abandoned, yet its manufacture in this country is carried on to a prodigious extent, furnishing employment for more than five hundred thousand human beings. The quantity of silk annually consumed in England alone, amounts in weight to four millions of pounds; in France, Germany, Italy, Turkey, and the continent of Asia, it is also an article of great commercial importance.

Silk is spun by a caterpillar called the silk-worm, which feeds on the leaves of the mulberry-tree: this caterpillar is produced from eggs, laid by a moth in the autumn of the preceding year. In May the eggs are hatched, and produce small black caterpillars less than the tenth of an inch in length; these daily increase in size, and gradually alter their colour till they become nearly white.

In this country the caterpillar takes fifty-six days to arrive at perfection, during which time it invariably sheds its skin as many as four, and occasionally five times; the cause of this occasional additional change is not known. After every change the caterpillar is lighter in colour, and has a larger head, than previous to the change; it spins during five or six days, making about sixty-two days passed in the caterpillar state. In warmer climates the caterpillar arrives at its full growth in forty-seven days, and has finished spinning in five more, making together fifty-two days; these may be reckoned thus:—from the hatching to the first change, seven days; changing, two days; between the first and second change, seven days; changing, two days; between the second and third change, seven days; changing, three days; between the third and fourth change, seven days; changing, four days; from the fourth change to the period of beginning to spin, eight days; spinning, five days.

When the caterpillar is about to change its skin it ceases to eat, holds its head up stiff, and appears ill and sulky; the new head is plainly to be discovered through the transparent skin, behind the old one, and rather of a triangular shape—the apex of the triangle being uppermost; after remaining in this state two or three days, as above stated, the skin opens behind the head, which cracks longitudinally, and is cast with the skin; the caterpillar then twists itself from side to side, and writhes about, while the skin gradually slips from the body and comes off at the tail.

Whilst the silk-worms are feeding, they should be kept very clean and abundantly supplied with fresh leaves; open trays, made of pasteboard, are very convenient for holding them; and from these, if supplied with food, they never wander. Care should be taken to preserve silkworms from birds and mice, both of which are excessively fond of them; the influence of the sun is highly injurious to them, as are also cold north and east winds; but plenty of air, in warm weather, is beneficial. The leaves should be given to the caterpillars perfectly dry; if brought from a distance, they preserve their freshness for many days in a tin box, or on the cold bricks or stones of a cellar. After the fourth change the silk-worms require constant watching; twice a day they should be carefully looked over, and those ready to spin picked out and placed in little cells, made of writing-paper, about as large as one's thumb, open at one end and closely screwed up at the other; these paper cells may be pinned to lines crossing a room, and placed touching each other on the line.

The period of a silk-worm's being ready to spin is plainly indicated by its ceasing to eat, and becoming suddenly more transparent and of a yellow colour; it will also begin to spin a few threads of silk among the leaves, or in a corner of the tray. The silk is elaborated in two long slender vessels lying at the sides of the stomach and intestines, and terminating in a single tube, through which the viscid fluid, of which the silken threads are composed, is forced by the peristaltic action of the muscles. This tube terminates in the centre of the lower lip of the caterpillar. Although, however, the two vessels unite into a single tube, it is evident that the silken threads are not united; since we learn from the recent microscopical investigations of Dr. Ure,* that each of the silk threads was found to be composed of two distinct cylinders, which in good silk appear to be perfectly parallel and quite cylindrical; the unevenness or the want of parallelism producing inferiority in the raw material.—Each of these cylinders varies in diameter from one two-thousand two hundredth part of an inch (the measure in silk of the best quality), to one eighteen hundredth of an inch. When imported, however, several distinct threads are found to be reeled together, which is done by the grower of the silk-worms, the threads being passed through several eyelets, and then wound off. The imported raw silks are of various qualities, depending upon the mode and time of feeding, as well as upon the food of the silk-worms. These compound threads are one five hundredth part of an inch in diameter, each being divisible into eight threads; that is, into four pairs of cylinders, in the best silk. The specific gravity of silk, according to this author, is greater than had been generally supposed, being 1256 to 1200, and consequently greater than the strongest muriatic acid or water.

When placed in the paper cell the silk-worm spins a few loose connecting threads, attached to every side of the cell: it then forms a regular oval ball of silk, which is suspended

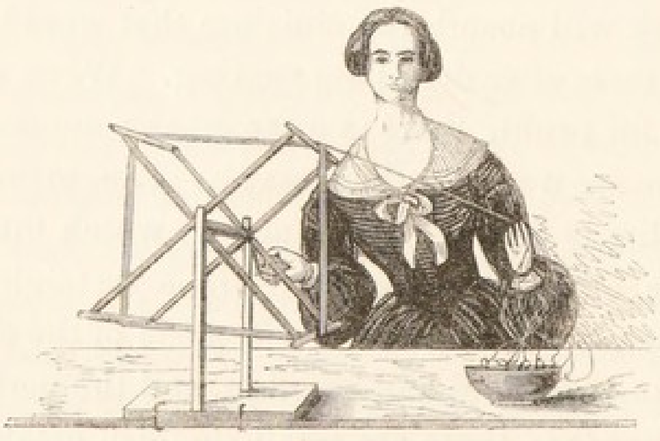
* 'Trans. Ent. Soc.' vol. i. Journ. of Proceedings, p. 50.

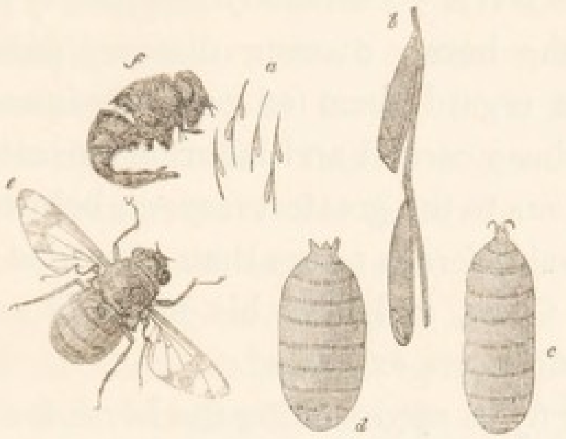
in the centre of the cell, and in the interior of this it continues to work for five days. If the cells containing the spinning silk-worms are placed regularly on the line, in the order in which they begin to spin, then there will occur no difficulty in taking them off in the succession in which they stand, as the first in order on the line will be the first requiring to be wound off. After a silk-worm has been ten days in the cell, its cocoon of yellow silk will be compact and complete; this must be taken out of the cell and the exterior or waste silk stripped off, until a single thread runs by itself; an operation which will be much assisted by allowing the cocoon to float on warm water. When so much of the silk has been wound off, that the remainder appears of a thinner, paler and inferior quality, the thread should be broken, the remaining portion of the cocoon being weak, gummy, and of little value; this should be taken out of the water and laid aside, to prevent its getting entangled with the others.

Within the cocoon is the chrysalis, from which the future moth is produced; these may be thrown on a tray containing bran, which will absorb the moisture that would otherwise remain on them after their long soaking. When silk-worms are reared for profit, there is a far greater number of chrysalides than are wanted; these may be given to fowls, which are exceedingly fond of them, and to which they afford a wholesome and nutritious diet. In a fortnight or three weeks after the winding of the silk, some of the chrysalides will be found cracking and opening, and the perfect moths will then appear: these are small sluggish creatures, of a pale buff colour, seldom leaving the tray, mat or paper on which they are placed, and where the females lay their eggs.

As regards the hatching of the eggs, it is important to know that this may be retarded as long as the owner pleases, by subjection to a low temperature; and it will be well for those who purpose keeping silk-worms for the sake of profit, to defer the hatching of the eggs until the mulberry-trees are sufficiently forward to ensure a constant supply of food. The usual time for the hatching of silk-worms' eggs in this country is about the 12th of May, but a fortnight later is much better; for at that time the mulberry-trees have not generally put forth their leaves, and great difficulty continually occurs in procuring food: for, as far as we have yet learned, no other food than mulberry-leaves affords to silk-worms wholesome nutriment; lettuce, dog-wood and black-currant leaves have been often tried, but without success.

It may be remarked that in winding off the silk, when the single threads of half a dozen cocoons are found, they may be guided with one hand on a small reel constructed for the purpose, which may be turned with the other hand, the cocoons at the same time floating on a basin of warm water.






*a*, Eggs of the breeze-fly of the horse. *b*, the same magnified. *c*, larva or bot. *d*, chrysalis. *e*, perfect insect. *f*, position of the female in the act of oviposition.

# CHAPTER III.

## HISTORY OF BREEZE-FLIES.*

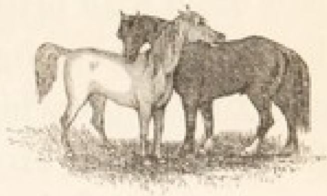
THE name of gad-fly has been repeatedly given to the insects whose history is detailed in this chapter, but that term more properly belongs to those blood-sucking flies which cause such pain and misery to our horses, in places abounding in wood, especially in warm cloudy weather and before thunder showers. The present insects when in the larva state are termed "bots" in horses, "maggots" in sheep, and "wornils" or "warbles" in cows and oxen; and these three represent three divisions of the family, differing essentially in their history. The perfect insect produced from each kind of larva is properly termed a breeze-fly.

* Authority:—An Essay on the Bots of Horses and other animals, by Bracy Clark, F.L.S.

The opinions respecting the breeze-fly of the horse, or *bot* as it is usually termed, as to the benefit or injury derived from it, are very opposite; some observers go so far as to assert that the larvæ occasionally completely perforate the stomach of the horse, causing disease, pain, and even death; others regard them as perfectly innocuous; and one author, whose careful and laborious investigations entitle his opinions to the greatest respect, believes the effect of bots to be salutiferous rather than otherwise: this author is Mr. Bracy Clark, and from his masterly essay the following particulars are extracted.

The female fly in approaching the horse for the purpose of oviposition, carries her body nearly upright in the air, the protruded ovipositor being curved inwards and upwards. Suspending herself for a few seconds before the part of the horse on which she intends to deposit the egg, she suddenly darts upon it, and leaves the egg adhering to the hair: she hardly appears to settle, but merely touches the hair with the egg held out on the extreme point of the ovipositor (see fig. *f*), the egg adhering by means of a glutinous liquor with which it is covered. She then leaves the horse at a small distance, prepares a second egg, and, poising herself before the part, deposits it in the same way: the liquor dries, and the egg becomes firmly glued to the hair. This is repeated till four or five hundred eggs are sometimes placed on one horse. The skin of the horse is usually thrown into a tremulous motion on the touch of the insect, which merely arises from the very great irritability of the skin and cutaneous muscles at this season of the year, occasioned by the heat and continual teazing of the flies, till at length these muscles appear to act involuntarily on the slightest touch of any body whatever.

The fly does not deposit her eggs at random on the horse's body, but selects those parts which are most likely to be nibbled by the horse: the inside of the knee is frequently chosen, but all naturalists must have remarked how commonly the eggs of the bot are deposited on that part of a horse's shoulder which he can never reach with his mouth, and thus, to a casual observer, it would seem that they must perish, and fail in the object for which their parent designed them. Now there is a provision of nature which exactly counteracts this difficulty. When horses are together in a pasture, and one of them feels an irritation on any part of the neck or shoulder which he cannot reach with his mouth, he will nibble another horse in the corresponding part of his neck or shoulder, and the horse so nibbled will immediately perform the kind office required, and begin nibbling away in the part indicated. The horses, when they become used to this fly, and find it does them no injury by sucking their blood, hardly regard it, and do not appear at all aware of its object.



When the eggs have remained on the hairs four or five days they become mature, after which time the slightest application of warmth and moisture is sufficient to bring forth in an instant the latent larva. At this time, if the lips or tongue of the horse touch the egg, its operculum is thrown open and the young larva liberated: this readily adheres to the moist surface of the tongue, and is from thence conveyed with the food to the stomach. It is worthy of remark, that it is probable the greater part of the eggs deposited by this fly are taken up in consequence of the irritation of other flies, as the *Tabani* and *Stomoxides*, which, by perpetually settling on the skin, occasion a horse to nibble himself in those parts, and thus receive the larvæ on the tongue and lips whence they are introduced into the stomach. The egg is glued on the hair with the broad end downward (page 25, figs. *a, b*), and is thus well disposed for the operation of the tongue in removing the operculum, which is of an oval figure, and surrounded with a prominent margin. The microscope shows the case of the egg to be shagreened in squares, or impressed longitudinally and transversely with delicate striæ. When the larva or grub is hatched from the egg it is a small active worm, long in proportion to its thickness; but as its growth advances it becomes proportionably thicker and broader, and beset with bristles. These larvæ are very frequent in horses that have been at grass, and are in general found adhering to the white insensible tissue or coat which comes from the lining of the œsophagus, and extends over the upper part of the stomach. They make small, deep, round holes wherever they adhere to this white tissue, and sometimes so deep as to pass through it, but not through the other layers or coats of the stomach.

The larvæ usually hang in dense clusters from the lining of the stomach, and maintain their hold by means of two dark brown hooks; between these a longitudinal slit or fissure is seen, which is the mouth of the larva. When the larvæ are removed from the stomach with a sudden jerk so as not to injure them, they will, if fresh and healthy, attach themselves to any flaccid membrane, and even to the skin of the hand. For this purpose they sheath or draw back the hooks almost entirely within the skin, till the two points come close to each other; they then present them to the membrane, and keeping them parallel till it is pierced through, they expand them in a lateral direction, and afterwards, by bringing the points downwards towards themselves, they include a sufficient piece of the membrane to enable them to remain firmly fixed for any length of time as at anchor, without requiring any further exertion. The body of the larva is of a whitish red colour, and appears to be composed of eleven segments, surrounded with a double row of horny bristles, a longer and a shorter series, and placed alternately: the two last segments appear to be naked or destitute of them. These spines are of a reddish colour, except the points, which are black, and are directed towards the tail or large end of the larva.

The larva, when matured, quits the stomach of the animal and falls to the ground, and finding a convenient place of retreat, undergoes its change to a chrysalis, the skin then losing its organization, and changing in colour to a reddish brown. After remaining torpid in the chrysalis state a few weeks, the superfluous moisture being removed and the parts of the future insect hardened by drying, it bursts from its confinement, and the fly makes its exit at the small end of the case. A few hours after quitting their shell they become dry, take wing, and seek their mates.

A second species of breeze-fly has a still more wonderful history: its eggs are laid in the nostrils of sheep, from one to seven or eight in each individual, and these on becoming larvæ, enter the frontal and maxillary sinuses, and even the horns, and feed on their secretions: when the larvæ are young they are perfectly white and transparent, except two small, black, horny plates: as they increase in size the upper surface becomes marked with two transverse brown lines on each segment, the anterior being shorter and narrower than the posterior; and some spots are also observable on the sides. The body consists of twelve segments besides the head. These larvæ move with considerable activity, holding with their tentacula to a fixed point and drawing up the body. When full grown the larvæ fall through the nostrils of the sheep, and change to the pupa state lying on the earth or adhering to the side of a blade of grass: in about two months the case of the chrysalis opens, and the fly makes its appearance.

Sheep are exceedingly annoyed by these flies, and to avoid them lie down in ruts with their heads close to the ground; at other times we see them huddled together under trees in a dense mass or phalanx, the nose of each being pushed into the fleece of another.

There is a third species of breeze-fly, far more formidable than either of those previously described: its eggs are laid on the backs and sides of cows and oxen, and the larvæ hatched from them enter the hide, producing tumours as large as pigeons' eggs. The larva itself is of an oblong figure, larger at one extremity than at the other: the body is divided into ten or twelve segments by transverse bands, and these are again intersected by six longitudinal lines, which purse up the skin, and produce along the sides a series of mammiform protuberances, each possessing at its extremity a respiratory pore: on each segment of the body may be observed ridges, or dotted prominent lines, interrupted however by the longitudinal lines already noticed: there are in pairs a narrower and broader line of minute dots or points; the narrower line is found, under a lens, to be formed of hooks bent towards the posterior extremity of the insect; the broader lines consist of smaller hooks bent in an opposite direction, or towards its head: it is probably by the aid of these hooks that the animal raises or depresses itself in the tumour, and finally, when mature, effects its escape.

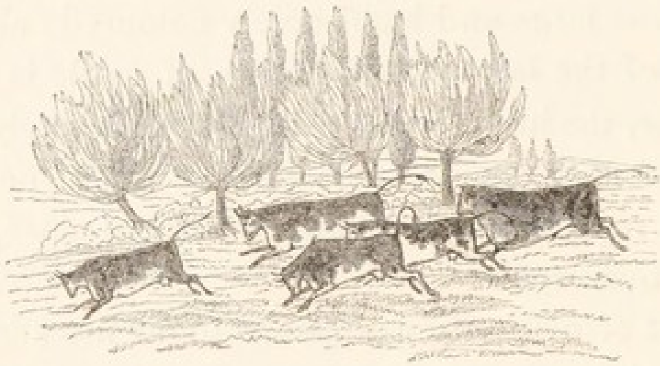
The food of the larva appears to be the pus or matter surrounding it in the tumour in which it exists: as regards the period of its continuing to feed we have little satisfactory information. Its colour when young is white, but as it advances towards maturity it becomes browner, and finally of a deep dark brown approaching to black: having attained its full size it presses itself against the upper part of the tumour, and by some unknown process makes an aperture in the hide of about sufficient size to admit a pea; through this the larva wriggles itself a segment at a time until it comes quite out, and falling to the ground seeks a convenient retreat in which to become a chrysalis.

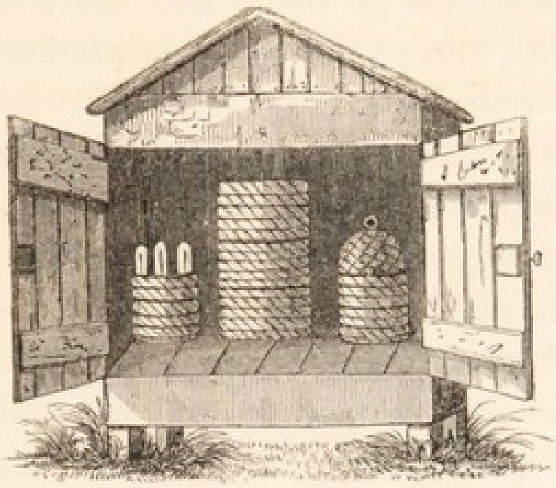
The chrysalis is of a dark brown colour, and in figure somewhat resembles the half of a walnut-shell, being narrower at one end than the other, flat on one side, and very rounded and convex on the other: after lying on the ground for some weeks a portion of the indurated skin or cover, of a triangular shape, is forced up at the smaller end, and through the aperture thus occasioned the fly emerges.

The fly is large and handsomely coloured; although the presence of the larva in the backs of cattle is frequently observable, the insect in its perfect state is rarely met with, and very few of our cabinets possess good specimens: it flies with rapidity, but apparently without noise, and never ventures over water.

The act of oviposition appears to be attended with severe suffering, or apprehension at least, which makes the cattle run wild and furious, and gad or stray from the pastures, and hence the ancient epithet of gad-fly. When oxen are yoked to the plough, the attack of this fly is attended with real danger, since they become perfectly uncontrollable, and often run directly forwards through the hedges, or whatever obstructs their way. On this account many ploughs are provided with a contrivance for setting the oxen immediately at liberty. When the cattle are attacked by this fly it is easily known by the extreme terror and agitation of the whole herd; the unfortunate object of the attack runs bellowing from among them, and seeks a refuge in the nearest water; the tail becomes rigid, and is brandished aloft or held straight out from the body.

Its frightened companions follow in the rear of the animal attacked, and a wild and apparently unmeaning chase takes place, which, from the inelegant gallop of the cows, has often a very ludicrous effect.





Representation of a Bee house on an approved construction.

# CHAPTER IV.

## HISTORY OF THE HONEY-BEE.*

To the bee we are indebted for two valuable articles of commerce,—honey and wax: since the introduction of sugar, honey has become less an article of general use, and more one of luxury; but wax is still extensively consumed throughout the civilized world. Honey is collected from flowers, is swallowed by the bees, and afterwards regurgitated: the bee, laden with honey, returns to the hive, enters a cell, pierces a hole in the crust on the surface of the honey already therein, disgorges the honey in large drops from its mouth, new models the crust, and closes up the hole; this mode of proceeding is regularly adopted by

* Authority:—Huber's History of the Hive Bee, as copied by Dr. Bevan, &c.

every bee that contributes to the general store. Wax is secreted, as occasion may require, from small sacs, situated between the segments of the body of the bee, on the under side; it is used for constructing the combs in which the family provision of honey and the young brood are deposited: the wax of commerce is produced by melting down these combs.

A bee-hive contains three kinds of individuals,—a queen, drones, and workers; the queen is a female, and not only the ruler, but, in great part, the mother of the community; the drones are males, and the workers are abortive females. The sole office of the queen appears to be the laying of eggs, and this occupies her almost incessantly, as a single one only is deposited in each cell, thus causing her to be in continual motion: she is slow and majestic in her movements, and differs from the workers in being larger, having a longer body, shorter wings, and a curved sting. The queen is accompanied by a guard of twelve workers, an office which is taken in turn, but never intermitted: in whatever direction she wishes to travel, these guards clear the way before her, always with the utmost courtesy turning their faces towards her, and when she rests from her labours, approaching her with humility, licking her face, mouth, and eyes, and fondling her with their antennæ.

The drones are all males; they are less than the queen, but larger than the workers; they live on the honey of flowers, but bring none home, and are wholly useless, except as being the fathers of the future progeny; when this office is accomplished, they are destroyed by the workers. A buzzing commences in the hive; the drones and the workers sally forth together, grapple each other in the air, hug and scuffle for a minute, during which operation the stings of the workers are plunged into the sides of the drones, who, overpowered by the poison, almost instantly die.

The workers are the smallest bees in the hive, and by far the most numerous; they have a longer lip for sucking honey than either of the others; their thighs are furnished with a brush for the reception of the pollen of flowers, and their sting is straight. The workers do the entire work of the community; they build the cells, guard the hive and the queen, collect and store the honey, elaborate the wax, feed the young, kill the drones, &c. The average number of these three kinds of bees in a hive is one queen, 2,000 drones, and 20,000 workers. The eggs are long, slightly curved, and of a blueish colour; when laid, they are covered with a glutinous matter, which instantly dries, attaching them to the bottom of the cell.

For eleven months the queen lays only workers' eggs; afterwards, those which produce drones: as soon as this change has taken place, the workers begin to construct royal cells, in which, without discontinuing to lay the drones' eggs, the queen deposits here and there, about once in three days, an egg which is destined to produce a queen. The workers' eggs hatch in a few days, and produce little white maggots, which immediately open their mouths to be fed; these the workers attend to with untiring assiduity: in six days each maggot fills up its cell; it is then roofed in by the workers, spins a silken cocoon, and becomes a chrysalis: and on the twenty-first day it comes forth a perfect bee. The drones emerge on the twenty-fifth day, and the queens on the sixteenth.

It has been already stated, that the queen, for nearly a year, lays no eggs that are destined to produce queens; it therefore follows, that if any evil befall her, the hive is left without a queen: it sometimes happens that she dies, or is taken away by the owner of the hive, to observe the result. For twelve hours little notice is taken of the loss; it appears not to be known, and the workers labour as usual: after that period, a hubbub commences; work is abandoned; the whole hive is in an uproar; every bee traverses the hive at random, and with the most evident want of purpose. This state of anarchy sometimes continues for two days; then the bees gather in clusters of a dozen or so, as though engaged in consultation, the result of which seems to be a fixed resolution to supply the loss. A few of the workers repair to the cells in which are deposited the eggs of workers; three of these cells are quickly broken into one, the edges polished, and the sides smoothed and rounded, a single egg being allowed to remain at the bottom.

When this egg hatches, the maggot is fed with a peculiarly nutritive food, called royal bee-bread, which is never given to any maggots but such as are to produce queens; work is now resumed over the whole hive, and goes on as briskly as before: on the sixteenth day the egg produces a queen, whose appearance is hailed with every demonstration of delight, and who at once assumes sovereignty over the hive. When, under ordinary circumstances, a young queen emerges from the chrysalis, the old one frequently quits the hive, heading the first swarm for the season, and flying to some neighbouring resting-place is observed by the owner, captured, placed under a new hive, and a new colony is immediately commenced.

Before a swarm leaves the hive, sure indications are given of the intended movement; the workers leave their various occupations and collect in groups, especially near the door of the hive, as though in consultation on the important event about to take place.

As the summer advances many queens are hatched; but the workers do not allow them instant liberty, as severe battles would take place between them and the reigning queen, in which one would be killed: the workers, therefore, make a small hole in the ceiling of the royal cell, through which the captive queen thrusts her tongue, and receives food from the workers. In this state of confinement the young queen utters a low querulous note, which has been compared to singing. When the reigning, or a newly-created queen, finds one of these captives, she uses every effort to tear open the cell and destroy her rival: to prevent this, the workers often interpose, pulling her away by the legs and wings; to this she submits for a short time, when, uttering a peculiar cry, called her voice of sovereignty, she commands instant attention and obedience, and is at once freed from her assailants. The cocoon spun by the maggots of the workers and drones completely envelopes the chrysalis; but that spun by the maggot of the queen appears imperfect, covering only the upper end of the chrysalis: it has been supposed that they are thus designedly exposed to the attacks of other queens, and their destruction, before emerging, facilitated. When the chrysalis of the queen is about to change to a perfect insect, the bees make the cover of the cell thinner by gnawing away part of the wax; and with so much nicety do they perform this operation, that the cover at last becomes pellucid, owing to its extreme thinness.

The combs of a bee-hive comprise a congeries of hexagonal cells, built by the bees as a receptacle for honey, and for the nurseries of their young: each comb in a hive is composed of two ranges of cells, backed against each other: the base or partition between this double row of cells is so disposed as to form a pyramidal cavity at the bottom of each. There is a continued series of these double combs in every well-filled hive; the spaces between them being just sufficient to allow two bees, one on the surface of each comb, to pass without touching. Each cell is hexagonal, the six sides being perfectly equal. This figure ensures the greatest possible economy of material and space; the outer edges of the cells are slightly thickened, in order to gain strength; the same part is also covered with a beautiful varnish, which is supposed to give additional strength. The construction of several combs is generally going on at the same time: no sooner is the foundation of one laid, with a few rows of cells attached to it, than a second and a third are founded on each side, parallel to the first, and so on till the hive is filled, the combs which were commenced first, being always in the most advanced state, and therefore the first completed.

The design of every comb is sketched out, and the first rudiments laid by a single bee: this foundress-bee forms a block out of a rough mass of wax, drawn partly from its own resources, but principally from those of other bees, which furnish wax from the small sacs before described, taking out the plates of wax with their hind feet, and carrying it with their fore feet to their mouths, where it is moistened, masticated, and rendered soft and ductile. The foundress-bee determines the relative position of the combs and their distance from each other, the foundations which she marks serving as guides to the ulterior labours of the wax-working bees, and of those which build the cells, giving them the advantage of the margins and angles already formed. The mass of wax prepared by the assistants, is applied by the foundress-bee to the roof or bottom of the hive, and thus a slightly double-convex mass is formed: when of sufficient size, a cell is sculptured on one side of it by the bees, who relieve one another in the labour. At the back, and on each side of this first cell, two others are sketched out and excavated: by this proceeding the foundations of two cells are laid, the line betwixt them corresponding with the centre of the opposite cells: as the comb extends, the first excavations are rendered deeper and broader; and when a pyramidal base is finished, the bees build up walls from its edges, so as to complete what may be called the prismatic part of the cell. The cells intended for the drones are considerably larger and more substantial than those for the workers; and being formed subsequently, they usually appear nearer the bottom of the combs: last of all are built the royal cells for the queens; of these there are usually three or four, sometimes ten or twelve, in a hive, attached commonly to the central part, but not unfrequently to the edge of the comb. The form of the royal cells is an oblong spheroid, tapering gradually downwards, and having the exterior full of holes: the mouth of the cell, which is always at the bottom, remains open until the maggot is ready for transformation, and it is then closed like the rest.

When a queen has emerged, the cell in which she was reared is destroyed, and its place supplied by a range of common cells: the site of this range may always be traced by that part of the comb being thicker than the rest, and forming a kind of knot. The common breeding cells of drones and workers are occasionally made the depositories of honey; but the cells are never sufficiently cleansed to preserve the honey undeteriorated. The finest honey is stored in new cells constructed for the purpose of receiving it, their form precisely resembling that of the common breeding cells: these honey-cells vary in size, being larger or smaller according to the productiveness of the sources from which the bees are collecting, and also according to the season. The cells formed in July and August being intended only for honey, are larger and deeper than those formed earlier: the texture of their walls is thinner, and thus they have more dip or inclination: this dip diminishes the risk of the honey's running out, which, from the heat of the weather at this season, and its consequent thinness, it is liable to do. When the cells intended for holding the winter's provision are filled, they are always closed with waxen lids, and are never re-opened till the whole of the honey in the unfilled cells is expended: the waxen lids are thus formed;—the bees first construct a ring of wax within the verge of the cells, to which other rings are successively added, till the aperture of the cell is finally closed by a lid composed of concentric circles.

Larva of the Bee.

Pupa of the Bee.

Worker Bee.

Ants climbing grass, &c. previously to taking their flight in Autumn.

# CHAPTER V.

## HISTORY OF THE YELLOW ANT.*

In describing ants, it should be observed that considerable difference exists in the manners of the different species: it is best, therefore, to confine our attention to one only, and for this purpose the *yellow ants* may be selected. These collect near their habitation all the little bits of stubble, wood, leaves, small pebbles, or any thing they can readily convey, that will serve to increase its height: thus, shells sometimes find their way to the heap, and not uncommonly also wheat, oats and barley; whence the fame which these little creatures have obtained for the virtue of providence,—a fame certainly undeserved on the score of making provision for the winter, as in that season they never eat.

* Authority :—'Recherches sur les Mœurs des Fourmis Indigènes,' par P. Huber.

Although the hillock when complete appears but a careless heap, it is in reality a most ingenious device for keeping out water, for evading the effects of wind, and the attacks of enemies, and yet more especially for receiving and husbanding the heat of the sun. The exterior of the hillock always presents the appearance of a dome; the base being covered with earth and minute pebbles, the structure is completely hidden from us. From the summit of the hillock, avenues carefully excavated like tunnels lead downwards into the interior, and the number of these avenues depends entirely on the population and extent of the nest: the external apertures of these avenues are of varied size; there is sometimes a principal one at the top; but usually there are several somewhat unequal ones, and around each are passages symmetrically arranged. These apertures are required to permit free egress to the multitudes of labourers of which the commonwealth is composed: not only do the needful labours of the community continually call them abroad, but they seem to prefer labouring in the open air, and, moreover, appear perfectly unconcerned at the presence of an observer; in this the yellow ants differ from most other species, which often use their habitation as a protection from the sun.

In the habitations of several species of ants, we never find an aperture of sufficient size to allow the entrance of enemies, or permit rain-water to penetrate. The dome, commonly of earth, is closed on every side, and has no aperture unless near the base, and not unfrequently the ants approach the nest by a serpentine gallery, many feet in extent. The yellow ants standing in crowds on their nest during the day, are quite fearless of any disturbance to the interior; but at night when retired to the bottom of their habitation, they cannot perceive what is passing on the exterior: how then are they protected from the accidents which threaten them? how comes it that the rain does not penetrate their habitation, open as it is on every side? these simple questions appear to have obtained the attention of no naturalist before Huber. On closely watching the appearance of one of these nests, he found it undergoing an hourly change, and that the apertures, so spacious in the middle of the day, gradually diminished in size towards the evening, and at night entirely disappeared; the dome became closed in every part, and all the ants were concealed within. In order to accomplish this, the ants draw into the openings little bits of wood, placing them across the entrance and sinking the ends in the covering of the hill; they then fetch others, laying them across the first, and so continue selecting other pieces, smaller and smaller as the work advances towards its accomplishment, and finally close the opening with bits of dried leaves, and similar materials.

In the morning a few ants may be seen wandering about the exterior of the nest, the number gradually increasing as others emerge from the interior, under the little roofs formed at the entrance of each avenue, and these soon set to work, and begin to clear away the barricades. This employment continues for hours, until at length the apertures are sufficiently extended, and the materials used in closing them distributed over the exterior of the nest. This is a daily labour unless it rains, or the morning threatens rain; and if after it has been performed rain come on, they hasten to close the apertures as at night.

At its commencement the nest is simply an excavation made in the earth: a number of the labourers wander about in quest of materials suitable for the superstructure; others carry out particles of earth from the interior, and these particles, interspersed with the fragments of wood and leaves brought in continually from every quarter, give a kind of stability to the edifice: it daily increases in size, the ants taking care to leave the spaces required for the galleries which lead to the exterior. The dome contains a number of spacious chambers, excavated by the labourers in the solid, compact substance of the edifice itself; but though spacious, these chambers are low, irregular in figure, and carelessly constructed, but convenient nevertheless for the purpose for which they are intended, that of containing the larvæ and pupæ at certain hours of the day. These chambers communicate with each other by means of galleries constructed in a similar manner.

It is in these chambers that the eggs are first deposited by the parent, and respecting the eggs a remarkable fact has been observed; on watching them from day to day, after their being first laid by the female, they have been found not only continually to vary in colour and form, but to increase in size long before the emancipation of the larva or grub from its shell, an event which takes place at the end of fifteen days. On extrusion the body is perfectly transparent, the head and abdominal segments alone being visible; the larvæ have neither legs nor antennæ, and are solely dependant on the labourers for support. They are most carefully protected by a number of labourers, who stand around them as a body-guard, each having its body bent and its sting protruded, ready for an instant attack on any insect enemy that might perchance have found its way into the interior of the nest. At the same time other labourers, in the chambers but apparently not on duty, appear to be spending the time of relaxation in sleep.

Ants do not prepare for their larvæ any particular kind of food, as is the case with bees and some other insects, but give them day by day whatever suitable food they meet with in the course of their peregrinations. The larvæ, although apparently so helpless, are sufficiently knowing to demand and receive their food; lengthening their bodies, and with their mouths sucking the mouths of the labourers, as little birds stretch out their necks and open their bills on the approach of their parents. The labourer opens his mouth, and gives to his little charge the required supply. As the larvæ increase in size and strength, the aliment provided for them becomes daily more solid and nutritious.

When the larvæ have attained their full growth they spin a silken covering, called by entomologists a cocoon: in this they completely enclose themselves, and remain perfectly quiescent without receiving any nutriment, awaiting the final change when they are to assume the form of perfect ants. This stage of its existence is the pupa, but is commonly, although very erroneously, called the egg. "Ants' eggs," as they are vulgarly called, are a favourite food for partridges and pheasants, and are eagerly sought after by persons who rear these birds from the egg. The cocoon containing the pupa is of a long cylindrical form, of a dirty white colour, and is perfectly without motion. The pupa within the cocoon has now attained the form which it will finally possess; its limbs are distinct, but want strength and consistence, and are covered by a skin which has yet to be cast. In colour it changes from white to a pale yellow, then to red, and finally becomes almost black; its wings, if a male or female, are distinctly visible, but do not assume the shape, size, or character, they are hereafter destined to bear.

As the laying of eggs continues for some weeks, and each egg is hatched, as before stated, at a period of fifteen days, it necessarily follows that the family, although equally progressing towards maturity, must be in different stages, so that eggs, larvæ of all sizes, and pupæ, abound in the nest at the same time. When the rays of the sun warm the exterior of a nest thus stocked with inhabitants, a most animated scene takes place. The ants on the exterior are the first to feel the influence of the warmth: they enter the nest, run along the avenues and galleries to the various chambers, and communicate the intelligence to every ant they meet, tapping one gently with their antennæ, and even biting another severely with their mandibles. At last the whole colony seems to partake of the excitement, and each labourer then carefully takes a larva or pupa in its mouth, conveys it through all the winding passages to the outside, and places it in such a position as to receive the rays of the sun. This operation is attended with vast exertion, for the pupæ of the females are often more than double the weight of the labourers who carry them, and are not to be conveyed through the long circuitous passages without a labour that appears almost incredible. Notwithstanding, however, the difficulties which have to be overcome in placing the larvæ and pupæ in this situation, they are seldom allowed to receive the full rays of the sun for a longer time than fifteen or twenty minutes, and are then conveyed into little cells, constructed on the exterior of the nest purposely to receive them, and protected from the too great ardour of the sun's rays, by a slight covering of chaff, stubble, or other light matter. As the heat of the sun decreases in the afternoon, the larvæ and pupæ are again fully exposed to it for a short season as before, and are then carefully returned one by one, through the almost interminable passages, each into the identical chamber from which in the morning it was originally brought; and now the time of feeding has arrived, and this duty has to be carefully performed.

But it is not only to the sunning and feeding of the larvæ that the care of the labourers in their behalf extends. It is an addition of duty to keep the larvæ clean, and perfectly free from all impurities; and it is an almost incessant occupation to lick them over and over, cleansing every part of the body, and keeping it in a state of the most perfect whiteness. This care commences with the extrusion of the larva from the egg, and ceases not until it is about to assume the ensuing state of pupa or nymph.

As soon as the insect is sufficiently mature to issue from the cocoon into which we have before traced it, the assistance of the labourers is again required. The pupæ of ants, unlike those of other insects, know not how to escape from their self-wrought shroud, by moistening its texture and cutting it with their mandibles. They scarcely possess sufficient strength to enable them to move. The cocoon in which they are enclosed is of too compact a texture, and of too strong a material, for the unassisted prisoner to tear it open. How the indefatigable assistants ascertain the exact period when it requires to be liberated, remains, and ever must remain, a profound secret. They may be observed mounting on a cocoon when its occupant has arrived at maturity; they may be seen scraping away the silken texture, and, having inserted their mandibles into the aperture, using them as we use a pair of scissors, cutting across the cocoon in a direct line.

At the period of emancipating the winged ants a great deal of excitement prevails in the nest. Some of the labourers may be seen arduously at work, in the operation of cutting open a cocoon, while others with great gentleness are drawing through the aperture the newly-born mother of a future colony. The labour of these assiduous attendants does not end here; for when the perfect ant is at last drawn from its cocoon, it is not in a state to take its flight and provide for itself; on the contrary, it is weak and helpless, and every part of its body and limbs is swathed in a delicate satiny membrane or skin, which has to be carefully removed before it can even stand upon its feet. This new difficulty the labourers have now to overcome; first, with the utmost gentleness stripping the antennæ and palpi; then the legs, the wings, and lastly the body. The next care is to feed the newly-born insect, for which process it always appears in readiness.

When all the newly-matured ants have thus been emancipated, the labourers carry away the empty cocoons and skins to the furthest part of the exterior of the nest, and sometimes take them to a considerable distance. For some time the new-born ants remain under the careful superintendence of the labourers: they are attended in all their wanderings about the nest, and are made acquainted with all its galleries and chambers: the wings of the males and females, previously folded together, are extended, and this is always accomplished with such skill and tenderness that these delicate members are never injured by the operation; in fine, these founders of future colonies are in all respects served with unremitting attention until their final departure from the nest.

It need scarcely be observed, that besides the males and females, or winged ants, numerous labourers are continually emerging from the cocoons, and these are in every respect similar to the other labourers which have been taking charge of them; and as soon as their limbs have attained sufficient strength and firmness, they join their nurses in the cares and labours of the community. We have now traced the history of the ants, and seen the care which has been bestowed on them up to the moment of their having obtained wings, and the power of transporting themselves from place to place; let us now observe them under their altered condition. In the autumn we frequently observe one of their hillocks closely covered with a living mass of winged ants, which continue to promenade, as it were, over its entire surface: they mount on every plant in the vicinity of their nest, and the labourers (for now the entire population of the nest has turned out) accompany them as closely as possible, following them to the extreme tip of every blade of grass, and when at length those possessed of wings spread them in preparation for flight, the labourers will often hold them back, as if loath to trust them alone, or desirous of sharing the perils of their trackless course. If the temperature is unfavourable, either from cold or wet, at the period of the grand autumnal production of winged ants, they remain in the nest for several days, until a favorable change in the weather takes place, when the labourers open all the avenues to the exterior, and the winged multitude passes forth at the portals in glittering and iridescent panoply. When the air is warm and still they rise in thousands, and sailing, or rather floating on the atmosphere, leave for ever the scene of their former existence.

Myriads of these flying ants, attracted by the brilliant surface of water illumined by an autumnal sun, rush into the fatal current and are seen no more: myriads are devoured by birds, and but a small proportion of the immense swarm which left the nest escapes and lives to found new colonies.

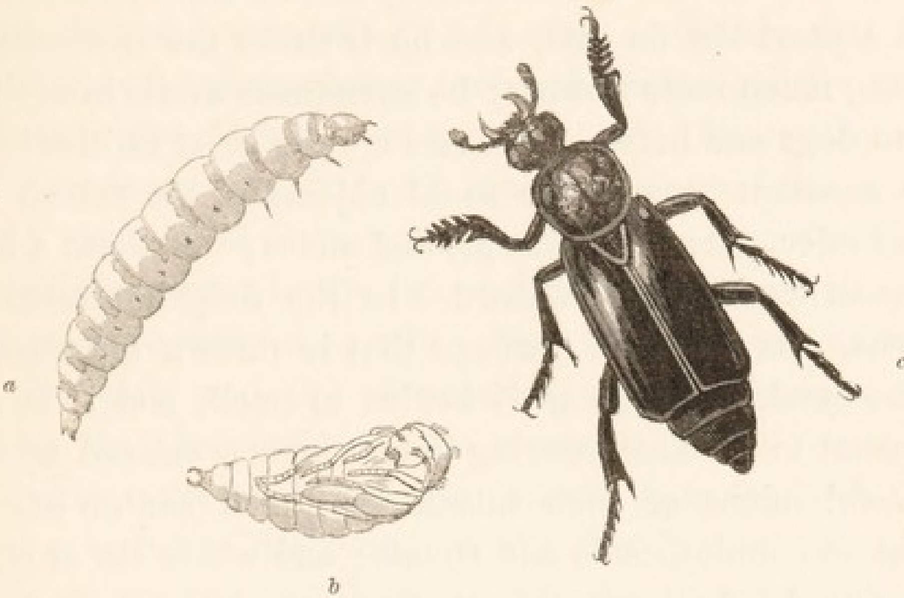
Each female, immediately on alighting from her aerial voyage, examines the situation in which chance has placed her, and if she find it adapted to her purpose she turns her head back over her shoulders, and with her sharp mandibles shears off the wings which bore her from the place of her nativity. Strange as this propensity may seem, it is dictated by an unerring instinct, for the object for which wings were given her is now accomplished, and henceforth they would prove an incumbrance, and retard, rather than assist, the performance of her duties. Sometimes a few workers, wandering at this period of excitement far from their home, may happen to meet with her, and if so, they unite their labours with hers in excavating a small and humble dwelling in the earth, which serves as the nucleus of a future colony: in all operations the female, now a queen, takes a most energetic part, and continues to labour until she has laid eggs, when the conduct of the workers undergoes a great change, for they now treat her with the most marked respect, and consider her worthy the honours of a sovereign. But it not unfrequently happens that the queen or mother ant, excavates without assistance her future dwelling-place, and in perfect solitude lays her eggs, feeds the larvæ, and pays every requisite attention to the pupæ.

*Slave Ants.*—The most remarkable fact connected with the history of ants, is the propensity possessed by certain species to kidnap the workers of other species, and compel them to labour for the benefit of the community, thus using them completely as slaves; and, as far as we yet know, the kidnappers are red or pale-coloured ants, and the slaves, like the ill-treated natives of Africa, are of a jet black.

The time for capturing slaves extends over a period of about ten weeks, and never commences until the male and female ants are about emerging from the pupa state, and thus the ruthless marauders never interfere with the continuation of the species: this instinct seems specially provided, for were the slave ants created for no other end than to fill the station of slavery to which they appear to be doomed, still even that office must fail were the attacks to be made on their nests before the winged myriads have departed, or are departing, charged with the duty of continuing their kind.

When the red ants are about to sally forth on a marauding expedition, they send scouts to ascertain the exact position in which a colony of negroes may be found; these scouts having discovered the object of their search, return to the nest and report their success. Shortly afterwards the army of red ants marches forth, headed by a vanguard, which is perpetually changing; the individuals which constitute it, when they have advanced a little before the main body, halting, falling into the rear, and being replaced by others: this vanguard consists of eight or ten ants only. When they have arrived near the negro colony, they disperse, wandering through the herbage and hunting about, as if aware of the propinquity of the object of their search, yet ignorant of its exact position. At last they discover the settlement, and the foremost of the invaders rushing impetuously to the attack, are met, grappled with, and frequently killed by the negroes on guard: the alarm is quickly communicated to the interior of the nest; the negroes sally forth by thousands, and the red ants rushing to the rescue, a desperate conflict ensues, which, however, always terminates in the defeat of the negroes, who retire to the innermost recesses of their habitation. Now follows the scene of pillage; the red ants with their powerful mandibles tear open the sides of the negro ant-hill, and rush into the heart of the citadel. In a few minutes each of the invaders emerges, carrying in its mouth the pupa of a worker negro, which it has obtained in spite of the vigilance and valour of its natural guardians. The red ants return in perfect order to their nest, bearing with them their living burdens. On reaching the nest the pupæ appear to be treated precisely as their own, and the workers when they emerge perform the various duties of the community with the greatest energy and apparent good will; they repair the nest, excavate passages, collect food, feed the larvæ, take the pupæ into the sun-shine, and perform every office which the welfare of the colony seems to require; in fact, they conduct themselves entirely as if fulfilling their original destination.

One of the authors of the 'Introduction to Entomology' being in Paris in 1817, called on the late M. Latreille, and accompanied by that learned entomologist, visited the Bois de Boulogne for the purpose of observing this singular phenomenon, and was highly gratified in being able completely to verify the whole of M. Huber's statements.



*a*, larva of the Sexton Beetle. *b*, pupa. *c*, perfect beetle.

# CHAPTER VI.

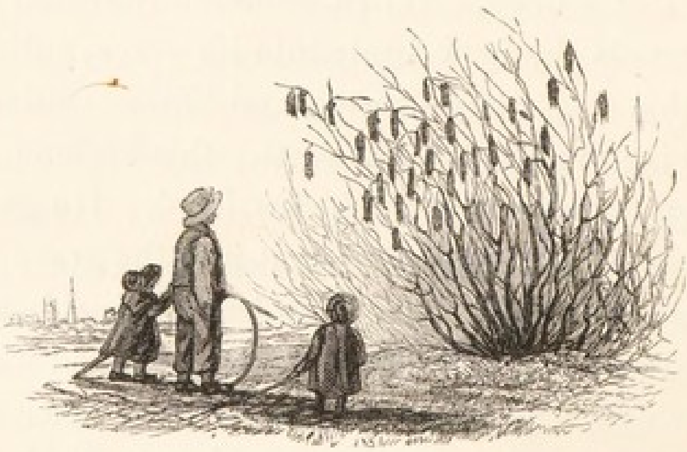
## HISTORY OF THE SEXTON BEETLE.*

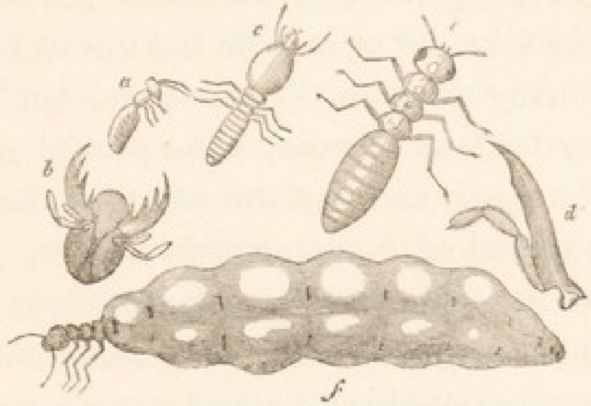
THE sexton beetle is about an inch in length; it is of a black colour, and so fetid that the hands smell for hours after handling it; and if it crawl on woollen clothes which are not washed, the smell continues for several days. The sexton beetle lays its eggs in the bodies of putrifying dead animals, which, when practicable, it buries in the ground. In Russia, where the poor people are buried but a few inches below the surface of the ground, the sexton beetles avail themselves of the bodies for this purpose, and the graves are pierced with their holes in every direction; at evening, hundreds of these beetles may be seen in the church-yards,

* Authority :—Rusticus of Godalming. See Entomological Magazine, vol. iii. p. 506.

either buzzing over recent graves, or emerging from them. The sexton beetle in this country seldom finds so convenient a provision for him, and he is under the necessity of taking much more trouble; he sometimes avails himself of dead dogs and horses, but these are too great rarities to be his constant resort; the usual objects of his search are dead mice, rats, birds, frogs, and moles; of these a bird is most commonly obtained. In the neighbourhood of towns, every kind of garbage that is thrown out attracts these beetles as soon as it begins to smell, and it is not unusual to see them settling in our streets, enticed by the grateful odour of such substances. The sexton beetles hunt in couples, male and female; and where six or eight are found in a large animal, they are almost sure to be males and females, in equal numbers; they hunt by scent only, the chase being mostly performed when no other sense would be very available, viz., in the night. When they have found a bird, great comfort is expressed by the male, who wheels round and round above it, like a vulture over the putrifying carcass of some giant of the forest,—the female settles on it at once, without this testimonial of satisfaction; the male at last settles also, and a savoury and ample meal is made before the great work is begun. After the beetles have appeased the calls of hunger, the bird is abandoned for a while; they both leave it to explore the earth in the neighbourhood, and ascertain whether there is a place suitable for interment; if on a ploughed field there is no difficulty; but if on grass, or among stones, much labour is required to draw it to a more suitable place. The operation of burying is performed almost entirely by the male beetle, the female mostly hiding herself in the body of the bird about to be buried, or sitting quietly upon it, and allowing herself to be buried with it: the male begins by digging a furrow all round the bird, at the distance of about half an inch, turning the earth outside; his head is the only tool used in this operation; it is held sloping outwards, and is exceedingly powerful. After the first furrow is completed another is made within it, and the earth is thrown into the first furrow; then a third furrow is made, and this is completely under the bird, so that the beetle whilst working at it is out of sight: now, the operation can only be traced by the heaving of the earth, which soon forms a little rampart round the bird: as the earth is moved from beneath, and the surrounding rampart increases in height, the bird sinks. After incessant labour for about three hours the beetle emerges, crawls upon the bird, and takes a survey of his work. If the female is on the bird, she is driven away by the male, who does not choose to be intruded on during the important business. The male beetle then remains for about an hour perfectly still, and does not stir hand or foot; he then dismounts, dives again into the grave, and pulls the bird down by the feathers for half an hour; its own weight appears to sink it but very little. At last, after two or three hours' more labour, the beetle comes up, again gets on the bird, and again takes a survey, and then drops down as though dead, or fallen suddenly fast asleep. When sufficiently rested he rouses himself, treads the bird firmly into its grave, pulls it by the feathers this way and that way, and having settled it to his mind, begins to shovel in the earth; this is done in a very short time, by means of his broad head. He goes behind the rampart of earth, and pushes it into the grave with amazing strength and dexterity; the head being bent directly downward at first, and then the nose elevated with a kind of jerk, which sends the earth forwards. After the grave is thus filled up, the earth is trodden in, and undergoes another keen scrutiny all round, the bird being completely hidden; the beetle then makes a hole in the still loose earth, and having buried the bird and his own bride, next buries himself.

The female having laid her eggs in the carcass of the bird, in number proportioned to its size, and the pair having eaten as much of the savoury viand as they please, they make their way out, and fly away. The eggs are hatched in two days, and produce fat scaly grubs, which run about with great activity; these grubs grow excessively fast, and very soon consume all that their parents had left. As soon as they are full grown they cease eating, and burrowing further in the earth become pupæ. The length of time they remain in this state appears uncertain; but when arrived at the perfect state, they make round holes in the ground, from which they come forth. There are several beetles which possess this singular propensity to perform the office of sexton, and are therefore equally deserving of the name; they may be readily obtained from the bodies of dead animals, and are not unfrequently to be shaken from a mole-tree.






White Ants.
*a*, labourer. *b*, under side of its head magnified. *c*, soldier. *d*, one of its jaws magnified.
*e*. king, after losing his wings. *f*, queen.

# CHAPTER VII.

## HISTORY OF THE WHITE ANTS.*

NEXT to the locusts, the white ants may be reckoned the most destructive insects known to man; not only articles of food, but clothing, fences, trees, and even houses, are doomed to fall before them. They live in immense communities, consisting of a king and queen, soldiers, and labourers; the king and queen are perfect insects, male and female; the soldiers are said to be the pupa state, and the labourers the larva state, of the same insect. The only office of the king and queen is to increase their kind; the queen laying eggs to the amount of eighty thousand every day. It is the office of the soldiers to attack every object

* Extracted from an "Account of the Termites of Africa, by Henry Smeathman." Read before the Royal Society, 15th Feb. 1781.

or living thing that in any way injures or endangers the safety of the nest; this duty they perform with the most reckless bravery, the labourers retiring within the nest during the time of danger. The offices of the labourers are manifold; they take the eggs from the queen as fast as she lays them, convey them to the nurseries, tend them until hatched; they feed the young, store provisions, build the nest, repair damages, and perform every kind of labour requisite for the good of the community.

The nests of the white ants are so numerous all over the island of Bananas, and the adjacent continent of Africa, that it is scarcely possible to stand upon any open place, such as a rice-plantation or other clear spot, where one or more of these buildings is not to be seen within fifty paces. In some parts near Senegal, as mentioned by Mons. Adanson, their number, magnitude, and closeness of situation, make them appear like the villages of the natives. These buildings are usually termed "hills," from their outward appearance, which is that of little hills, generally pretty much in the form of sugar-loaves, and about ten or twelve feet in height. These hills continue quite bare until they are six or eight feet high; but in time become, like the rest of the earth, almost covered with grass and other plants, and in the dry season, when the herbage is burnt up by the rays of the sun, somewhat resemble very large hay-cocks. The exterior of the building is one large shell in the manner of a dome, large and strong enough to enclose and shelter the interior from the vicissitudes of the weather, and the inhabitants from the attacks of natural or accidental enemies. It is always, therefore, much stronger than the interior building, which is the habitable part, divided with a wonderful kind of regularity and contrivance into an amazing number of apartments, for the residence of the king and queen and the nursing of their numerous progeny; or for magazines, which are always found well filled with stores and provisions. These hills make their first appearance above ground by a little turret or two in the shape of sugar-loaves, which are run a foot high, or more. Soon after, at some little distance, while the former are increasing in height and size, the ants raise others, and so go on increasing the number and widening them at the base, till their works below are covered with these turrets, which they always raise the highest and largest in the middle, and by filling up the intervals between each turret, collect them, as it were, into one dome. They are not very curious or exact about these turrets, except in making them very solid and strong; and when, by the junction of them, the dome is completed, for which purpose the turrets answer as scaffolds, they take away the middle ones entirely, except the tops (which, joined together, make the crown of the cupola), and apply the clay to the building of the works within, or to erecting fresh turrets for the purpose of raising the hillock still higher; so that no doubt some part of the clay is used several times, like the boards and posts of a mason's scaffold.

The outer shell or dome is not only of use to protect and support the interior buildings from external violence and heavy rains, but to collect and preserve a regular degree of genial warmth and moisture, which seems very necessary for hatching the eggs and cherishing the young ones. The royal chamber, so called on account of its being adapted for, and occupied by, the king and queen, appears to be, in the opinion of this little people, of the most consequence, being always situated as near the centre of the interior building as possible, and generally about the height of the common surface of the ground at a pace or two from the hillock. It always resembles the shape of half an egg or an obtuse oval within, and may be supposed to represent a long oven. In the infant state of the colony, it is not above an inch or thereabout in length; but in time will be increased to six or eight inches, or even more, being always in proportion to the size of the queen, who, increasing in bulk as in age, at length requires a chamber of such dimensions.

The floor of this singular part is perfectly horizontal; and in large hillocks, sometimes an inch thick and upwards of solid clay. The roof also, which is one solid and well-turned oval arch, is generally of about the same solidity, but in some places it is not a quarter of an inch thick: this is on the sides where it joins the floor, and where the doors or entrances are made level therewith, at pretty equal distances from each other. These entrances will not admit any animal larger than the soldiers or labourers, so that the king and the queen (who is, at full size, a thousand times the weight of a king) can never possibly go out. The royal chamber, if in a large hillock, is surrounded by an innumerable quantity of others of different sizes, shapes, and dimensions; but all of them are arched, the arches being sometimes circular and sometimes elliptical or oval. These either open into each other, or communicate by passages equally wide, and being always empty are evidently made for the soldiers and attendants, of whom it will soon appear great numbers are necessary, and of course always in waiting. These apartments are joined by the magazines and nurseries. The former are chambers of clay, and are always well filled with a kind of provisions, which, under the microscope, appear to consist of the gums or inspissated juices of plants. These are thrown together in little masses, some of which are finer than others, and resemble the sugar about preserved fruits; others are like tears of gum, one quite transparent, another like amber, a third brown, and a fourth quite opaque, as we often see in parcels of ordinary gums. These magazines are intermixed with the nurseries, which are totally different from the rest of the apartments; for these are composed entirely of wooden materials, seemingly joined together with gums. They are called nurseries, because they are invariably occupied by the eggs and young ones; the latter appear at first in the shape of labourers, but white as snow. These nurseries are exceedingly compact, and divided into very small irregularly-shaped chambers, not one of which is to be found half an inch in width. They are placed all round the royal apartments, and as near as possible to them. When the nest is in the infant state, the nurseries are close to the royal chamber; but as in process of time the queen enlarges, it is necessary to enlarge this chamber also for her accommodation; and as she then lays a greater number of eggs, and requires a greater number of attendants, so is it necessary to enlarge and increase the number of the adjacent apartments; for which purpose the small nurseries that are first built are taken to pieces, rebuilt a little farther off, and a size larger, their number being at the same time increased. The nurseries are always found slightly overgrown with mould, and plentifully sprinkled with white globules, about the size of a small pin's head. These may at first be mistaken for eggs; but on being examined under a microscope, they evidently appear to be a species of fungus, in shape like our edible mushroom in the young state in which it is pickled. They appear, when whole, white like snow a little thawed and then frozen again, and when bruised, seem composed of an infinite number of pellucid particles, approaching to oval forms, and difficult to separate; the mouldiness seems likely to be the same kind of substance. The nurseries are enclosed in chambers of clay, like those which contain the provisions, but much larger. In the early state of the nest they are not larger than a hazel nut, but in old hills are often as large as the head of a child a year old.

The royal chamber is situated nearly on a level with the surface of the ground, at an equal distance from all the sides of the building, and directly under the apex of the hill. It is surrounded on all sides, both above and below, by what may be called the royal apartments, which have only labourers and soldiers in them, and can be intended for no other purpose than for these to wait in, either to guard or serve their common father and mother, on whose safety depends the happiness, and probably even the existence, of the whole community. These apartments compose an intricate labyrinth, which extends a foot or more in diameter from the royal chamber on every side. Here the nurseries and magazines of provisions begin, and, being separated by small empty chambers and galleries which go round them, or communicate from one to the other, are continued on all sides to the outward shell, and attain two thirds or three fourths of its height, leaving an open area in the middle, under the dome, which very much resembles the nave of a cathedral; this is surrounded by three or four very large gothic-shaped arches, which are sometimes two or three feet high next the front of the area, but diminish very rapidly as they recede from thence, like the arches of aisles in perspective, and are soon lost among the innumerable chambers and nurseries behind them. These chambers and the passages communicating with them, being arched, help to support each other; and while the interior large arches prevent their falling into the centre, and keep the area open, the exterior building supports them on the outside. There are, comparatively speaking, few openings into the great area, and they, for the most part, seem intended only to admit into the nurseries that genial warmth which the dome collects. The interior building or assemblage of nurseries, chambers, &c., has a flattish top or roof, without any perforation, which would keep the apartments below dry, in case through accident the dome should receive any injury, and let in water: and it is never exactly flat and uniform, because the labourers are always adding to it by building more chambers and nurseries; so that the divisions or columns between the future arched apartments resemble the pinnacles upon the points of some old buildings, and demand particular notice, as affording one proof that for the most part the insects project their arches, and do not make them by excavation. The subterraneous passages which run under the lowest apartments in the hill, in various directions, are of an astonishing size, being wider than the bore of a large cannon. These passages or galleries, which are very thickly lined with the same kind of clay of which the hill is composed, ascend the inside of the external shell in a spiral manner, winding round the whole building up to the top, and intersecting each other at different heights, opening either immediately into the dome in various places, or into the interior buildings, the new turrets, &c., and sometimes communicating therewith by other galleries of different bores or diameters, either circular or oval. From every part of these large galleries are various small pipes or galleries, leading to different parts of the building. Under the ground there are a great many which lead downwards by sloping descents, three and four feet perpendicularly, among the gravel; from this the labouring *Termites* cull the finer parts, which, being worked up in their mouths to the consistence of mortar, form that solid clay or stone of which all their hills and buildings, except the nurseries, are composed. Other galleries again ascend, leading out horizontally on every side, and are carried under ground, near to the surface, a vast distance; for if you destroy all the nests within a hundred yards of your house, the inhabitants of those which are unmolested farther off, will nevertheless carry on their subterranean galleries, and invade the goods and merchandize contained in it, by undermining them, and do great mischief, if you are not very circumspect.

But to return to the cities from whence these extraordinary expeditions and operations originate:—it seems there is a degree of necessity for the galleries under the hills being thus large, as they are the great thoroughfares for all the labourers and soldiers going forth or returning upon any business whatever, whether fetching clay, wood, water, or provisions; and they are certainly well calculated for the purposes to which they are applied, by the spiral slope which is given them; for if they were upright, the labourers would not be able to carry on their building with so much facility, as they ascend perpendicularly with great difficulty, and the soldiers can scarcely do it at all. It is on this account that a road like a ledge is sometimes made on the perpendicular side of any part of the building within their hill; this road is flat on the upper surface, and half an inch wide, ascending gradually like a staircase, or like those roads which are cut on the sides of hills and mountains which would otherwise be inaccessible; by this and similar contrivances, they travel with great facility to every internal part. This too is probably the cause of their building a kind of bridge, of one vast arch, which answers the purpose of a flight of stairs from the floor of the area to some opening on the side of one of the columns supporting the large arches, an arrangement which must shorten the distance exceedingly to those labourers who have to carry the eggs from the royal chamber to some of the upper nurseries, a distance which, in some hills, would be four or five feet in the most direct line, and much more if carried through all the winding passages leading through the inner chambers and apartments. One of these bridges, of an elliptic form, was found to measure half an inch in breadth, a quarter of an inch in thickness, and ten inches in length. It was strengthened by a small arch at the bottom, and the footway on its upper surface was grooved throughout its entire length, either for the purpose of affording greater security to the labourers in passing over it, or from being so worn by their constant treading.

It has been before observed that each community of white ants consists of a king and queen, soldiers, and labourers. The labourers are the most numerous, there being at least a hundred of them to one soldier. They are in this state about one fourth of an inch long, and twenty-five of them weigh about a grain ; so that they are not so large as some of our ants. From their external habit and fondness for wood, they have been very expressively called *wood-lice* by some people ; and the whole genus has been known by that name, particularly among the French.— They run as fast or faster than any other insects of their size, and are incessantly bustling about their affairs. The second order, or soldiers, have a very different form from the labourers, and by some authors have been supposed to be the males, and the former neuters ; but they are in fact the same insects as the foregoing, only they have undergone a change of form, and approached one degree nearer to the perfect state. They are now much larger, being half an inch long, and equal in bulk to fifteen of the labourers. The third order, or the insect in its perfect state, varies in form still more than ever. The head, thorax and abdomen, differ almost entirely from the same parts in the labourers and soldiers ; and besides this, the animal is now furnished with four fine, large, brownish, transparent wings, with which, at the time of emigration, it is to wing its way in search of a new settlement. In short, it differs so much from its form and appearance in the other two states, that it has never been supposed to be the same animal, but by those who have seen it in the nest; and some of these have distrusted the evidence of their senses.

In the winged state they are also much altered in their size as well as form. Their bodies now measure between six and seven tenths of an inch in length, and their wings above two inches and a half from tip to tip, and they are equal in bulk to about thirty labourers, or two soldiers.—They are now also furnished with two large eyes, one on each side of the head, and very conspicuous; if they have any before, they are not easily to be distinguished. Probably in the two first states their eyes, if they have any, may be small, like those of moles; for as they live, like these animals, always under ground, they have as little occasion for these organs, and it is not to be wondered at that we do not discover them; but the case is much altered when they arrive at the winged state, in which they are to roam, though but for a few hours, through the wide air, and explore new and distant regions. In this form the animal comes abroad during or soon after the first tornado, which at the latter end of the dry season proclaims the approach of the ensuing rains, and seldom waits for a second or third shower, if the first, as is generally the case, happens in the night and brings much wet after it.

The numbers that are to be found the next morning all over the surface of the earth, but particularly on the water, is astonishing; for their wings are only calculated to carry them a few hours, and after the rising of the sun not one in a thousand is to be found with four wings, unless the morning continues rainy, when here and there a solitary being is seen winging its way from one place to another, as if solicitous only to avoid its numerous enemies, particularly various species of ants, which are hunting on every spray, on every leaf, and in every possible place, for this unhappy race, of which probably not a pair in many millions get into a place of safety, fulfil the first law of nature, and lay the foundation of a new community.

Not only do ants, birds and reptiles, but even the inhabitants of the country, eagerly seek after these wingless creatures and devour them with the greatest avidity. Mr. Smeathman himself considered them delicious and delicate eating.

It is wonderful that a pair should ever escape so many dangers and get into a place of security. Some, however, are so fortunate; and being found by some of the labouring insects that are continually running about the surface of the ground under their covered galleries, which will shortly be described, are *elected* kings and queens of new states; all those which are not so elected and preserved certainly perish, and most probably in the course of the following day. The manner in which these labourers protect the happy pair from their innumerable enemies, not only on the day of the massacre of almost all their race, but for a long time afterwards, seems to justify the use of the term *election.* The little industrious creatures immediately enclose them in a small chamber of clay suitable to their size, into which at first they leave but one small entrance, large enough for themselves and the soldiers to go in and out, but much too small for either of the royal pair to make use of; and when necessity obliges them to make more entrances, they are never larger: so that of course, the voluntary subjects charge themselves with the task of providing for the offspring of their sovereigns, as well as to work and fight for them, until they shall have raised a progeny capable at least of dividing the task with them. The business of oviposition soon commences, and the labourers, having constructed a small wooden nursery, as before described, carry the eggs and lodge them there as fast as they can obtain them from the queen.

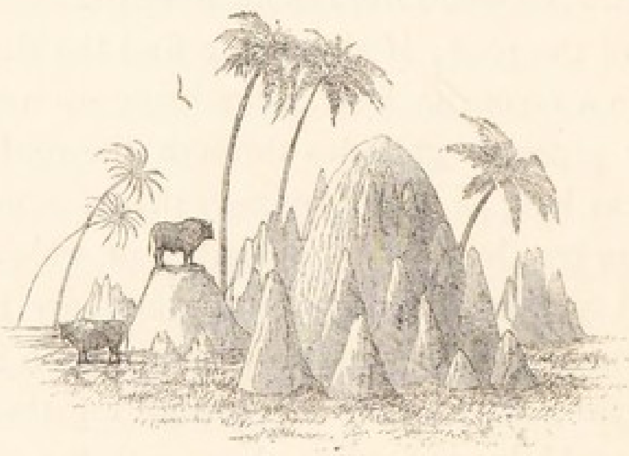
About this time a most extraordinary change begins to take place in the queen, to which we have nothing similar, except in the jigger of the West Indies (*Pulex penetrans* of Linneus), and in the different species of *Coccus* (cochineal). The abdomen of this female begins gradually to extend and enlarge to such an enormous size, that in an old queen it will increase so as to become fifteen hundred or two thousand times the bulk of the rest of her body, and twenty or thirty thousand times the bulk of a labourer, as will be found on carefully weighing and computing the different states. The skin between the segments of the abdomen extends in every direction; and at last the segments are removed to half an inch distance from each other, although at first the length of the whole abdomen is not half an inch. They preserve their dark brown colour, and the upper part of the abdomen is marked with a regular series of brown bars throughout its entire length, while the intervals between them are covered with a thin, delicate, transparent skin, and appear of a fine cream colour, a little shaded by the dark colour of the intestines and watery fluid seen here and there beneath. The animal is supposed to be upwards of two years old when the abdomen is increased to three inches in length; and they are sometimes found nearly twice that size. The abdomen is now of an irregular oblong shape, being contracted by the muscles of every segment, and is become one vast matrix full of eggs, which make long circumvolutions through an innumerable quantity of very minute vessels that circulate round the inside in a serpentine manner, which would exercise the ingenuity of a skilful anatomist to dissect and develope. This singular matrix is not more remarkable for its amazing extension and size, than for its peristaltic motion, which resembles the undulation of waves, and continues incessantly without any apparent effort of the animal; so that one part or other is alternately rising and falling in perpetual succession, and the matrix seems never at rest, but is always protruding eggs, to the number of sixty in a minute in old queens, or eighty thousand and upwards in one day of twenty-four hours. These eggs are instantly taken from the body of the queen by her attendants, (of whom there always are, in the royal chamber and the galleries adjacent, a sufficient number in waiting), and carried to the nurseries, some of which in a large nest may be four or five feet distant, in a straight line, and consequently much farther by their winding galleries. Here, after they are hatched, the young are attended and provided with every thing necessary, until they are able to shift for themselves, and take their share of the labours of the community.

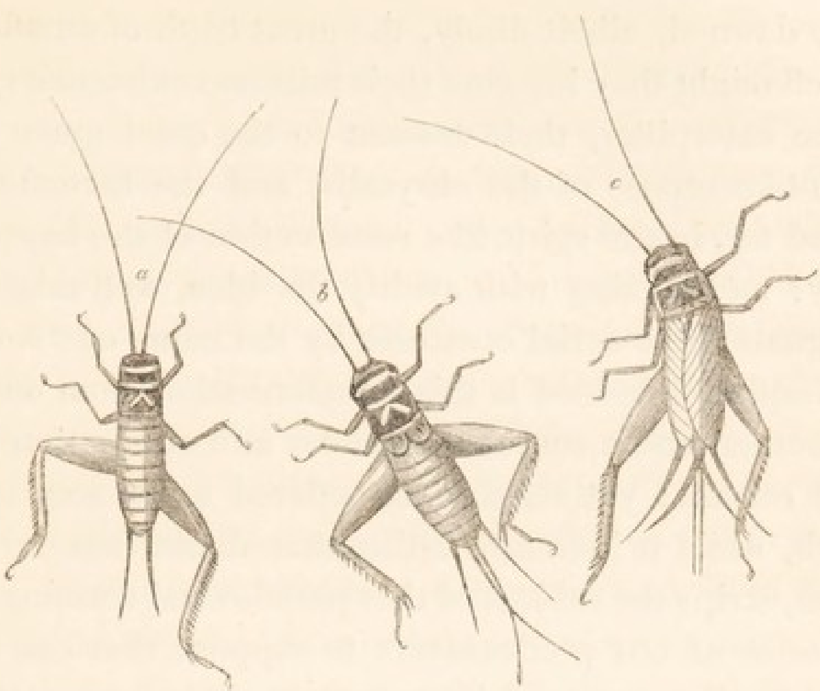
The working and the fighting insects never expose themselves to the open air, but either travel under ground, or within such trees and substances as they destroy, except indeed when they cannot proceed by their latent passages, and find it convenient or necessary to search for plunder above ground. In that case they make pipes of the material with which they build their nests. The larger sorts use the red clay, the turret-builders use the black clay, and those which build in trees employ the same ligneous substances of which their nests are composed. With these materials they completely line most of the roads leading from their nests into the various parts of the country, and travel out and home with the utmost security in all kinds of weather. If they meet with a rock or any other obstruction, they will make their way upon the surface; and for that purpose erect a covered way or arch, still of the same materials, continuing it with many windings and ramifications through large groves; and having, where it is possible, subterranean pipes running parallel with them, into which they sink and save themselves, if their galleries above ground are destroyed by any violence, or the tread of men or animals alarm them. When a person accidentally enters any solitary grove, where the ground is pretty well covered with their arched galleries, they give the alarm by loud hissings, which are distinctly heard at every step; soon after this their galleries may be searched in vain for the insects; but little holes are found, just large enough to admit of their escape into the subterraneous roads. These galleries are of sufficient size to allow the *Termites* to pass and repass without stopping each other (though there are always numerous passengers), and to shelter them equally from light and air, as well as from their enemies, of which the ants, being the most numerous, are the most formidable.

The *Termites,* except their heads, are exceedingly soft, and are covered with a very thin and delicate skin; being blind, they are no match on open ground for the ants, who can see, and are all of them covered with a strong, horny shell not easily pierced, and are of dispositions bold, active and rapacious. Whenever the *Termites* are dislodged from their covered ways, the various species of ants, which are probably as numerous above ground as the *Termites* are in their subterranean passages, instantly seize and drag them away to their nests, to feed the young brood. They are therefore exceedingly solicitous about preserving their covered ways in good repair; and if one of these be demolished for a few inches in length, it is wonderful how soon they will rebuild it. At first in their hurry they run into the open part an inch or two, but stop so suddenly that it is evident they are surprised; for though some will run straight on, and get under the further part of the arch as speedily as possible, most of them run back as fast, and very few will venture through that part of the gallery which is left uncovered. In a few minutes they may be seen engaged in rebuilding the arch, and even if three or four yards of their gallery have been destroyed, it will be restored by the next morning; and on again opening it, the *Termites* will be found as numerous as ever, passing both ways. If the gallery be several times destroyed, they will at length seem to give up the point, and build another in a different direction; but if the old one led to some favorite plunder, in a few days they will rebuild it again, and unless the nest be destroyed they never totally abandon their gallery.

The *Termites* generally make their approaches to the nest under ground, descending below the foundations of houses and stores at several feet from the surface, and rising again either in the floors, or entering at the bottoms of the posts of which the sides of the buildings are composed, they bore quite through them, following the course of the fibres to the top, or making lateral perforations and cavities here and there as they proceed. While some are employed in gutting the posts, others ascend from them, entering a rafter or some other part of the roof; if they once find the thatch, which seems to be a favourite food, they bring up wet clay, and build their pipes or galleries through the roof in various directions, as long as it will support them; sometimes eating the palm-tree leaves and branches of which it is composed, and perhaps (for variety seems very pleasing to them) the rattan or other running plant which is used as a cord to tie the various parts of the roof together, and that to the posts which support it: thus, with the assistance of the rats, which, during the rainy season are apt to shelter themselves there and to burrow through it, they very soon ruin the house by weakening the fastenings and exposing it to the wet. In the mean time the posts will be perforated in every direction as full of holes as the timber in the bottoms of ships which has been bored by the worms; the fibrous and knotty parts being left to the last.

In carrying on this business they sometimes find, by some means or other, that the post has a certain weight to support, and then, if it is a convenient track to the roof, or is itself a kind of wood agreeable to them, they bring their mortar, and as fast as they take away the wood replace the vacancy with that material, which being worked together by them closer and more compactly than human strength or art could ram it, when the house is pulled to pieces, the posts formed of the softer kinds of wood are often found reduced almost to a shell, and all or most of them transformed from wood to clay, as solid and as hard as many kinds of free-stone used for building in England. When the hills are more than half their height, it is the practice of the wild bulls to stand as sentinels upon them while the rest of the herd is ruminating below.






*a*, common cricket in the larva state. *b*, ditto in the (so called) pupa state. *c*, ditto in the perfect state.

# CHAPTER VIII.

## METAMORPHOSIS OF INSECTS.*

THE preceding chapters serve to illustrate, in some degree, the remarkable change in form and manner of life which is so peculiarly characteristic of insects. This change has in all ages attracted admiration. What can be more wonderful than the fact that an unsightly worm should pass through a shrouded and death-like sleep, and should wake at last a glorious butterfly, to bask in sunshine, float on the impalpable atmosphere, and quaff the luscious nectar of beauteous flowers! Well might such a miracle be made a poet's theme! Well might those philosophers, on whose minds

* The substance of this chapter was read before the Linnean Society, on the 1st of April, 1834, and subsequently published in the 3rd vol. of the 'Entomological Magazine.'

there dawned, albeit dimly, the great truth of an after life, —well might they imagine their toilsome existence typified in the caterpillar, their descent to the quiet grave in the tomb-like repose of the chrysalis, and the hereafter they sighed for, in the spirit-like resurrection of the happy butterfly: and seizing with avidity the idea, well might they designate these aerial creatures by the name of "souls." *

Wonderful indeed is this transformation from one form to another, and a source of wonder and admiration it ever must remain: yet science has offered us an explanation, which, while it increases rather than diminishes our admiration, strips the subject of that paradoxical seeming which led some of our predecessors to suppose that one animal was actually converted into another. It is now established beyond a doubt, that the wings, legs, and other parts of the butterfly, pre-exist in the chrysalis and even in the caterpillar: these facts have been ascertained by immersing the chrysalis and caterpillar in boiling water, and dissecting them when a greater degree of solidity has thus been given to their various parts.

It may be observed of organized beings in general, that when they first exist they possess little or no similarity to the creatures they are destined to become: or in other words, to the parents to which they owe their existence. We may take as wide a range as we please in examining the truth of this position; amongst vegetables, compare the acorn with the oak tree; among animals, the egg with the gorgeous peacock. When an organized being has reached perfection, it precisely resembles its parent. The degrees or steps by which a being mounts to this perfection and similarity to its parent, constitute that which in an insect is termed metamorphosis.

* Ψυχὴ signifies a "soul."

A few words as to the cause of metamorphosis. In every organized being we trace these three tendencies ; *first*, to have its component parts become unfit for their functions; *secondly*, to throw off or discard all parts thus becoming unfit; *thirdly*, to form, create, or supply, fresh portions in lieu of those thus thrown off. In this threefold tendency we shall find a solution of *all* the mysterious changes we behold in animals and vegetables; whether we regard the loosening of teeth, the shedding of hair, the moulting of feathers, the casting of skins or the falling of leaves. This change of substance is generally observable in the exterior covering, but in man, the most perfect animal, it is more obvious in the bones. Numberless experiments prove that the substance of bones is continually changing ; some portions are constantly undergoing absorption, others secretion. Thus certain particles of matter escape to fulfil other ends, while new particles, introduced as aliment for the system, are mixed with its fluids and rush to supply the place of those which have escaped.

All animals possessing an internal skeleton or frame of bones similar to that of man, like man also exhibit this tendency more strongly in their bones than in any of their less solid parts. Now in insects the skeleton is external, and exactly comparable to an indurated skin; yet it serves the same purpose as the skeleton of other animals. This different situation of the skeleton accounts in great measure for the difference in the effects of the tendency to change, for while in the larger animals these effects are concealed from view, and are going on without any consciousness on the part of the animal, in an insect they are very apparent, and from their locality temporarily detract from its present well-being, always causing sickness, and often death.

There are many animals, as crabs, lobsters, &c., which resemble insects in the possession of an external skeleton, but from these, insects may at once be distinguished by their being furnished with *six* legs and *four* wings; they also differ in wanting that singular property possessed by crabs and lobsters, of reproducing a limb that has been accidentally lost. The great value of these characters is proved by the importance attached to the exceptions which have been detected; flies have two of their wings small and imperfect; butterflies have the first pair of legs unfitted for walking; and a Dr. Heineken thought he found something like a re-production of the antennæ of cockroaches. The beings, therefore, of which the 'Grammar of Entomology' professes to treat, are animals which possess an external skeleton, which are provided with four wings and six legs, which cannot re-produce an injured limb, and finally, which arrive at perfection by undergoing metamorphosis in one or other of the following modes.

1. By passing through an amorphous state,—

AMORPHA;

In which the penultimate state is provided neither with mouth nor organs of locomotion; consequently it neither eats nor moves, nor does it bear any resemblance to the perfect state. This group contains two classes of insects.

Class I. Lepidoptera; in which the perfect insect has four fully developed wings, all of them covered with a kind of scales, which are symmetrically arranged on each other, like the scales of a fish or the tiles of a house. The silk-worm, p. 17, and all moths and butterflies, are examples of this class.

Class II. Diptera; in which the perfect insect has two fully developed wings, and two merely rudimentary ones, which are distinguished by the name of halteres or poisers. The breeze-fly, p. 25, and all two-winged flies, are examples.

2. By passing through a necromorphous state,—

NECROMORPHA ;

In which the penultimate state is provided with mouth and organs of locomotion, detached from the body, but so enveloped in a case that it can employ neither. The resemblance therefore to the perfect insect is very considerable, except in the total want of motion. This group contains two classes of insects.

Class III. HYMENOPTERA ; in which the perfect insect has four fully developed wings, all of them transparent or membranous, and without scales. The honey-bee, p. 40, and bees and wasps generally, are examples of this class.

Class IV. COLEOPTERA ; in which the perfect insect has two fully developed wings, and two wing-cases which cover the wings. The sexton beetle, p. 53, and all other beetles, are the examples.

3. By passing through an isomorphous state,—

ISOMORPHA ;

In which all the states are active and voracious, and of similar form. This group contains two classes of insects.

Class V. ORTHOPTERA ; in which the perfect insect has four wings, the first pair being leathery, of little use in flight, and often very minute and scarcely apparent ; the mouth is furnished with two strong mandibles, meeting transversely. Crickets, p. 73, and grasshoppers are the examples.

Class VI. HEMIPTERA; in which the perfect insect has four wings, a portion of the first pair often being leathery: the mouth is a tubular sucker, formed for extracting the sap of plants. Plant-bugs and plant-lice are the examples.

4. By passing through no uniform state,—

ANISOMORPHA;

In which the Amorphous, Necromorphous, and Isomorphous characters appear, together with others not possessed by those groups. This group contains but one class of insects.

Class VII. NEUROPTERA; in which the perfect insect has four reticulated wings. Dragon-flies are examples, as are also the white ants at p. 57.

The first or Amorphous group, is again divisible into two minor groups, dependant on the circumstance of throwing off or retaining the prior skin when in the quiescent state; those which throw off this skin, as butterflies and moths, exhibit the eyes, antennæ, legs and wings of the future insect, and such a chrysalis is called *pupa adermata:* those which retain the prior skin, as flies, exhibit no trace of the situation of the limbs, and such a chrysalis is called *pupa dermata.*

The insects of the last section, possessing, as they certainly do, the extreme character of the *Amorpha*, nevertheless, as has previously been stated, testify a very evident approach to the neighbouring *Necromorpha;* for when the skin or covering of the quiescent insect is broken, a perfectly Necromorphous form is disclosed; and thus, though nothing could appear more different than the exterior appearance of the two, yet this examination proves that the real difference exists only in the circumstance of one group retaining the covering of the previous state longer than the other group. If we select two well-known insects, the breeze-fly and the honey-bee, we shall find little or no difficulty in tracing the similarity. The grubs or maggots from which these insects proceed, are not very dissimilar; but the grub of the fly merely ceases to feed, becomes quiescent, and hardens externally (page 25, fig. *d*), while that of the bee ceases to eat, is walled in its cell by the workers, lines its cell with silk, casts its covering and becomes quiescent, every limb being distinct, detached, and perfect (p. 40), but enveloped in a delicately soft and smooth skin, and perfectly motionless. This is the true Necromorphous character. Now the breeze-fly, on the contrary, is Amorphous; but if a few days before the perfect insect appears, the hard and apparently inorganic case which covers it be gently opened, we find within a form precisely resembling the Necromorphous form of the bee just described; whence it appears clear that the so-called pupæ of the bee and the fly are neither substantially nor numerically the same state. Every ecdysis or sloughing is a transformation; so that, calling the imago, as it certainly is, the ultimate state, then the so-called pupa of the bee is the penultimate, and the so-called pupa of the fly the antepenultimate. The difference is thus explained:—the fly, on assuming the perfect state, casts two skins, the bee only one.

In turning to the other section of the *Amorpha*, namely, the *Amorpha adermata*, including the butterflies, moths, &c., we find, on examining them in the quiescent state, abundant evidence that we have before us not only organized but animated beings; in these the grubs, before becoming quiescent, cast their covering in the same manner as the bee; but still, unlike that insect, retain two distinct coverings, thus resembling the *Amorpha dermata*. Both these coverings are cast at the same time; the interior one, fine, semi-transparent, and delicately soft, must have been observed by all who have paid any attention to the rearing of Lepidoptera. Now the whole of the *Necromorpha*, as far as has yet been ascertained, finally undergo a *single*, and the whole of the *Amorpha*, on the other hand, a *double* ecdysis.

The *Isomorpha*, of which the common cricket is an example, have no quiescent state; nor can we find that they possess any state precisely equivalent to that portion of the lives of the two great groups we have been comparing. Their whole existence between the egg and the imago consists of a gradual series of approaches to perfection; and during this interval reproduction has been known to take place. No character is yet discovered by which the penultimate, antepenultimate, and prior states can be determined.

In the heterogeneous group, *Anisomorpha*, a group in metamorphosis, as in all other characters, equally related to the other three, we find a typical and distinct section in the dragon-flies. These, like the *Isomorpha*, have no quiescent state: their preparatory state is aquatic, active and voracious: when arrived at the period for assuming the imago, they leave the water, and fixing their feet firmly to a slender stick or blade of grass, emerge from a double skin and fly away. The exterior skin is hard, corneous, and brittle; the interior soft, fine and pliable. The May-fly, one of the Anisomorphous insects, has a metamorphosis still more striking, and one that has been deemed anomalous and unaccountable. In the antepenultimate skin it leaves the water, and attaches itself by the legs like the dragon-fly. Its antepenultimate skin then opens on the back; the insect emerges and flies away, leaving that one skin only — that beautifully delicate skin which the dragon-fly quits simultaneously with the harder one, being still retained by the May-fly. Here then we have the strange fact of an insect's flying before it reaches the imago; that is, flying in its penultimate state. In twenty or thirty minutes at farthest it settles again, casts its skin, and becomes a perfect imago.

It thus appears that although, until the final ecdysis, no insect arrives at perfection, yet, before that period, even in the state immediately preceding, it may feed, run, and even fly; or may swim, crawl, barely move, or be without motion, without apparent life, or without apparent organization. It appears that the apparently lifeless or quiescent state may be entered without ecdysis; that ecdysis itself may be either single or double; that the states called pupa, in various tribes, are neither substantially nor numerically the same. That comparing the few insects herein noticed, the fly, the bee, the cricket, the dragon-fly and the May-fly, all of which represent great orders, we shall find it perfectly impossible to apply, if we aim at precision, any other than a numerical denomination to their intermediate states; and finally, therefore, that insects, like higher animals, have but three eras of existence,—the fœtal, the adolescent, and the adult.

As to the number of times ecdysis takes place in the life of an insect, little can be said at present owing to the carelessness and imperfection of our researches; and on this account it will be found safer to count downwards from the imago, than upwards from the egg. Although the contrary has been asserted, and perhaps generally believed, it yet remains to be proved, that the grubs of Diptera and aculeleate Hymenoptera undergo any ecdysis until full grown. The order *Tenthredinites*, on the contrary, and the Lepidoptera, change very frequently, with some exceptions; for example, the caterpillar figured below sheds its skin but once: it produces the privet-moth.

These various facts, so simple, so obvious, so plain, so completely within the reach of the most cursory observer, proclaim that each variation in the number or manner of ecdysis is but another mode of metamorphosis; proclaim that metamorphosis, though in insects a complete and oft-repeated ecdysis, is but another instance of that constant loss and reparation of substance which is incident to all organized beings; proclaim the existence of a general uniformity of plan, with which the widest differences, the greatest discrepancies, are not only compatible, but are essential to perfect harmony, are the surest and safest guides to natural arrangement, and serve, like the key-stone of an arch, to unite objects previously devoid of continuity; proclaim finally the greatness of Him whose will shapes the whole into perfection.

THE

# GRAMMAR

OF

# ENTOMOLOGY.

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## BOOK II.

### ON THE COLLECTION AND PRESERVATION OF INSECTS.

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Above the sovereign oak a sovereign skims,
The purple Emperor, strong in wing and limbs;
The fair Camilla takes her flight serene,
Adonis blue, and Paphia, silver queen;
With every filmy fly, from mead to bower,
And hungry Sphinx, who threads the honeyed flower;
She o'er the Larkspur's bed, where sweets abound,
Views every bell and hums the approving sound.

CRABBE.

The Purple Emperor Butterfly, or Emperor of Morocco.

# CHAPTER I.

## APOLOGY FOR THE ENTOMOLOGIST.

Peter Pindar, in his tale of Sir Joseph Banks and the Emperor of Morocco, not only gives the opinion of the unlettered rustic on the subject of insect-hunting, but his own opinion, and the opinion of ninety-nine persons out of a hundred, even at the present day; namely, that a person who could take an interest in pursuing a butterfly must be a madman. The collector of insects must therefore make up his mind to sink in the opinion of his friends;—to be the object of the undisguised pity and ridicule of the mass of mankind, from the moment in which he commences so insignificant a pursuit: and precisely in proportion as he enters on the subject scientifically, will this pity and ridicule increase. Argument with others, in these cases, is wholly useless; but each individual may say to himself:— Insects are wonderfully and beautifully made; they appear equal, often superior, in structure and in powers, to any other work of the great Creator; He, moreover, in their unaccountable instincts, appears directly to guide the actions of each without the medium of reason or memory. How can these beings, thus so immediately under the care of the Creator, be too insignificant for me to notice?

It will not be amiss at the same time to reflect, that considered in relation to ourselves insects are not unimportant. *Cantharides*, a drug of great value, and which, as the principal ingredient of blisters, is yet unequalled, is the name given to beetles collected in great abundance from ash and other trees in the south of Europe; they are merely dried and pounded, and are at once fit for use. *Silk*, an article of dress, and one which gives employment and consequent means of subsistence to millions of human beings, is, as we have already related, the produce of the silk-worm. *Ink*, an article of immense importance in our communications with each other, and in the preservation of knowledge, is principally made from *galls* produced on trees by a minute insect called the gall-fly. *Cochineal*, the most valuable and beautiful of dies, is an insect which feeds on a species of *Cactus*, in Mexico, and other parts of the continent of America. *Kermes*, the most brilliant scarlet die known previously to the discovery of America, is an insect found abundantly on the *Quercus coccifera*, in the south of Europe: this was the celebrated Phœnician die. *Shell-lac*, a glutinous substance, now of very great importance in the manufacture of hats, and of value as an ingredient of printers' ink, is secreted by an insect which swarms on the trunks of several kinds of trees in India. *Wax*, that enlightens our drawing-rooms, and in combination is applied to a great variety of purposes, is manufactured by the bee, whose history has already been related. *Honey* is another production of the same industrious insect; and although much of its value has departed since the introduction of sugar, it is still an article of luxury. *Mead*, a wholesome and delicious beverage, for which this country has long been famous, and the manufacture of which is still carried on with great skill and success in some of our counties, is made from honey. *Locusts*, as an article of food, are spoken of in Scripture. The inhabitants of Fez, Morocco, and adjacent countries, eat them at this day; and the Hottentots hail the coming of the locusts with delight, and are said to fatten on them. The *fructification* of many plants is entirely accomplished by different species of bees, which convey the pollen from plant to plant, and also from the stamens to the stigma of the same plant. As *food* for birds and fishes, insects may be considered by far the principal article; there is scarcely a bird or a fish but devours them with avidity.

The *turnip-fly* has the power of destroying almost the whole crop of that excellent and useful vegetable, and as yet no certain cure for its ravages is known. Rusticus, an author before quoted, has ascertained that salting the seed acts in a good degree as a preventive. The *hop-fly* has the power of destroying the produce of the hop in the most remarkable manner: the crop appears exclusively dependant on the scarcity or abundance of this insect. The *locust*, by causing pestilence or famine, has in all ages possessed the power of sweeping millions of human beings from the face of the earth. The *mosquito*, by its unceasing attacks, is capable of rendering life an almost insupportable burden: gnats and other flies, in hot countries, have an influence over us scarcely less fearful.

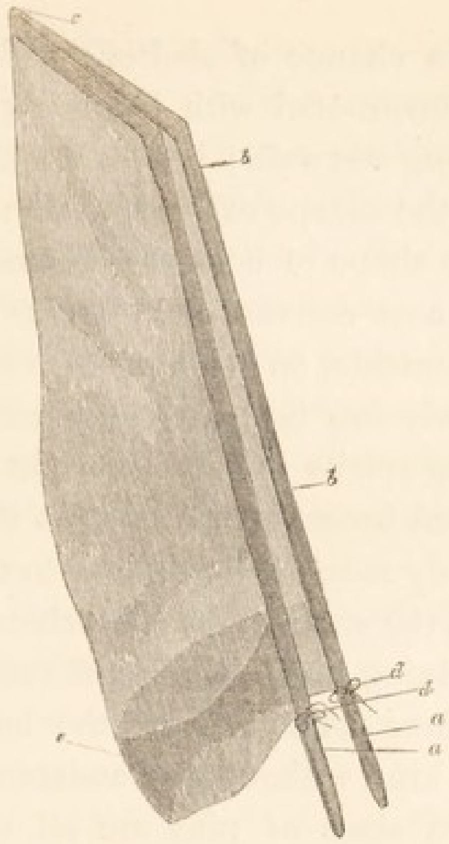
*Economy* of space and materials in architecture is taught us by the bee; the construction of the honeycomb in hexagonal cells, with triangular bottoms, accomplishes these objects in perfection: geometricians can discover no possible improvement on the plan which bees adopt. The *strength of an arch* is taught us by the white ant, whose plaster domes are so strong that men may safely ascend them, and it has been said that wild bulls stand on them. *Mortar* is made by several kinds of bees, and of the best possible composition, hardening almost instantly on exposure, and not being liable to be moistened again by wet. *Nocturnal lights* are recommended to us by the use made of them by the various fire-flies, which illuminate the trees in tropical countries all night long with their sparkling lamps.

These facts, combined with the foregoing histories, tend to show that insects perform no very inconsiderable part in creation; and that, whether as instruments of convenience and utility, as sources of injury and annoyance, or as examples of industry and economy, they cannot reasonably be despised.

It is further objected against the entomologist, by those who would allow there is some reason in the preceding considerations, that he unnecessarily takes away animal life; — that he causes unnecessary pain; — and that the pursuit is altogether hardening to the heart. On the subject of taking life. We meet with few individuals in our daily intercourse with the world, who would not consider it a praiseworthy action, and indeed almost a matter of duty, to tread on a worm in his garden, or to crush a wasp or a spider in his window, and this avowedly for the sake of his personal convenience; an entomologist, if we make as strong a case against him as possible, takes the lives of the same beings for his personal gratification in a scientific view; surely, *self* being the object in both instances, the charge of cruelty is equally applicable to both. But let us go farther: the common destroyer has heard of some wonderful mischief done by the worm, the wasp, and spider; he therefore kills as many as possible. The entomologist knows their history; he knows they do much more good than harm; he therefore kills as few as possible.— The animosity against these tribes originates in a want of knowledge of Entomology. As to causing pain. To support this charge it is insisted, that were we treated as we treat insects, we should suffer intense agony. This is very true, but very poor argument; because, before we can reason from ourselves, we must prove a similarity of circumstances. If a man could walk about for days without his head, and if his head continued eating and drinking for days without a body, then it would be fair to judge of the sensations of an insect by those of a man; for the heads and bodies of insects freely perform these feats. Then as regards hardening the heart. Entomologists, with constantly regarding the beautiful structure of insects, acquire such a kind feeling for them that they seldom or never unnecessarily kill the objects of their study, and almost invariably take much more care than indifferent persons to avoid doing them any injury. And the various schemes which have been invented for killing insects in the most expeditious manner, prove, at least, that the entomologist is not willing to occasion them suffering.

Thus can the entomologist readily answer the charges brought against his pursuits, as either frivolous or cruel: but something more than this is needful. It is no merit in reasoning creatures to spend their time on subjects which possess merely the negative recommendation of being harmless. Before we give up any great portion of our time to Entomology, we should believe it to be a useful study; we should convince ourselves that the just classification of the countless tribes of insects, exercises the mind aright by increasing its powers of speculation and reflection: we should trace in the beautiful and well-adapted structure of insects, the handywork of an allwise Creator; and in their wondrous instincts, acting without tuition, His continued and watchful care for the preservation of beings which we have been but too ready to regard with feelings of aversion or contempt.

The figure below represents the beautiful caterpillar of the spurge hawk-moth.



The clap-net used by Entomologists.

## CHAPTER II.

### OF THE DRESS AND INSTRUMENTS FOR THE COLLECTOR OF INSECTS.

Insects may be taken in nearly all places, at nearly all times, and under nearly all circumstances; but still it is necessary to describe those places, times, and circumstances which insure the greatest success. However, before starting the entomologist on his hunting excursion, we must fit him out for his employ. Dress is an article of great importance, both as to material and make. The best material with which the author is acquainted is called *lasting*. It has these advantages: it is light; it keeps out much wet; it does not catch the thorns of brambles and other bushes; it does not feel cold when wet. These are matters not to be despised by him who often wanders for hours without a chance of shelter; and a cape made of cloth, and waterproofed with Raper's patent, is very serviceable in a long wet walk; it does not oppress the wearer by preventing the escape of perspiration. The best colour is green: as to shape of coat, the common shooting jacket is by far the most convenient. There should be ample cross pockets outside, on the hip; also several breast pockets, particularly two (at least) very small ones, for glass vials containing spirits to stand upright in: these should be inside the left breast of the coat, so that the right hand can conveniently reach them. Close to these vial-pockets, and sewed into the stuff of the coat, should be a large pincushion, containing two or three different sizes of pins, so arranged, in three columns, that the hand might at once take of either kind without the assistance of the eye to direct it. Two sizes of pins are all that are generally required; but a third kind, very slender indeed, is used for very minute moths.

There are two shops in London, and perhaps more, at which pins are sold expressly for the use of entomologists: these are, Durnford's, in Gracechurch Street, and Hale's, in the Dover Road; but the art of making pins is not yet arrived at sufficient perfection to satisfy the entomologist. The universal fault is, that the heads come off, and then the insect on the pin cannot be moved without great risk.

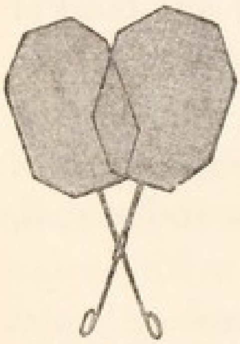
The principal implements of the collector are boxes and nets. The boxes should be of mahogany, opening readily, on brass hinges; length seven inches, breadth four inches, depth two inches; the top and bottom should be lined with fine soft cork, and covered with white paper. The pockets of a shooting jacket will readily carry three or four such boxes as these. Besides these boxes, there should be two long cylindrical tin boxes for the caterpillars of Lepidoptera: the tin not only keeps the caterpillars cool, but it causes the leaves on which they feed to retain their freshness many days. Tin boxes are also useful to bring home Diptera alive: in this case a cylinder of tin passes through the lid of the box, and is corked at the top.

The clap-net, represented at the head of this chapter, is the grand weapon of the entomologist. This is a large piece of muslin, four feet long and nearly three wide, supported on two light rods, *a*, *a*, which pass along a border, *b*, *b*, made of brown holland, or other strong substance, bend towards each other at an obtuse angle, and meet at the top of the net, *c*: one of these rods is held in each hand, the handles being the parts uncovered, and lettered *a*, *a*, the net is fixed to each rod by means of a piece of tape, which passes through a hole made in the rod at *d*, *d*, and is tied firmly in a bow.

The rods of the clap-net are each composed of five pieces, united by ferules; when taken to pieces and placed in the net, the latter may be folded in a very moderate compass, slipped into a brown holland case, and put in the coat pocket. For this kind of net both green and white muslin are used; but white is much the best, as the small insects are more readily distinguished on it; green muslin however has the merit of being less conspicuous, which under some circumstances is an advantage, for instance, in those country lanes where the pedestrians are unused to such an exhibition, the white net never fails to attract a little crowd, which causes some slight inconvenience to the entomologist as well as loss of time, for he is invariably under the necessity of explaining to the by-standers what he is doing.

This net is the best for pursuing butterflies and moths on the wing; the hunter tries to get the net under the object, and strikes upwards, closing the rods at the same time. A loose bag is formed, by a fold of the muslin, across the bottom of the net, *e;* this prevents any thing from getting out. The same net is held in one hand under the boughs of trees, &c., while these are beat by the stick of the water-net held in the other hand; and thus, besides perfect insects, a great number of caterpillars may be obtained.

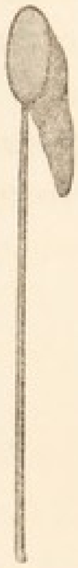
The other nets used by entomologists are of many kinds; these two are the best: first, the forceps, with handles like



those of scissors, with holes for the finger and thumb, and two circular or octagonal frames of iron, on which muslin or cheese cloth is stretched. This instrument is particularly useful for taking the Diptera and Hymenoptera, which settle on umbelliferous flowers. The forceps should be kept in the right hip pocket of the coat, to afford a greater facility in taking them out when wanted to be used with celerity: but it must be borne in mind that this weapon is never to be trusted when insects are on the wing; because its size is so small that the object at which you snap is beyond your reach before the forceps can close, however correct your aim: and a repetition of the snap is seldom attended with better success.

The second net is the water-net. It is composed of a strong hoop of iron, jointed so as to fold up in a convenient form; on this hoop is fastened a strong bag net, made of cheese cloth; the hoop has a male screw which fits a female screw at the end of a stout stick, about four feet in length. With this instrument all water insects are taken; the water straining off through the net, and the insects remaining at the bottom: the manner in which it is used is shown at the end of this chapter.

The same net, or a lighter one of similar form, screwed on a similar or the same stick, is called the sweeping net, and is used for sweeping grass, on which myriads of minute insects are always to be found: the weeds on the banks of rivers and canals are also excessively productive in insects, which can only be taken in this manner. In walking through meadows it will be found a good plan to hold this net in such a position that it may continually strike the projecting blades of grass.

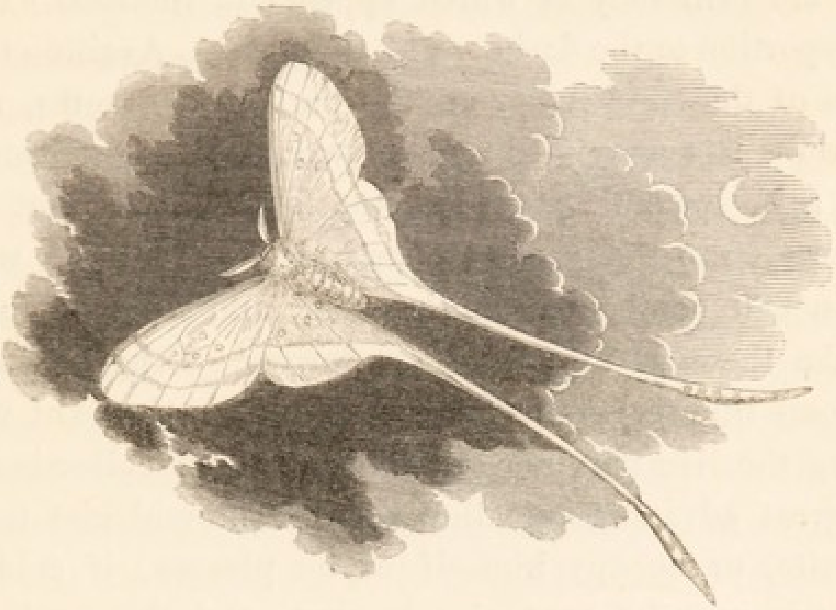


The entomologist should be provided with two wide-mouthed vials; one empty and perfectly dry, having a quill passing through the cork, and going a considerable way below it: this quill may be stopped at top by a second small cork: within the vial some blotting-paper may be kept, which not only absorbs any moisture, but serves as something to crawl on for the living insects which are taken from time to time and dropped through the quill. The other vial should be made very strongly, well corked, and three parts filled with spirit: common whisky is the best spirit; pure alcohol injures the colours of beetles, and gin makes them sticky.

A digger is another useful instrument: it is simply a piece of round iron, about fifteen inches long, bent round at one end, and furnished with a wooden handle at the other. This serves to rip the bark off dead trees, and to dig at the roots of living ones for chrysalides.

Quills cut off close to the feather are very useful for bringing home minute insects of all classes. The aperture should be most carefully corked, the corks being cut expressly for the purpose, and should be of sufficient length to go half an inch into the quill, and thus not liable to come out in the pocket.

Finally, pill-boxes, obtainable of any druggist, complete the outfit of the entomologist. There is now an excellent kind manufactured, the tops and bottoms of which never come out: it is important to get these. It is important also to avoid sitting on pill-boxes, as it must interfere with their structure: to avoid this, the author carries them in a breast pocket.



Nocturnal Moth flying by Moonlight.

## CHAPTER III.

### ON COLLECTING INSECTS.

Lepidoptera fly mostly in the night: when the air is warm and the sky serene, and the moon is lighting up the fringes of the clouds, the downy moths wing their way from the bushes and crevices where they have spent the hours of daylight, and wander in the woods and over the meadows, each bent on the task of continuing its kind, or seeking food in the nectaries of flowers. Hundreds may be seen fluttering round the blossoms of brambles, ivy, martagon lily, honeysuckle, and jasmine. But although these nocturnal wanderers delight in the moonbeams, some of them vaulting in graceful aerial dances round the tops of trees, it is not on such nights that the collector will meet with most success, for they are then beyond his reach. All night-flying moths are attracted by the light of a candle or lantern, the brilliancy of which appears to increase exactly in proportion to the darkness of the night. Availing themselves of this propensity on the part of the moths, many entomologists sally forth to the woods at night provided with a bright bull's-eye lantern, fastened in front by a leathern strap going round the waist, and armed with a clap-net to catch them on the wing, and a pair of forceps to take them when settled on flowers. Others less venturesome illuminate their rooms, and hold a levée of moths during the live-long night. This mode of collecting has the great advantage of allowing the entomologist to read or write, or occupy himself as he pleases: if cold, the windows may be kept closely shut, and the moths will knock for admittance; and, not deterred by the severe blow they receive by flying with all their might against the intervening glass, will hover about the window until it is opened to admit them. For the purpose of attracting moths a sinumbra lamp has been found the best. When a moth comes to the lamp it may readily be taken in the forceps, or in a tumbler or wine-glass: or if it fly to the ceiling and begin buzzing about, the clap-net must be used, or it will very soon injure the beautiful downy crest on its thorax, and thus render itself unfit for a cabinet specimen. When taken in the clap-net it may be transferred to a tumbler, and the tumbler inverted on the table. It is then a good plan to light a small piece of German tinder about half the size of a sixpence, and introduce it under the edge of the tumbler; the moth is almost instantly stupified by the smoke of the tinder, and may be readily taken out and pierced with a pin. In the second volume of the 'Entomological Magazine,' the Rev. C. S. Bird has given a most interesting account of his captures at

Burghfield, by means of a sinumbra lamp; and in the fifth volume of the same work, is a delightful detail of Mr. Doubleday's nocturnal entomologising, during his residence at Trenton Falls in the United States.

The berries of the yew are most attractive to moths. When these berries are thoroughly ripe, the moths will so completely gorge themselves with the luscious saccharine juice, that they make scarcely any attempt to escape when approached by the entomologist. A bull's-eye lantern is indispensable in seeking moths while thus engaged: a strong light must be thrown on the tree, and every twig carefully examined. When a moth is seen, if within reach, it may be taken with the forceps, pinned, and at once transferred to the pocket box: if beyond reach of the forceps, a bag-net on a long stick must be carefully held beneath it, and the twig on which it is settled must be gently touched with another stick held in the other hand, when it will almost invariably fall into the bag-net, whence it must be taken with the forceps, and then pinned as before: the singular instinctive propensity which many insects have to feign death when alarmed, contributes greatly to the ease with which moths are thus taken. A very pleasant account of this mode of entomologising is given by Mr. Walton in the second volume of the 'Entomological Magazine.' At Norbury Park, near Dorking, Mr. Walton captured in this way eighty moths per night, from the 10th of October to the 14th of November.

Sweets of all kinds, as honey, sugar, &c., appear to attract moths quite as well as the more natural juices of flowers and fruits. An empty sugar-hogshead is an unfailing lure: the plan is simply to place in some open situation, as a meadow, a large garden, or an open space in a wood, a sugar-hogshead which has just been emptied, and to which, of course, some small quantity of sugar still adheres. The moths do not come immediately, but in the course of two or three nights it will be visited by swarms, and its attractive power continues, particularly on moist evenings, as long as any saccharine matter remains.* If the hogshead be heated it will be still more attractive.† East India sugar-bags have been employed for the same purpose, with very great success, and on these the moths may be captured with far greater facility than on a sugar-hogshead, which from its shape is less accessible.

A plan used by the oldest collectors, and one which, as regards individual species, is perhaps the most successful of all, is to place a female moth that has recently emerged from the chrysalis, in a small wooden box with a gauze lid, and take the captive into a wood, when the males of the same species will congregate by hundreds, perfectly fearless of the propinquity of the entomologist; they will run about over his clothes and hands, and even creep into the pocket of his coat if he happen to have placed there his attractive captive. It has been ascertained that moths thus attracted have travelled miles in so short a space of time, that they must have approached in an almost direct line.

Nearly the whole of the night-flying moths may occasionally be captured in the day: they are found reposing on the north side of the trunks of trees, or park palings, in out-houses, summer-houses, sheds, &c., also in thick bushes, whence they may be beaten into the clap-net, both sticks of which must then be held in the left hand. Many moths thus disturbed from their diurnal slumber immediately take flight, and are very difficult to overtake and catch; others drop at once into the net and are quickly secured.

Some moths fly at twilight only, and of these the larger

* Mr. Doubleday in 'Entomological Magazine.' † Mr. Dale in ditto.

*Sphingides* or hawk-moths may be quoted as examples; these are particularly fond of the blossoms of the honey-suckle, and this plant, especially if in the neighbourhood of the sea-coast, will be found an excellent lure for them. The hawk-moths are very difficult to procure, and though we have a large number of occasional visitors among this tribe, few cabinets are supplied with British specimens of more than half the species; the practice of giving high prices for these beautiful moths, offers a temptation to the cupidity of dealers which it is next to impossible to resist, and in consequence hundreds of exotic specimens are annually imported, their pins exchanged, their position altered, and their claim as natives solemnly averred. Every young collector of British insects should most carefully abstain from the purchase of these expensive rarities; or if he wish to adorn his cabinet with them, he may frequently find opportunities of obtaining French, Spanish, Italian, or German specimens at a very low price, and these should be carefully ticketed with the name of the locality whence they were obtained, and kept apart from those which he knows to have been captured in Britain. Some of the species of hawk-moths fly only in the sunshine, and do not settle on flowers whilst extracting their sweets, but hover about them, thrusting their long suckers into the corollas; this mode of feeding, and their elegant appearance, has obtained for them the name of *humming-birds.* Two of the species may often be seen in the spring, hovering about the

flowers of the common bugle; these have transparent wings, and possess but a very slight resemblance to the generality of moths. Another species frequents our geraniums and jasmines at all times of the year.

Butterflies are to be met with only in the day-time: they delight in sunshine, and are particularly attracted by flowers. Some butterflies, as the purple emperor (p. 85), are fond of flying high in the air, and around the tops of the highest oak trees, seldom coming down within reach of the clap-net. The emperor generally fixes his station on the summit of a lofty oak. Mr. Haworth, in his excellent work entitled 'Lepidoptera Britannica,' observes that the emperor invariably fixes his throne on the summit of a lofty oak, from the utmost sprigs of which he performs his aerial excursions; in these he will sometimes ascend until lost to sight from his extreme height: if he meet with another emperor, the monarch of some neighbouring oak, a battle always ensues; they fly up and up, fighting by the way, and when exhausted, descend and often settle on the very sprigs whence they rose. The emperor is only to be taken in a bag-net, fixed to a rod twenty or thirty feet in length; unless he should condescend, as is sometimes the case in very dry weather, to come to the ground in order that he may enjoy its moisture. It has been observed of this and other high-flying butterflies, that a stone thrown into the air will induce them to follow it in its descent. In capturing most of our butterflies there is little difficulty: they fly slowly and languidly along our hedge-rows, and are very fond of settling on flowers and on the moist or muddy places in roads or woods; the clap-net is the only efficient instrument for securing them. Another net, of a complex structure, is sometimes used; it is composed of a stick or handle, and two parallel pieces of whalebone, which, being pushed outwards, form a hoop, and to this is attached a large muslin bag: when a butterfly is captured, this net is let off by a kind of trigger, when the pieces of whale-bone again become parallel. This weapon, like the armour worn at a lord mayor's show, is little more than a gaudy incumbrance.

The pupæ of butterflies are mostly to be found suspended in out-houses and sheds, on walls, palings, trunks of trees, &c., and those of moths are to be obtained plentifully in the winter and spring, by digging at the roots of trees and in gardens.

The caterpillars of butterflies and moths are to be found in abundance on the leaves of trees throughout the summer, and may be beaten or shaken into a clap-net and taken home in tin boxes. To rear caterpillars it is necessary to be provided with numerous square cages ; the lower part, for about a third of the height, should be of tolerably strong wood-work, and the upper part a mere frame covered with gauze. The lower part is better if lined with tin or lead, and must be filled with earth, in which many of the caterpillars will bury themselves previously to assuming the chrysalis state ; sprigs of the plants on which the caterpillars feed, should be stuck into a narrow-necked vial filled with water, and placed within the cage, and the caterpillars should be placed on the leaves. The cages must be kept in a cool, and, if possible, a moist situation. The larvæ will do as well thus artificially reared, as in a state of nature ; they will spin among the leaves, or on the sides of the cage, or hide themselves in the earth ; in nearly every instance the moths will emerge rather before than after the usual time, and will generally be more perfect and finer specimens than can be obtained in any other way. In the cages in which caterpillars are thus reared ichneumons will be constantly making their appearance, and these should be preserved with great care, and if it is known on what species of lepidopterous insect they are parasitical, the fact ought to be carefully noted, for although it may not be serviceable at the moment when noticed, it may afterwards become valuable, and serve to illustrate some important point in the natural history of insects.

Diptera, or flies and gnats, seem to be inhabitants of every place under the sun; they settle on man, horses, and cattle, to suck their blood; on all kinds of flowers to eat their pollen or extract their honey; on leaves either to sun themselves or to sip the honey-dew; on all kinds of putrefying substances, either for the sake of food or as a dwelling for their young; palings, walls, trunks of trees, blades of grass and corn, are very favorite resorts; and lastly, they seem to have made themselves perfectly at home in our houses, parading our windows, roosting on our ceilings, feasting on our sweets, and performing aerial gambols in our drawing-rooms. It seems idle to attempt to give instructions as to the finding and capturing animals of so common occurrence: the sweeping net will be found most useful for those frequenting grass, and the forceps for nearly all other situations in which they may occur.

The class Hymenoptera includes bees, wasps, sand-wasps, ants, ichneumons, and saw-flies: bees are to be taken in great abundance on sunny sandy banks in spring, and on flowers in summer and autumn; the same situations may be searched with advantage for wasps, sand-wasps, &c.: ichneumons and saw-flies will generally be found on leaves and flowers; and ants on the ground, and on herbs and shrubs. All kinds of Hymenoptera may be occasionally beaten from trees and shrubs into the clap-net, but the best instrument for this class is the forceps. There is one tribe of minute parasitical Hymenoptera called *Chalcidites*, the species of which are to be obtained by sweeping grass, &c., under oak trees, with a muslin sweeping-net;

they may also be occasionally found in company with many minute Diptera on our windows, and this situation may prove a very prolific one when an entomologist on his travels is detained by a rainy day.

Coleoptera, or beetles, are to be found every where: on the flowers, leaves, and bark of living plants; on the bark and wood of dead or dying trees; in the carcasses of dead animals; in living or putrefying Fungi; in all kinds of dung and rubbish; in flour; in corn; under stones and logs of timber; in cellars; under faggot-stacks; in earth, at the roots of trees; in sand and gravel pits; in moss; in mud; in water; and very frequently flying in the air. Beetles are captured with greater facility than any other class of insects: the best instruments are, the clap-net for holding under trees while you beat the leaves; the forceps for taking them off flowers; a digger for sand or gravel pits, and earth at the roots of trees, or for stripping the bark off a decaying trunk; and finally the water-net, which may be used with great success where there are many water-plants growing in little stagnant pools. When beetles are taken, as a general rule they may be put in a glass vial filled with weak spirits of wine, but a few which are of bright or delicate colours may be carried home alive in tin boxes, vials, quills, or pill-boxes. In the winter months moss should be brought home from the woods and shaken over a white cloth; by this process an immense number of minute beetles may be obtained.

Orthoptera are generally found in the autumn in dry meadows: there are but few species inhabiting this country, and these may be taken with the clap-net; their capture will be found troublesome, and there are so many individuals in proportion to the number of species, that entomologists have very much neglected them, thinking them scarcely worth the toil of collecting. Crickets inhabit houses, mills, and bakehouses; and the mole-cricket burrows in the loose soil of marshy commons, banks, and moist gardens. Cockroaches, like crickets, seek the habitations of men, and, as regards the larger species, are never to be found in a perfectly wild state in this country. Earwigs secrete themselves in cracks and crevices by day, and in the night devour the petals of flowers, and when they can obtain an entrance, the pulpy parts of ripe fruit.

Hemiptera are mostly found on trees and shrubs: the plant-bugs are known to every one by their very disagreeable smell; a collection of them is only to be obtained by beating into a clap-net. Three or four species inhabit the larch fir; two inhabit the juniper; one the furze; others do not appear attached to any particular species of plant, but seem to love variety: although they are furnished with wings they are rarely to be seen on the wing; they fly heavily, slowly, and a very short distance at a time. *Aphites*, blights or plant-lice, are also found on vegetables, and the singular little frog-hoppers, or cuckoo-spittle insects in the same situations. A few of the Hemiptera, as the water-measurer and water-boatman, frequent stagnant pools, canals, or the still places in running streams; the former may be seen skimming over the surface, its body and legs being armed with a velvety down, which prevents it ever becoming wet; the boatman dives under the water, occasionally coming to the surface for a supply of air; the long legs projecting from its sides have much the appearance of oars, and it uses them for the same purpose, propelling itself through the water by powerful and simultaneous strokes. These aquatic Hemiptera are only to be taken in the water-net.

Lastly, the Neuroptera are of varied manners, and have various propensities. The dragon-flies have a more powerful and rapid flight than any other insects; like swallows, they appear to be possessed of untiring wings; it is a beautiful thing to behold one of the larger species hovering over a pool with quivering wings, intently watching for prey, then to see it soar aloft, sailing backwards and forwards, round and round, until nearly lost to sight, and then to mark its descent with the rapidity of an arrow to within a yard of the surface of the pool, where it will hover as before. For such a daring fly as this no instrument but the clap-net can be used with much probability of success, and great patience on the part of the collector is requisite; pursuit would be of no avail whatever; his only chance is to wait silent and motionless: the fly will approach nearer and nearer, until every mark on his beautiful body is distinctly visible: as if attracted by curiosity he will circle slowly round the head of the hunter, at last hovering over the pool immediately before his face; now is the time for an instantaneous stroke; great activity and absolute perfection in the use of the weapon are requisite; the eye should measure the exact distance, and strike rather beyond the object; if the stroke fail, the hunter may as well abandon the pursuit, his game will be too wary to give him a second chance. There are many species of smaller slender-bodied dragon-flies, frequenting ditches and water-plants, which have a languid and feeble flight, and are taken without trouble. The May-flies or caddews, stone-flies, &c., frequent watery places, constituting the principal food of fish, and the angler would do well to study attentively their different forms and times of appearance, with a view to manufacture their likenesses; this has been in a degree attempted, and our fishing-tackle shopkeepers make up queer things to which they give the name of flies: it is said that trouts sometimes rise to these nondescripts; if this be true they must possess a much greater development of the organ of inquisitiveness than of that of alimentiveness. All fisherman's flies are to be met with towards evening, and may then be readily taken on the wing, or may be beaten during the day from bushes overhanging running streams.

The above is a brief sketch of the haunts of the more abundant orders of insects, and the modes by which they may be taken: it would be impossible, within the limits of a work like this, to record the dwellings of each species; this knowledge is to be acquired by practice and careful observation.

No portion of the study of Entomology will be found more interesting than its Geography: the authors who have given most attention to this subject are Latreille and MacLeay, but neither of these has been fortunate in laying down any rules on the subject that are likely to be of permanent utility to the collector. It must be obvious to every one who has seen a box of insects from the Brazils, Africa, New Holland, or China, how great is the variety, how large the size, how brilliant the colours of the productions of those countries, when compared with the insects of our own; and it is absolutely necessary to obtain some general knowledge of the geographical distribution of particular forms of insects, and the causes influencing those forms, before any extended views of the science can be entertained. It will be found, on inspecting a well-filled cabinet of insects, that there are many giant groups, as *Scarabæus*, *Buprestis*, &c. which possess scarcely a representative in the British islands; while other groups, such for instance as contain the death's head hawk-moth and the stag beetle, may be considered as duly represented in this country by those gigantic species: and in one tribe of insects, known by the vulgar appellation of devil's coach-horses (genus *Staphylinus*), the immediate neighbourhood of London produces, as far as we yet know, a greater number of species than the entire continents of South America and Africa. Thus the entomologist who ventures beyond our temperate islands, must not lay his plans as he would for our native insects, but must first obtain an idea of the products of the country he is about to visit, from a careful inspection of some national or other large collection. The gigantic butterflies and beetles of South America, and the huge and grotesque species of walking leaves or *Mantides*, require different treatment in their capture and preservation to that which we would bestow on our humbler tribes. The boxes wherein to collect them must be of larger dimensions, the pins must be longer and stronger, and the bottles for those which are to be brought home in spirits must be very capacious, and very wide in the mouth; and however great may be supposed the facility of obtaining the requisite stock of materials when abroad, it will be found the more prudent course to take from home every article that can be obtained there, with the exception of spirits, which, alas! are but too abundant wherever what is called civilization has begun, or wherever the white man has set his foot. The dress of the entomologist under the vertical rays of a tropical sun, must be adapted to the heat he has to bear; and every reasonable precaution should be used against the bites of poisonous snakes, gad-flies, &c.— Where the heat is intense, life is no sooner extinct in an animal than the process of putrefaction commences, and in a few hours it would become a mass of corruption: it is therefore indispensable to empty the bodies of some of the larger insects, filling the cavity with cotton wool, or some other material, soft, elastic and dry. Finally, when the entomologist is rewarded with abundant success, his care must not cease; for the ants and white ants which abound in the tropics, will penetrate his store-houses and lay waste their contents. To guard as far as possible against such a termination to his labours and his hopes, he must have an abundant supply of camphor and spirits of turpentine, and must enclose his boxes in a tin case, so carefully fitted that the most minute insect will fail to find an entrance.

The entomologist visiting foreign countries cannot be too particular in recording the exact locality of each capture; and in reference to this important subject, the author begs to be allowed to quote the following excellent observations by Mr. Doubleday, from the 2nd volume of the 'Entomological Magazine.'

"Perhaps there is no branch of Entomology more worthy of attention than the geographical distribution of insects; yet this is totally disregarded by almost every entomologist. He who carefully excludes from his collection of British insects every doubtful species, arranges in his exotic cabinet species after species, genus after genus, without once thinking of indicating the part of the world whence they have been obtained; or, if he does note this, it is in so general a manner that little is to be learnt from it,—a line of one of six different colours, which serve to indicate Europe, Asia, New Holland, Africa, and North and South America, being thought abundantly sufficient.

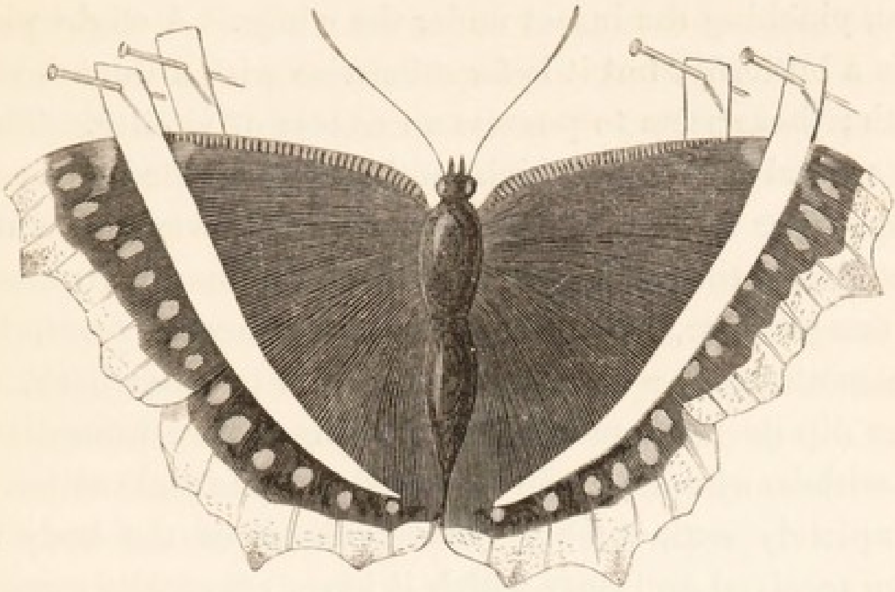
"In Dejean's 'Catalogue des Coléoptères' we certainly find the native country of each species pointed out rather more clearly; but sometimes, even there, we are left to guess as to what part of a region, extending over 50° of latitude, and as many of longitude, and offering, at its two extremities, a difference of 30° Fahr. of temperature, is the principal station of an insect. Besides this deficiency in exactness, there is an omission of still more consequence: —no notice is taken of the range over which a species extends.

"From this want of care and accuracy in pointing out that country which is the principal station of a species, and the extent of its range over other countries, arise difficulties which overwhelm us in our attempts to arrive at anything like a correct view of the geography of insects; and which, joined to our limited knowledge of extra-European species, forbid our speaking with confidence on any part of this subject. It has been well and truly observed with regard to plants, by an illustrious traveller [the Baron Humboldt], that it is impossible to enter fully into their geography, unless we are thoroughly acquainted with the distinctions, the characters and the names of each species.—'Ne tamen obliviscare, quemadmodum Physiologia animalium sine Anatome esse non potest, neque Geologia sine Oryctognosia, eodem modo te Geographiam Plantarum penitùs inspicere non posse, nisi Botanicæ innitens, singularum specierum notas, characteres, nomina accuratissimè dignoscas."

Much has been written by entomologists on the subject of weather, but unless we are to imagine the collector totally devoid of sense, we shall scarcely suppose he will choose wet or windy days for the pursuit of insects on the wing. He will find it of much more importance to take a hint or two as to the time of day: early in the morning insects will be found in abundance on the foliage of trees, and they are then generally in a heavy or drowsy state, which allows of their being readily beaten into the clap-net: if the weather prove warm after 9 o'clock they will be actively running or flying, or perhaps settled on flowers; in either case the difficulty of capturing them is increased. Butterflies are on the wing from sunrise to noon, and from 2 o'clock till sunset; then they become drowsy and fly more languidly, settling repeatedly, and apparently seeking roosting-places for the night.

As to seasons for insects, little can be done in the way of laying down general rules. In Britain butterflies are abundant in May, August, and September; moths in

May, June, and October; caterpillars in May, June, and September: collectors often speak of the spring beating and autumnal beating for caterpillars. Entomologists will soon find that particular insects are attached to particular flowers: who has not seen the honey-bee revelling on a bank of thyme? or the peacock butterfly perched on our commonest thistle, closing his beautiful wings, and exhibiting only their sable surface?



Camberwell Beauty Butterfly, with card braces, showing the mode in which a Butterfly should be set.

## CHAPTER IV.

### OF KILLING, SETTING, ARRANGING AND NAMING INSECTS.

ALTHOUGH the author is fully satisfied that insects have not the acute sense of pain possessed by ourselves and warm-blooded animals, yet he wishes to impress on the collector of insects, that it is unjustifiable to subject any animal to even the possibility of suffering for our own gratification. Therefore let us resolve to adhere to two rules; *first*, to destroy no more specimens than are really requisite; *secondly*, to kill them in the most certain and expeditious manner: under any circumstances, the reflection that we have done this will be agreeable.

Butterflies and moths require to be pinned immediately on being taken; the pin is passed through the very centre of the mesothorax,* or that part to which the wings are attached, the finger and thumb of the left hand, at the same time, pinching the insect under the wings. A slight pinch kills a butterfly, but it is far otherwise with a thick-bodied moth; these seem to possess an excess of vitality. There are several modes by which moths may be killed, but some of these are not at all times convenient; however, it will be best to give them all, and then the reader may avail himself of one or other, according to circumstances. *First*, take the moth by the wings, held together over its back, and then dip its body suddenly in boiling water; immediately on withdrawing it, it will be found that life and motion are completely extinct; but the downiness of the body will have received an injury which it never effectually recovers. *Secondly*, fix a piece of thin cork firmly at the bottom of a gallipot; then, having pinned the moth, as before described, through the mesothorax, stick the pin in the cork, and invert the gallipot in a basin of boiling water: the steam produces death almost instantly, and does not injure the plumage of the moth. *Thirdly*, having pinned the moth, take its body between the finger and thumb of the left hand, then withdraw the pin, and having previously prepared a sharp-pointed piece of quill or wood, dip it in prussic acid or a strong solution of oxalic acid, and introduce it into the aperture made by the pin; death follows almost instantly. A *fourth* mode of killing moths as well as other insects, has been recorded by Mr. Stephens, in the second volume of the 'Entomological Magazine;' it is as follows:—"take three or four juicy leaves (the younger the better, with, if a more powerful effect is required, a small portion of the tip of the stalk) of the common laurel; break or cut them into

* These anatomical terms will be fully explained in the following book, entitled 'Physiology of Insects.'

small pieces, and crush them quickly between two stones, in a thin piece of paper; screw up the produce in the latter, with as little exposure to the air as can be avoided, and fix the mass by a pin in a corner of the collecting-box, in which the living insects are to be previously placed; keep the box closely shut, and in about five minutes every specimen will have expired. It is necessary that the external air should be excluded, otherwise the fumes of prussic acid which are evolved from the crushed leaves, will become too much attenuated to affect the respiratory organs of the insects, and the latter will partially revive if too speedily exposed to the vivifying influence of a purer atmosphere. I have tried the experiment rather extensively upon insects of various families; *Bombi* and *Helophili* die very rapidly, in less than two minutes, and without any struggling, as is the case when heat &c. is applied; and moths, in a state of repose, expire without a single previous motion: consequently the process I have recommended is most admirably adapted for killing the larger Lepidoptera almost immediately upon their capture, and thus fine specimens may be conveyed home uninjured. I yesterday killed a gigantic spider in less than half a minute; and a specimen of *Helops cæruleus*, with one or two fresh-captured *Philonthi*, at liberty in the box, were also dead when it was opened. I therefore strongly recommend the above process to the notice of the practical entomologist, as being, from its convenience, better adapted for general application than any hitherto proposed."

Diptera and Hymenoptera are generally best carried home alive in pill-boxes, vials, or quills, as recommended in the previous chapter; the same also with very minute moths: Coleoptera of almost every kind may be safely immersed in the vial of spirits: Orthoptera and Hemiptera, if large, may be pinned; if small, put in pill-boxes: dragon-flies require to be pinned. Diptera and Hymenoptera should, when sufficiently large, be pinned, like the Lepidoptera, through the centre of the mesothorax; Coleoptera, through the right wing-case; Orthoptera, through the prothorax; and Hemiptera, through the mesothorax, generally in this class a triangular plate: dragon-flies should be pinned in the centre between the four wings.

All insects taken home alive in pill-boxes may be killed thus. Open the lids of the boxes a very little way, just so as to admit the passage of air, but not the exit of the insect; then make a pile of the boxes, thus partially opened, on a piece of soft leather placed on a table; invert a pint basin over the boxes; burn one or two matches under the basin. If the basin and boxes are placed close to the edge of the table, the facility of burning a match under the basin is increased. The basin should be pressed down, and the leather precludes the ingress of fresh air and the egress of the sulphur-smoke; if the boxes are examined in a few minutes, the insects will be found perfectly dead. But it must be borne in mind that the fumes of sulphur have different effects on different colours; yellow and red retain their brightness when submitted to it, or even acquire additional lustre, but blues and greens, on the contrary, are frequently totally destroyed.

All kinds of insects are killed instantaneously by immersion in boiling water; and with the exception of Diptera and Lepidoptera, none are materially injured by the process. The minute insects brought home in quills may be readily killed by immersing the quill in hot water, at the same time holding the cork between the finger and thumb. The beetles brought home in spirits should be subjected to this process, first, as a cleansing and purifying operation; secondly, because the spirit appears only to stupify and deprive them of motion, so that without this second killing they generally revive. All insects killed in water should be very carefully spread on blotting paper; those large enough for pinning should be then selected, and left until thoroughly dried; those which are so small as to be injured by a pin should be removed to a sheet of pasteboard; each should be floated on a drop of water, and the water withdrawn by a camels' hair brush. The legs and wings usually spread out neatly of themselves, but if they do not, a little assistance from the brush will accomplish it; the board should then be carefully put away, and the insects will dry in the position in which they were left, but are so slightly attached to the board that a touch of the pencil will remove them.

A number of very small pieces of card should next be prepared; they should be triangular, with one angle very acute; a pin should be passed through each, near the base; then with a fine brush touch the acute point of the card with clean transparent gum-water, and again moistening the brush take up one of the insects and place it on the gum, to which it will instantly adhere. All minute Hymenoptera may be mounted in this way. The wings of minute Diptera are more difficult to deal with, being of a softer texture. As few of these should be mounted as possible, and great care should be exercised in the operation; the rest of the Diptera should be pinned. The minute insects brought home alive in the vial may be instantly killed by immersing the vial in hot water, after which they may be mounted at any future opportunity, when more time can be spared for the operation: each vial should be labelled with the date and place, when and where taken; and thus a winter's amusement may be provided.

In setting, *i. e.* arranging the legs and wings of those insects sufficiently large to require pinning, there are two modes: the first is to place the wings horizontally, the second is to bend them so as to touch the drawer; the first is the continental, the second the English plan. In setting insects with expanded wings, a piece of stiff card, pinned through with a stout pin, supports the wings from below; another similar piece is placed on the wings above; the two pieces holding the wing immovably fixed, (see the figure at the head of this chapter): the legs are held in their places by a bent pin. In Lepidoptera, Diptera, Hymenoptera, some Orthoptera, and in Neuroptera, the wings are thus spread, but not in Coleoptera. In Coleoptera the habit would generally be totally destroyed by opening and spreading out the wings: insects of this class, and also generally those of the class Hemiptera, are set with the wings and wing-cases quietly folded in the usual position on their backs; the legs and antennæ, however, are carefully placed, and arranged by means of the bent pins. The bent pins are reduced to this more convenient shape by means of an instrument somewhat resembling a pair of pliers; it was invented by Mr. George Waring, of Bristol, and is now very commonly employed by entomologists: the old plan was, to fasten a foot in its place by a small card brace.

For all the operations of preserving insects, nicely corked setting-boards, about a foot square, should be prepared, and on these all the insects should remain until perfectly dry and stiff; after which, if kept in a warm room, there is little danger of their receiving any injury. These setting-boards should slide into a case, one above another, to the number of six or seven: the sides of this case should be made of mahogany, but the back and front must be covered with wire-gauze, or some other material equally adapted for the free passage of air; a matter of very great importance, for if insects are placed in a cabinet before they are thoroughly dried, they speedily become disfigured with mould, and are moreover much more liable to the attacks of minute *Acari* &c., which much disfigure and often totally destroy them.

The value of a collection of insects is of course very much enhanced by exhibiting them in all their states; this, however, is but little attended to. A few of our larger Lepidopterous larvæ have been preserved in spirits, but this plan obviously precludes the simultaneous exhibition of the larva and imago. Various other plans of preserving caterpillars have been tried; the following, recorded by Mr. Fennel in the 'Entomological Magazine,' appears the best.

If the caterpillar be hairy or spiny, enlarge the posterior orifice, and from thence endeavour, by gentle pressure performed with a smooth instrument, to squeeze out as much of the contents of the inside as possible: and while thus operating let the subject be laid on a sheet of blotting-paper, that the moisture exuded being imbibed, may be prevented from wetting and spoiling the hairs and spines.—This done, insert frequently fresh pieces of dry blotting-paper rolled round the end of a smooth piece of stick, and continue to do so until the dryness of the paper, when retracted, indicates that no moisture remains within. Let the skin be now distended into its proper shape, by means of a stuffing of down or other soft material, taking the precaution to guard against the attacks of destructive insects, by enclosing within a small quantity of camphor, cayenne pepper and red oxide of lead. In preserving hairless caterpillars, care must be taken that their colours be not removed by a too rough application of the absorbing instrument. The chrysalis of Lepidopterous insects is very readily preserved; it requires to be left until thoroughly hardened; then vitality destroyed by immersion in boiling water; and when dried, it is fit for the cabinet. The majority of Lepidoptera spin something like silk before they change into a chrysalis; this is usually called a cocoon, and the shape in which it is formed, its texture, its degree of compactness, and finally, its situation, whether on palings and trunks of trees, amid the leaves of trees, or among leaves fallen to the ground, often afford the characters by which entomologists have distinguished one group from another, and can never fail to excite our admiration at the immense diversity exhibited in the mode in which the continuation of each species is infallibly provided for.

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*Cabinets.*—A well-made cabinet is of the greatest importance, and is not to be obtained without some difficulty: every cabinet-maker will at once take your order, but what is called tradesman-like acumen will prevent his doing you justice. Many parts of the cabinet are not visible from the exterior, and it is almost impossible to persuade a tradesman to use good and seasoned wood for those parts which are not exposed to sight; it is therefore absolutely necessary to inspect the work while in progress, to examine the wood, and ascertain that it is thoroughly seasoned; if the wood retains any sap it is of no use, as it invariably warps and thus prevents the drawers from moving, and the cabinet becomes useless. Nothing but the best mahogany must be used; a great variety of wood has been tried, particularly a kind of resinous cedar, which has a colour and grain much resembling mahogany, but which is far worse for cabinets than the most resinous deal; after the cabinet has been a short time built, it will become saturated with resin, and all the insects it contains will be speedily spoiled. Other cheap woods are also much in use, and are veneered in front with mahogany, and the parts which are exposed on taking out a drawer are smeared over with a brownish composition to keep up the deception.

A cabinet should consist of two tiers of drawers, fifteen or twenty in each tier: if the number be fifteen only, there is abundance of room for a book-case to stand above them, which is not only convenient, but has an agreeable effect. The drawers should be enclosed in front by two folding doors, all the edges of which must be carefully covered with velvet; by this precaution dust is effectually excluded. Each drawer should be from fifteen to eighteen inches square, and two or two and a half inches deep ; the smaller size is sufficient for British insects, the larger for tropical or extra-European. Each drawer should be covered with thin slices of very soft cork ; these slices are glued together at the edges, and fastened to the bottom of the drawer by small tacks and glue, the tacks, or rather brads, being without heads. When the cork is secured its surface must be made perfectly smooth by rubbing it with pumice-stone, and the whole is then neatly covered with white paper, the paper being pasted on the cork. It will be found that the cork admits the pin on which an insect is placed, to pass into it with the greatest facility, and yet is sufficiently elastic to retain it steadily in its place. The sides of the drawers must be double, leaving a vacant space for powdered camphor, a substance that serves to preserve all specimens of Natural History from the attacks of moths, mites, &c., which would otherwise find their way in, and cause rapid devastation. The drawer is covered by a pane of the best flatted glass, carefully fixed with putty in a square frame, and the frame is nicely fitted to the drawer, thus ensuring the exclusion of any dust that may have passed the folding doors.

Before placing insects in a cabinet, it is usual to rule the paper at the bottom of the drawers with ink or pencil lines, thus providing for the arrangement of the insects in parallel columns, of a width varied in proportion to the size of the insects. In the first edition of the 'Grammar of Entomology,' the author recommended this plan, but he has subsequently found it a matter of convenience to omit the lines altogether; he thinks the drawers are neater without them, and moreover, on occasionally re-arranging a collection, and, as it increases, this is absolutely necessary, the lines of a former ruling require to be obliterated and others introduced, a task which occasions great trouble and loss of time.

Mr. Stephens has, with great labour and assiduity, compiled 'A Systematic Catalogue of British Insects,' including all the species which have been ascertained to be natives of this country; this catalogue is almost universally employed for the arrangement of British insects, and will be found very useful to the young entomologist, who must however be cautioned against using or noticing names which have no reference to a description attached to them, as such names will never be adopted by scientific men; those names only have a claim on our notice, under which insects or other animals have been actually described and published: and it is very doubtful whether any names be really admissible until descriptions of the individuals to which they refer have been published in Latin, which is considered peculiarly the language of science. Mr. Stephens has published a synopsis of his Catalogue in a smaller form, and printed on one side only, so that the names may be cut out and used for labelling cabinets. This plan saves much trouble, and gives a neat and finished appearance to a cabinet; each name is a distinct label, and should be pinned in the drawer, the generic name, printed in capital letters, being placed at the head of the genus, and the specific names in small letters below the species. Attached to the name is the initial or part of the name of the author who gave it; thus SPHINX, L., or SPHINX, Lin., signifies that Linneus gave the name of *Sphinx*.

Lepidoptera should be placed with extended wings, following each other in a line of three, four or more, if a variable species; the upper specimens should be males, the lower females. Diptera, Hymenoptera, and Neuroptera should be arranged in the same way. Coleoptera should be placed in rows, three abreast; the upper three males, the lower three females. All these should have closed wings, as the under wings are not at present employed for any scientific purpose, neither do they in any way add to the beauty or neatness of a collection. Orthoptera should be placed three males and three females abreast, as the Coleoptera, and then a single open-winged specimen below them: the same plan should be adopted with the Hemiptera.

Preserved insects should be kept perfectly dry. They are subject to three very annoying casualties, which it must be the constant study of the entomologist to counteract; these are destruction by mites, &c., mouldiness, and greasiness. Destruction by mites, the larvæ of Dermestites, Ptinites, and Tineites, is very much avoided by attending to three rules: put every specimen into the drawers perfectly dry; never leave the glass off; and keep a good supply of camphor always in the drawer. Either of these depredators makes its presence instantly known by an appearance of dust below the specimen attacked. The best way on discovering this, is to take out the insect, and if a beetle, to dip it instantly in boiling water; then, after thoroughly drying it, return it to its place. If any other insect, baking in a moderately hot oven will be found an effectual cure.

Mouldiness is completely remedied in beetles by immersion in boiling water, and after brushing them with a camel's hair pencil, drying them thoroughly, and returning them to their places; in other insects, spirits of wine carefully applied with a camel's hair pencil effects a cure.

Greasiness is a constant cause of trouble with insects, particularly moths. Commencing in the body, it gradually spreads until the whole moth looks as though it had been dipped in oil; from the insects the oil runs down on the drawer below it, soiling the paper, and spoiling the appearance of the collection. No preventive to this is known, but a greasy insect may be restored by immersing it in naphtha, or essential oil of petroleum, and allowing the oil to evaporate before the insect is returned to its place.

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*Of Entomological Books.*—As the author intends this for an introductory work on Entomology, and has done his best to make it as complete as he was able, it would be but a poor compliment to his readers, after giving them so much trouble, were he to tell them of the necessity of buying other introductions. Works descriptive of species, will, however, be found highly essential, and the author will give a list of all the British ones with which he is acquainted, and such foreign ones as he considers to be peculiarly useful; he will arrange the books in the same order in which insects are classified at page 76.

Lepidoptera.—1. British Lepidoptera ('Lepidoptera Britannica'), by Adrian Hardy Haworth, 1803, *et seq.*, being published in four parts. One volume, pp. 586, without plates. This work is written in Latin; it contains concise and accurate descriptions of the British Lepidoptera, known at the time the author wrote. 2. 'Illustrations of British Entomology,' Part Haustellata, by James Francis Stephens. Four volumes, with numerous plates. This work is written in English; it contains descriptions of all the known British Lepidoptera. 3. 'Conspectus of Butterflies and Moths,' by James Rennie. One volume, no plates. This work is written in English, and contains descriptions of nearly all the British Lepidoptera.

Diptera.—'Systematic Description of the European Two-winged Insects,' by J. W. Meigen. In six volumes, with numerous plates. A short Latin description of each insect is given; the remainder of the work is in German. Nearly all the British species are described.

Hymenoptera.—1. Natural History of Ants, and a collection of Memoirs and Observations on Bees, by P. A. Latreille, in one volume. This work is written in French. It contains descriptions of all the Ants (or nearly so) inhabiting this country. 2. 'An Essay on the Indigenous Fossorial Hymenoptera; comprising a description of all the British Species of Sand-wasps,' by W. E. Shuckard. 3. 'Systema Piezatorum,' by J. C. Fabricius. One volume, written in Latin. Since this work was published, much knowledge has been gained concerning the insects which it describes. 4. Monograph of the Bees of England ('Monographia Apum Angliæ'), by William Kirby, in two volumes, with plates. This work is written in Latin, and is one of the most perfect entomological works any country has yet produced. Modern discoveries have, however, added some facts concerning identity of species. 5. 'Essay on Parasitic Hymenoptera,' by A. H. Haliday, published in the Entomological Magazine. 6. Monograph of Chalcidites ('Monographia Chalciditum'), by Francis Walker, published in the Entomological Magazine, vol. i. pp. 12, 115, 367, 455; vol. ii. pp. 148, 286, 340, and concluded as a separate work: this most laborious monograph contains descriptions of every British species. 7. Article 'Insecta,' by William Elford Leach, published in the Edinburgh Encyclopædia, vol. ix. p. 142. Three British genera and species described. 8. European Ichneumonology, ('Ichneumonologia Europæa'), by J. L. C. Gravenhorst, three volumes, written in Latin. An excellent and most laborious work. 9. Monograph of the Tenthredoes ('Monographia Tenthredinetarum'), by Le Pelletier de Saint-Fargeau, one small volume, written in Latin. Most of the British species are very clearly described in this work. It may here be observed, that we have no general work on Hymenoptera.

Coleoptera. — 1. British Entomology, ('Entomologia Britannica'), vol. i., Coleoptera, by Thomas Marsham, (written in Latin), one volume, without plates; a most invaluable book, on account of the neatness and scientific accuracy of the specific descriptions. 2. 'Illustrations of British Entomology,' Part Mandibulata; written in English, with a short Latin specific description of each species. Five volumes, with numerous plates. This work contains descriptions of all the known British Coleoptera. 3. 'Manual of British Beetles,' by J. F. Stephens, one volume, containing short descriptions of all the British species. 4. 'British Coleoptera Delineated,' consisting of figures of all the genera of British Beetles, drawn in outline by W. Spry, edited by W. E. Shuckard. One species of each genius is figured and described.

Orthoptera.—'Illustrations of British Entomology,' Part Mandibulata, written in English, with a short Latin description of each species. This work contains descriptions of all our British species.

Hemiptera.—There is no work containing arranged descriptions of the British species.

Neuroptera.—1. 'Illustrations of British Entomology,' Part Mandibulata; written in English, with a short Latin description of each species. This work contains descriptions of all our British species. 2. Memoir on the Larva of Nemoura, by F. J. Pictet, published in the Annals of the Natural Sciences, vol. xxvi. p. 369; and of Perla, vol. xxviii. p. 44. Both these memoirs are written in French. 3. 'Description of some Nondescript Species of May-flies of Anglers,' by John Curtis, published in the London and Edinburgh Philosophical Magazine, vol. iv. 4. Researches into the History and Anatomy of the Phryganites, ('Recherches pour servir à l'Histoire et à l'Anatomie des Phryganides'), by François Jules Pictet; one volume, 20 plates: a work of very great research and extraordinary merit. 5. Monograph of the European Dragon-flies, ('Monographia Libellularum Europæarum'), by P. L. Vander Linden, 42 pages, without plates. This little work is written in Latin, and is very complete and excellent of its kind. 6. Entomological Hours, ('Horæ Entomologicæ'), by Toussaint de Charpentier, one vol. 4to., with plates. In this work the species of the genus Libellula are accurately described in Latin. 7. 'Synonymy of the Perlites, together with brief descriptions of the old, and of a few new species,' by Edward Newman, published in vol. iii. of the Magazine of Natural History.

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*Of Investigating Insects.*—Having pointed out the best mode by which a collection may be made, and the books which will be most useful in naming it, it remains that we add a few words on the application of objects to descriptions, and descriptions to objects.

Character in insects is the variation in the mode or measure of development of any integral portion of either system of organs. Those characters are the best which are founded on such portions of a system of organs as are most readily observed; the organs of support afford these. It would be a work of insuperable difficulty had we to examine the interior of an insect to decide its species. All animals have a tendency to vary in those parts of the body which are the most remote from the centre: the extremities in quadrupeds, or in birds, afford us the best characters on this ground. Take a lobster, a prawn, a shrimp, and a crayfish; spread them on a setting board, you will find the extreme points, the tail, toes and antennæ, display the differences: so, in insects, take the extremities. The extremities of an insect are the wings, the tarsi, the head; and these afford abundant characters. First, take the most obvious parts, the parts most easily observed; then consult the more concealed parts, as the mouth; but even in the mouth try the palpi before the jaw or the lip from which they rise.

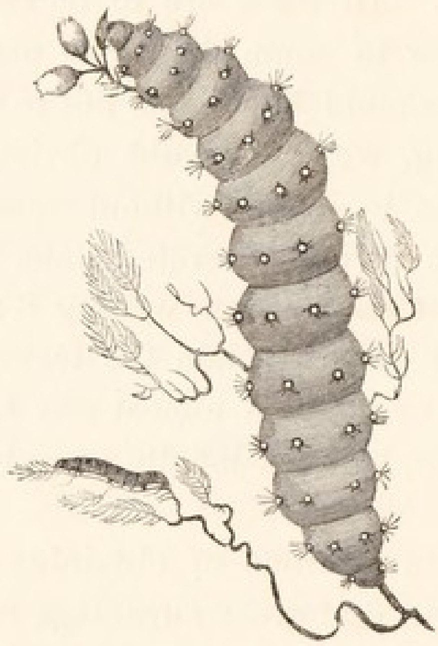
In investigating insects, a good glass is a matter of great importance; and here I cannot resist the pleasure it will give me most heartily to recommend Messrs. Bentley and Chant, of King's Head Court, St. Martin's-le-Grand. Being themselves good entomologists, they know exactly what entomologists require, and take every pains to supply it.

The knowledge of the principal orders of insects is very soon acquired; many we have known from our childhood upwards, as *butterflies* (*Papilionites*,) or *crickets* (*Achetites*). It is the safest plan to begin with large well-known groups first; the knowledge of a few of these leads us to desire an acquaintance with the rest.

After the orders are pretty well known, the study of species must be begun; for it is a remarkable fact, which the author cannot explain, that classes, orders and species, are much more readily ascertained, and much more obvious to the casual observer, than the intermediate divisions of stirpes, families and genera. It may also be observed, that in general, even with scientific investigators, there is less doubt as to the limits of classes, orders and species, than those of the other divisions. Genera are the most difficult groups to make out; they depend almost entirely on artificial characters, and their limits have never been agreed on by any two of the numerous writers on entomology.

Most descriptions are written in Latin, or a language intended for Latin; many words used are peculiar to Entomology, and these the author will endeavour to explain in the following pages; other words are purely English, with what is supposed to be a Latin termination added. Examples of this:—*setaceous* is latinized *setaceus; gross* is *grossus; expansion* is *expansio; rudimental* is *rudimentalis; petiolate* is *petiolatus; brown* is *brunneus; grey* is *griseus; bronze* is *bronzeus; anterior* is *anterior*. Many Latin words are altered to make opposites; *marginatus* signifies having a margin; and to describe an object that has no margin, the word *immarginatus* is made; words or names are often latinized by the simple addition of *us* or *um*. All these are to be considered errors; but we must bow in some degree to usage by adopting errors. Still we should be careful not to enlarge the list; and in describing, we must avoid obvious incongruities, and not describe in Latin without some knowledge of that language in its unadulterated state. Reading Latin is a very different matter from writing it; and the author has endeavoured so to explain the technical terms, that the reader may understand almost any Latin description he may meet with, by occasionally consulting a Latin dictionary.

Those who are desirous of obtaining a knowledge of foreign insects will find great advantage from studying the collection in the British Museum; and it is with great pleasure the author bears witness, not only to the readiness of the officers of that establishment to afford every facility to those who are desirous of consulting the collections with a scientific object, but to the rapid progress which is now making in the Entomological department, of which he is competent to form a more correct opinion than of either of the others: this change is in great measure attributable to the zeal, industry and ability of Mr. Adam White, a junior officer. It is however but justice to observe that a similar spirit of improvement is obvious in the other branches of Natural History, and that the entire establishment is rapidly becoming an honour to the country in which we live.



THE

# GRAMMAR

OF

# ENTOMOLOGY.

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## BOOK III.

### PHYSIOLOGY OR ANATOMY OF INSECTS.

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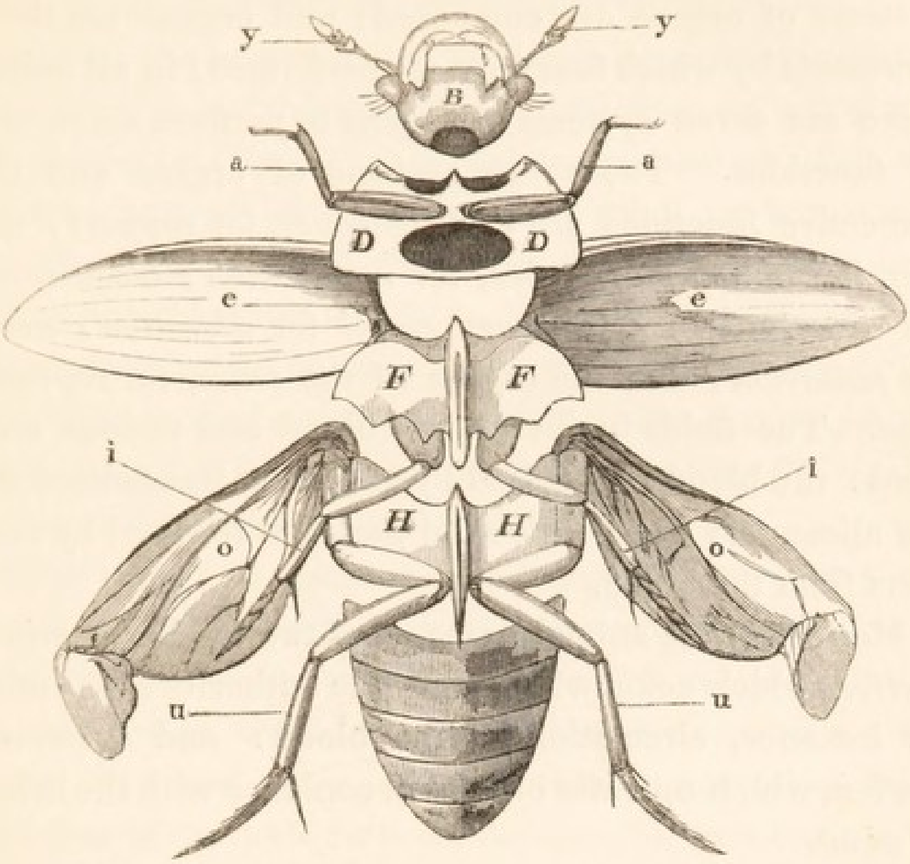
To trace in Nature's most minute design
The signature and stamp of power divine;
Contrivance intricate expressed with ease,
Where unassisted sight no beauty sees;
The shapely limb, the lubricated joint,
Within the small dimensions of a point,
Muscle and nerve miraculously spun,—
HIS mighty work, who speaks, and it is done.

COWPER.




Skeleton of a large Water Beetle, as seen from below. *B*, the head. *D D*, the prothorax. *F F*, the mesothorax. *H H*, the metathorax. a a, fore legs. e e, fore wings. ii, middle legs. o o, hind wings. u u, hind legs. y, antennæ.

# CHAPTER I.

## OF THE ORGANS OF SUPPORT, OR SKELETON.

The Physiology of Insects is the account of how they are made: there are in every animal four essential elements,—*matter*, *motion*, *sensation*, and *mind*.

Matter is inert—it does not move by its own powers; it is tangible— the touch ascertains that it resists: matter in animals has various degrees of consistency; convenience, however, has suggested its division into solid and fluid.

Matter, chiefly in its solid form, is the element of which the systems of organs are composed; and organs are the instruments by which functions are performed: in all animals there are seven systems of organs to perform seven series of functions. The seven systems of organs and their respective functions are these:—*bones*, for *support*; *muscles*, for *motion*; *air-tubes*, for *respiration*; *blood-vessels*, for *circulation*; *alimentary canal* for *digestion*; *nerves*, for *sensation*; and the organs of the *sexes*, for *reproduction*. The fluids in insects are blood and various secretions: the blood is supplied by nutriment transmitted from the alimentary canal: the solid parts are renewed by secretions from the blood.

Motion, in the animal frame, is of two kinds; *dominant motion*, which acknowledges not the authority of the mind; for instance, circulation of the blood: and *subservient motion*, which operates only in accordance with the behests of mind.

Sensation is the ultimate power of matter so perfected as to take cognizance of facts beyond the limits of the body: sensation is of two kinds; that derived from external objects, which appears the aim of animal life, and conduces to its maintenance, and that which conveys information from matter to mind, and behest from mind to matter.

Mind is the commanding element; the other elements in acting obey it, but in existence and characters are independent of it: no powers of mind can prevent the existence, or change the characters of matter, motion, or sensation: mind argues, then commands; it takes cognizance of causes, and provides for consequent effects, before the other elements can obey its behests. The great powers of mind are speculation and retention: speculation is the power which supposes an event that has not yet occurred;

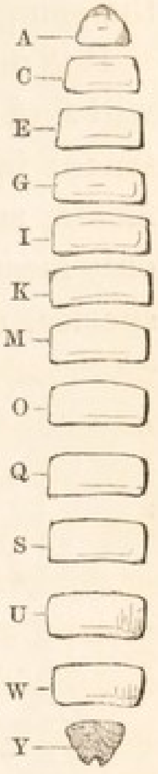
and retention is the power of preserving an image left on the mind by an event that has occurred. Of the connexion of mind with the organs which it commands we know nothing; mind itself is only known by its effects: its commands are carried by the nerves; a fact ascertained by separating a nerve; after which separation, the mind no longer controls the parts to which that nerve extended its branches.

The physiology of insects is, however, properly confined to the description of their systems of organs, and to the functions which these organs perform: therefore, excepting as connected with the organs, no further notice will be taken of any other element than matter.

With regard to the anatomical nomenclature employed in the following pages, it will be, perhaps, advisable to make one or two observations. The author has studiously guarded against the admission of those terms which are of recent date, and seem invented without any other object than that of caprice: in every instance he goes back to the earliest name of which the meaning is clearly defined: he has invented no name except for parts which he found totally nameless. The authorities for the nomenclature of the external or osseous parts of insects, are Fabricius, Savigny, Audouin, and Straus-Durckheim. The labours of Fabricius and Savigny have been noticed with tolerable accuracy in Kirby and Spence's 'Introduction to Entomology'; those of Audouin with more skill by Mr. MacLeay, in the 'Zoological Journal'; and those of Straus by Mr. Doubleday, in the 'Entomological Magazine.' The author of this work has attempted to build a uniform anatomical nomenclature on his own observations, seeking amid these learned authors for the prior name given to each part: a portion of the result was published in the 'Entomological Magazine' under the title of Osteology of Insects, but the subject not being adapted to the taste of the Entomologists of this country, it was abandoned. The terms now used are in accordance with those employed in the essay in question.

The chapter terminating the history of insects, and treating of their transformations, may perhaps be more strictly applicable to the present branch of the subject; but the author trusts that those graver and more scientific pages will serve, in some measure, to explain the changes previously described, and lead the enquiring mind to seek further information on the highly interesting subject of insect physiology. In the chapter in question it has been explained that insects, instead of an internal framework of bones supporting the softer parts, have their external skin or covering indurated, incrassated, ossified, invested with powers possessed by a skeleton or framework of bones, and fulfilling the very offices for which such a framework is designed, namely, supporting the softer parts, and affording points of attachment for the muscles. This indurated skin envelopes the animal in the manner of a suit of armour, enclosing and protecting from injury those parts which are softer and more immediately connected with vitality: in its composition this skeleton possesses more or less of the elements found in the bones of vertebrated animals.

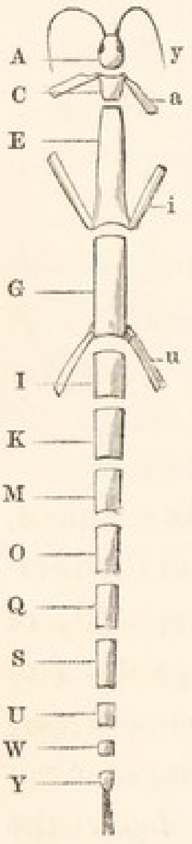
In order to admit of perfect freedom in the performance of those numerous acts in which an insect's life is passed, it is essential that this bony covering should be possessed of the power of turning to the right or left, upwards or downwards; otherwise constant difficulty must occur. To accomplish this, the body, which is very long in proportion to its breadth, is divided into thirteen segments, the interstices between these being filled up by a softer and more flexible portion of the same skin. This division of the body into segments is exhibited very clearly in the earlier stages of an insect's life, and we see it much more distinctly in a larva than in a perfect insect; and here it will be proper to observe, that the skin or covering which has subsequently to become so corneous and solid that the term *skin* seems almost theoretical, is generally in larvæ, thin, soft and flexible, in an equal degree with that of animals possessing the more obvious support of an internal skeleton. The figure in the margin is intended to show the segments in the larva of a large beetle, each separated from its neighbours in order that the division may be more clearly exemplified. In the caterpillar of the emperor moth, at page 130, the same segmental division is equally manifest, with the exception that the segments are there represented united, as in a state of nature. The caterpillar of the spurge hawk-moth, at page 90, is another exemplification of the same structure, the divisions being less manifest, but still to be traced; the thirteenth segment, or that posterior to the horn, being the only one not distinctly defined. See also the larva of the cricket, at page 73; of the sexton beetle, at page 53; of the bee, at page 40, &c. In examining larvæ, the young entomologist should pay particular attention to certain prehensile appendages erroneously called *legs*, and more correctly *false legs:* the absence, presence, number and situation of these, has been so correctly observed by entomological writers, that the genus of a moth or saw-fly may frequently be correctly given by a careful inspection of its larva. In the figure of the privet hawk-moth, at page 82, these false legs alone are used to hold it to the twig on which it is standing, the six real legs being unemployed: this is the usual and natural position of the insect when at rest: when eating



Elater.

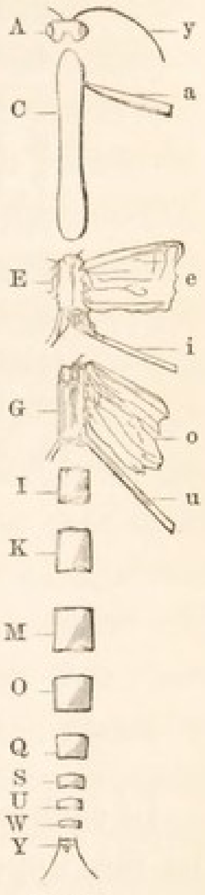
or crawling the six true legs are brought into action, clasping or embracing the twig, as shown in the figure of the spurge hawk-moth caterpillar, at page 90.

It is not, however, in caterpillars that the entomologist will find this division into segments of the greatest importance: in the perfect insect the modification of these segments, and the appendages which they bear, supplies the only means by which groups of insects, and even individual species, can be distinguished from each other. The most simple form of a perfect insect will best exhibit the existence of these segments. In the giant *Phasma*, or *walking stick* as it has been termed, — a large and singular insect, inhabiting Brazil and other hot climates,—the division into segments is not only more obvious, but from the entire absence of wings more satisfactorily defined than in any insect inhabiting this country; the author has therefore selected it to show the thirteen segments in what may be termed their most simple form. In this, as in the preceding figure, each segment is separated from its neighbours, and it will be observed that the 1st, 2nd, 3rd, and 4th, bear, each of them, an appendage on each side, a, i, u, y, making four pairs of appendages; those on the first segment are antennæ; the remainder are legs. These animals crawl on the ground or on trees, feeding on leaves, &c., and so much resemble dried sticks or living twigs, as to deceive the birds, which would otherwise prey on them.



Phasma.

Very similar in form and appearance to *Phasma* is another large and very singular group of insects, called *Mantis* or *walking leaves*, and these are usually provided with wings or additional appendages attached to the third and fourth segments, e, o, and thus we have before us all the organs of locomotion possessed by insects. Although so nearly resembling *Phasma* in appearance, the species of *Mantis* are totally different from them in mode of life; feeding on living insects, and displaying great savageness and cruelty of disposition, fighting each other with the most determined courage and ferocity, and using their fore legs, which are peculiarly constructed for the purpose, as weapons of offence: this employment of the fore legs renders it essential that they should possess greater muscular power than those of the quiet *Phasma*, and if we compare the size of the second segment in these two insects, we can scarcely fail being struck with the difference which they exhibit.



Mantis.

By examining the *Mantis* it will be seen that the posterior edge of each segment after the fourth, protrudes over the anterior edge of the following segment, thus the alternation of flexible and inflexible portions of the skin allows not merely a free motion to the right or left, upwards or downwards, but of increase or decrease in length, at the pleasure of the insect: contraction is performed by the segments being drawn one within another, and elongation by extending and separating the rings: this action, which is very observable in the bodies of the wasp or honey bee, is represented by the sliding of the tubes of a telescope.

The names of the thirteen segments of insects, and the limbs which they bear, are as follow; and in the figures which the author has drawn to illustrate the subject, similar references are invariably used, a plan which will be found to save much trouble, as all confusion is thus avoided.

| | | |
|---|---|---|
| 1. | Caput or head | A—*B* |
| 2. | Prothorax | C—*D* |
| 3. | Mesothorax | E—*F* |
| 4. | Metathorax | G—*H* |
| 5. | Propodeon | I—*J* |
| 6. | Podeon | K—*L* |
| 7. | Metapodeon | M—*N* |
| 8. | Octoon | O—*P* |
| 9. | Ennaton | Q—*R* |
| 10. | Decaton | S—*T* |
| 11. | Protelum | U—*V* |
| 12. | Paratelum | W—*X* |
| 13. | Telum | Y—*Z* |

| | |
|---|---|
| Propedes or fore legs | a |
| Proalæ or fore wings | e |
| Mesopedes or middle legs | i |
| Metalæ or hind wings | o |
| Metapedes or hind legs | u |
| Antennæ | y |

In each of the segments the Roman capital letter refers to the upper surface, and the *Italic* letter to the lower. With the exception of the first the segments have no English names, the Latin ones are therefore universally employed, and this is preferable to burthening the mind with two names for the same part.

The first segment is the *head;* it consists of a skull in which are situated two feelers or *antennæ*, two eyes and a mouth, and frequently three additional eyes or *ocelli*. The use of eyes and mouth are too obvious to require comment, but that of the feelers is not fully known; it is very certain that in the majority of insects they are organs of touch, but in some large tribes, for instance the moths, we never see them used for such a purpose, and yet their very perfect organization in this tribe would lead us to believe that they answer some important purpose in the life of the animal. The only rational suggestion on the subject is, that in addition to the sense of touch, they are either endowed with another sense of which we are ignorant, or with the sense of smell; the latter is rendered more probable from their situation between the eyes and mouth, and almost close to the latter: this in vertebrate animals may be considered the usual site of the nostrils. Professor Rennie considered the antennæ to be the organs of hearing, and called them ears without hesitation; his theory has been embraced by two subsequent writers, a Mr. Clarke, of Birmingham,* and Mr. Newport, of London,† but these writers have not adduced any fact either in the structure of antennæ, or the mode of using them, that at all bears out this view of the subject. It is very certain that their general office is that of tactors, and if we seek to add other powers we should be careful to ascertain that their structure is adapted to the office we wish to assign them, for each organ is found by anatomists to be admirably fitted for the functions it has to perform, and the form and solidity of the antennæ precludes the possibility of their conveying sound.

The second segment is the *prothorax;* it is very large in the common cockchafer, and indeed in all beetles, and in this class appears to receive the head as in an excavation or cup: in a locust or cricket it is equally large, but in a butterfly, fly, or bee, it is narrow, and scarcely perceptible: in bees, and most Hymenopterous insects, considerable doubt has been expressed by entomologists as to its extent, and much discussion has taken place on the question, which however is of interest only to those who wish

* 'Magazine of Natural History,' New Series, Vol. ii. p. 472.

† 'Transactions of the Entomological Society of London,' Vol. II., p. 229.

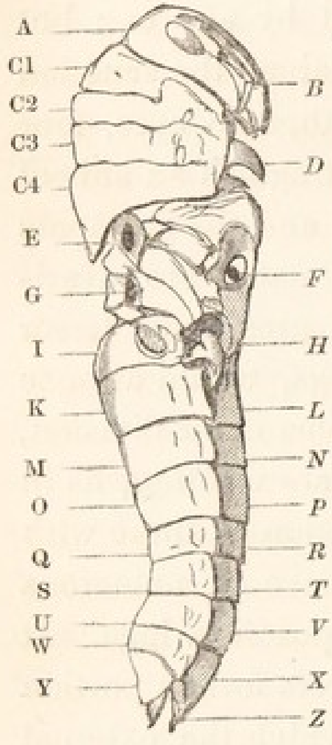
scientifically to investigate the subject, and is very unimportant in acquiring a general knowledge of the structure of insects. The *prothorax* bears a pair of legs, which are called fore legs or *propedes;* they are attached to its inferior surface, and are so articulated to the prothorax as to possess the most perfect freedom in all their movements. The articulation also of the head and prothorax is one which permits the head to move with freedom in every direction.

The third segment is the *mesothorax;* it is that large and prominent part so conspicuous in butterflies, bees, and flies: in beetles and the locust it is comparatively a narrow segment, and is so articulated with the *prothorax* as to allow that segment less freedom of motion than is possessed by the head, yet in beetles it moves with very great facility compared with that possessed by the following segments. The *mesothorax* bears two wings, one of which is attached to each side of it; these are called fore wings, *proalæ:* and two legs attached to its inferior surface; these are called middle legs, *mesopedes*, and have equal freedom with those of the *prothorax*.

The fourth segment is called the *metathorax;* it is small in butterflies, flies, bees, the hornet and the *Sphex*, but large in beetles and the locust; it is very rarely so conspicuous in any insect as the *prothorax* in beetles and the locust, or the *mesothorax* in the hornet or *Sphex*. The *metathorax* bears two wings; one of these is attached to each side; these are called the hind wings, *metalæ:* and two legs attached to its inferior surface; these are called the hind legs, *metapedes*.

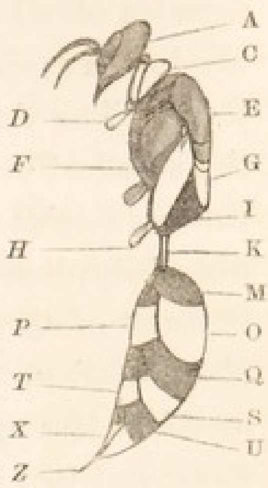
The order of these four segments, and the names and position of the limbs which they bear,—the antennæ, wings, and legs,—should be thoroughly impressed on the memory; notwithstanding the immense variety and confusion which prevails in anatomical nomenclature, there is no entomologist of moderate information but would at once understand the nomenclature here employed, for other names have seldom been adopted by any one but their inventor, and thus have never obtained the sanction of usage. The possession of one mouth, two eyes, four wings, and six legs, will at all times distinguish an animal as being properly and strictly an insect; and the segments on which these parts are respectively situated are invariably the same. The possession of a greater or lesser number of antennæ, mouths, wings or legs, would at once indicate that an animal belonged to some other division, except in a few instances where wings are wanting, as in some species of *Phasma*, and the connexion of these with insects is clearly proved by the occurrence of numerous closely allied species which invariably possess wings. It may not be amiss here to repeat that insects form a portion of a larger group of animals, to all of which the external skeleton is a character in common.

The fifth segment is the *propodeon;* it is generally of less size than either of the three preceding segments, and is frequently so closely united to the *metathorax* as to be distinguished from it only by a sutural line. The *propodeon* and following segments never bear limbs of any kind, whether wings or legs. Here it must be observed that the 2nd, 3rd, 4th, and 5th segments, are so closely united in Hymenopterous insects, that it is a matter of some difficulty to trace their divisions. In the locust, which is acknowledged by all entomologists to belong to the same class as the *Phasma* and *Mantis*, the third and fourth segments, instead of being distinct and separate as in those insects, are become as it were mixed, and their limits undefined, and were we unassisted by the presence of wings and legs, it would be next to impossible to determine the commencement or termination of either of these segments. The space intervening between the *prothorax*, C—*D*, and the *podeon*, K—*L*, is so intersected with lines, and so complicated in its structure, that it seems almost impossible to apply to it any nomenclature of parts that shall correspond with that used either for Coleoptera or Hymenoptera. It fortunately happens that the nomenclature of these parts is not particularly essential in descriptions of the locusts, the form of the *prothorax* being taken as a better guide to the discrimination of genera and species. To return to the *propodeon*, we find that this and the following segments never bear organs of locomotion of either kind. The *propodeon* of the *Phasma* and *Mantis* is a distinct, perfect segment, but in the locust it appears to possess a dorsal or upper surface only; the under surface of the *podeon*, *L*, apparently uniting with the under surface of the *metathorax*, *H*. The *propodeon* appears more essentially connected with the preceding than following segment, for if a locust which has long been preserved in a cabinet, and has become dry and brittle, be broken in two, the *propodeon* will rather remain with the anterior than the posterior half, the fracture usually taking place at the line between I and K.



Locust.

The sixth segment, *podeon* or *peduncle*, is usually much smaller than either of the preceding, although not materially so in the insects which have been chosen as illustrations; in the locust particularly it is a large and robust segment, exceeding in size the *propodeon* as well as the segments which succeed it. In many tribes, as the *Sphex*, it is so exceedingly slender and thread-like, that the insect is divided into two large incrassated masses, vulgarly known by the name of *thorax* and *abdomen :* the upper or thoracical mass is composed of the four segments already described, the alternate ones being shaded in the figure in order more distinctly to show the limits of each. From this appearance the terms *entomos*, *insectum*, *insecte*, *insect*, &c., have arisen. The *Sphex* figured in the margin, the *Ichneumon* at page 8, the breeze fly at page 25, the common wasp, honey-bee, butterfly, house fly, and multitudes of other insects, are familiar illustrations of this insected appearance, and may be aptly designated *pedunculated* insects. In all these instances the *podeon* is so articulated to the *propodeon* as to possess great freedom of motion; in beetles, the *Phasma*, *Mantis*, locust, &c., in which it is not materially less than the *propodeon*, it possesses on the contrary, but little power of motion.



Sphex.

The abdominal segments, forming the second incrassated mass, possess few characters of interest comparable to that of those which precede. The seventh segment, or *metapodeon*, in pedunculated insects is very small at its union with the *podeon*, and very large at its union with the following segment; in other insects it is of uniform size. The eighth segment, *octoon*, in the pedunculated insects is the largest segment, with the exception of the *mesothorax;* in some of the wasps, and the smaller *Ichneumones*, it is larger than the whole of the five following segments, which are not unfrequently concealed within it. The ninth segment, *ennaton*, tenth segment, *decaton*, and eleventh segment, *protelum*, gradually decrease in size, and are frequently retractile, each within the one preceding it. The twelfth segment, *paratelum*, is still smaller: in the females of all bees, wasps, and other stinging insects, it is the last segment, the *telum* not being present in its usual form. The thirteenth, *telum* or last segment, is usually the smallest of them all; it is often conical and pointed: in the females of bees, wasps, &c., it is wanting, and its place supplied by a sting.

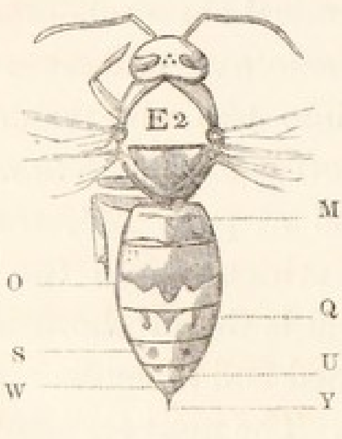
Each of these segments has an upper or dorsal surface, also called *notum* or *scutum*—the former is the more common but less appropriate term,—an under surface or *sternum*, and two lateral surfaces or *pleura;* these parts, like the legs, take their names from the segment to which they belong, and those segments only which bear the legs are usually examined for distinctive characters: the *prothorax* has a *pronotum*, *prosternum*, and two *propleura:* the *mesothorax* has a *mesonotum*, *mesosternum*, and two *mesopleura:* and the *metathorax* has a *metanotum*, *metasternum*, and two *metapleura:* the *propodeon* has only a dorsal surface in Hymenoptera, Coleoptera, and Orthoptera, and therefore the simple term *propodeon* always designates the upper surface, and no more particular description can be needed.

The *notum* and *sternum* are usually much more prominent than the *pleura;* they are also of much more solid substance, so that in the contraction of the body incident on emptiness, and on drying after death, these harder portions, especially of the abdominal segments, remain extended and prominent, while the lesser and softer portions constituting the *pleura* shrink and become invisible; indeed if we look at the abdominal segments of a wasp or a *Sphex* (see the fig. at page 145), we shall find the dorsal and sternal portions completely wrapping round the insect, and these portions alone possess any characters by which we can distinguish insects from each other in our technical descriptions.

The *notum* or dorsal portion of each segment is occasionally transversely divided by sutural lines or indentations into four smaller portions or sections, and in the *pro- meso-* and *metathorax* it is convenient to suppose all of these sections present, although no division is distinctly discernable: the sections are called *præscutum*, *scutum*, *scutellum*, and *postscutellum;* and entomologists agree in calling a certain part the *scutum* of the *mesothorax* in Hymenoptera, and another part the *scutellum* of the *mesothorax* in Coleoptera, without being able to trace in all instances the existence of the other three component sections. In the locust, as will be seen by a reference to the figure, page 144, the *prothorax* is very distinctly divided into four sections; C 1 is the *præscutum*, and immediately adjoins the head; C 2 the *scutum;* C 3 the *scutellum ;* and C 4 the *postscutullem*, adjoining the *mesothorax;* and this order of nomenclature is preserved throughout the other segments, the *præscutum* being invariably nearest the head, and the *postscutellum* farthest from the head. In beetles there is rarely any trace of sectional division in the *prothorax;* the dorsal portion would therefore be correctly described as the *pronotum*, but the term *prothorax* is frequently used and is universally understood, which after all is the great object to be aimed at in anatomical nomenclature.

In Hymenoptera the *pronotum*, *mesonotum*, and *metanotum*, are commonly each divided into two observable parts, and these may be termed the *scutum* and *scutellum* of each segment: in the *Sphex*, figured at page 145, the unshaded segment C is divided very evidently into two; the anterior part resembles a neck, and is the prothoracic *scutum*, the posterior part more elevated and immediately behind it, is the prothoracic *scutellum*. The next segment is shaded, E—*F*, and the divided structure of this segment is equally visible, the anterior portion being the mesothoracic *scutum*, the posterior the mesothoracic *scutellum*. The next segment G—*H*, left unshaded, may from its singular figure seem to possess somewhat arbitrary limits, but the presence of the hind wing in its usual place, and the hind leg at H, prove that the site of the segment is correctly marked, and its limits can scarcely be otherwise than those indicated; in this instance the anterior division or metathoracic *scutum* is much the smaller plate, and the posterior or metathoracic *scutellum* is the larger section. The fifth segment, I, is said by some writers to be merely a section of the fourth, but there appears no ground for this supposition, and its intervention between the *metathorax* and *podeon*, together with its displaying a dorsal surface only, as we have seen is the case with the *propodeon* of the locust, are sufficient to prove the propriety of considering it distinct. If it be asked why each of the other segments composing the thoracic mass is divided, and this entire—it may be replied that each of the others bears at least two limbs, and this is entirely without them; and it may be laid down as a rule, scarcely liable to exception, that the presence of legs or wings causes a more complicated structure in the segment which bears them.

The sections of the thoracic segments in a *Sphex*, although they may be said to be *really* identical with those of hornets, wasps, bees, and other pedunculated insects, yet undergo so great a change in form and situation that it is necessary further to explain them. If we take a hornet, and so place it as to look directly on its back, we shall observe a large convex triangular plate, E 2, the base of which extends from wing to



Hornet.

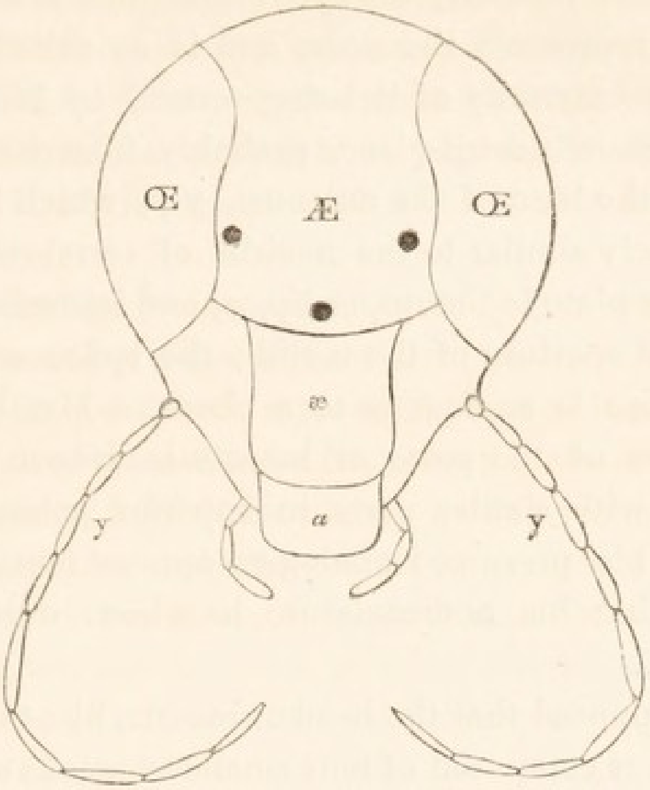
wing, and its apex reaches the head; this is the mesothoracic *scutum*, and the plate immediately behind it is the mesothoracic *scutellum;* behind this are the metathoracic *scutum* and *scutellum*, and still beyond these, and hidden in the bend of the body, the single plate of the *propodeon;* the letters will give the names of the abdominal segments, the sting being the terminal segment or *telum*. On each side, in front of the mesothoracic *scutum*, will be seen a somewhat triangular piece: concerning the true character of these much has been written, but it is the opinion of the best insect anatomists that these plates correspond with the *scutum* of the *prothorax*, shown in a more distinct and decided manner in the *Sphex*, (see page 145), and as we trace the changed appearance of this part in some other orders of Hymenoptera, we shall find it becoming perfectly distinct in the genera *Sirex* and *Cephus*, and united to the *mesothorax* by an articulation, possessing as great freedom of motion as that of the *prothorax* in beetles and locusts. Immediately at the base of each fore wing in the hornet, is a small tubercular plate, which is usually called the *tegula*.

In beetles, the structure is very simple as regards those parts, the variations in which are employed by authors as distinguishing characters. In the figure of *Hydrophilus piceus*,—a large water beetle, placed at the head of this chapter,—the skeleton is divided into five parts, exhibiting the inferior or sternal portion of the insect; *B* is the under side of the head; *D D* the sternal surface of the *prothorax*, properly described as the *prosternum; F F* is the *sternum* of the *mesothorax*,—this is properly described as the *mesosternum;* and *H H* is the sternum of the *metathorax*, and is properly described as the *metasternum*. Nothing can possibly be more simple, or more readily impressed on the memory, than this nomenclature. It not unfrequently happens that these parts, namely the *pro-meso-* and *metasternum*, are again intersected by lines dividing them into two or four plates: if two only, the plate nearest the head is termed the *sternum*, the other the *sternellum ;* if four, they have been named the *præsternum*, *sternum*, *sternellum*, and *poststernellum :* the prefixes *pro*, *meso*, and *meta*, signifying *anterior*, *middle*, and *posterior*, may be united to the terms indicating the sections of the segments, as well as to the segments themselves, thus we may write "the *metasternellum* of *Hydrophilus piceus* terminates in an acute elongate spine," instead of saying "the posterior portion of the *sternum* of the *metathorax* of *Hydrophilus* &c.," the construction of the word will at once carry the eye of the entomologist to the part intended.

Straus-Durckheim, in his laborious work on the anatomy of the common cockchafer, has assigned names to every plate into which their segments are divided; his descriptions are excellent, but the names, like those employed by Kirby, are too fanciful for adoption, and thus his magnificent work, however entertaining in the abstract, is unavailable for purposes of definition. He calls the *prothorax* the *corselet*, the *mesothorax* the *prothorax*, and the *metathorax* he allows to retain its proper name. "The *mesothorax*," according to Straus, "is composed of fourteen parts, besides several smaller ones connected with the *elytra ;* the lower surface of the *mesothorax* is occupied by the *mesosternum*, [*F F*], which, in many beetles, is so closely united to the *metasternum*, as not to leave the least trace of a suture: its form is similar to that of the *prosternum*, offering a central part and two *alæ*, with an internal *apophysis*. On each side of the *mesothorax* is a tetragonal plate composed of two parts, the first of which, the first *ilium*, is united below to the *alæ* of the *mesoster-*

*num*, and above to a membranous space, in which the *elytra* are fixed. The second *ilium* is united to the first by its anterior margin; its inferior margin closes laterally the opening of the *mesosternum*, which receives the *coxæ* of the second pair of legs; behind it is united by a membrane to the *metathorax*, and above, to the same membranous space as the first *ilium*. At the point of union between the first and second *ilium* is a short *apophysis*, formed by a fold of their margins, to which is articulated the *coxa*. Superiorly this fold is prolonged, and continued with the anterior margin of the first *ilium*, sending forth two *apophyses;* one is directed inward, forward and downward, serving for an attachment to many muscles; the other is shorter, horizontal, and serves as the point of articulation to the *elytra*. The *metathorax* is formed of eighteen parts, ten of which have their analogies in the *mesothorax;* its under surface is occupied by a *sternum* of larger size than that of the *mesothorax*, but in other respects resembling it: its *alæ* are rhomboidal, and extend from the *mesothorax* to the *coxæ* of the last pair of legs, to which they are united by a squamous articulation. The lateral angle of these wings presents a small *apophysis*, on which are articulated, on one hand, the *coxæ* of the *metapedes*, and, on the other, the second *ischium*. On the medial line of the *sternum* rises a stout vertical plate, terminated by three long *apophyses*. On each side of the *mesothorax* are two parts analogous to the *ilia*, but differently formed; these are the *ischia:* the second *ischium* is a flat semioval plate, placed above the wing of the *metasternum*, occupying its entire width, and united to it by a squamose articulation. Its upper margin is united to the first *ischium*, which is of a very irregular form, presenting behind a quadrangular external part, placed on a level with the second *ischium*, to which it is united by its inferior margin; posteriorly it borders on the hinder *coxa;* above it partly covers the membranous band of the first segment of the abdomen."

The upper surface of a beetle is extremely simple: first we see the head, then the *pronotum,* usually described as the *prothorax;* behind this are the *proalæ,* fore wings or *elytra,* quietly folded on the back, and completely covering the hind wings; between the *elytra,* at their base and adjoining the *prothorax,* we see a triangular plate, which is the *mesoscutellum* or *scutellum* of the *mesothorax;* this is invariably described as the *scutellum* of beetles: the pin in the vignette below is pointing to the unusually large *scutellum* of *Macraspis.*



Head of Ripipteryx. Æ, epicranium. Œ Œ, eyes. æ, clypeus. *a*, labrum. y y, antennæ.

# CHAPTER II.

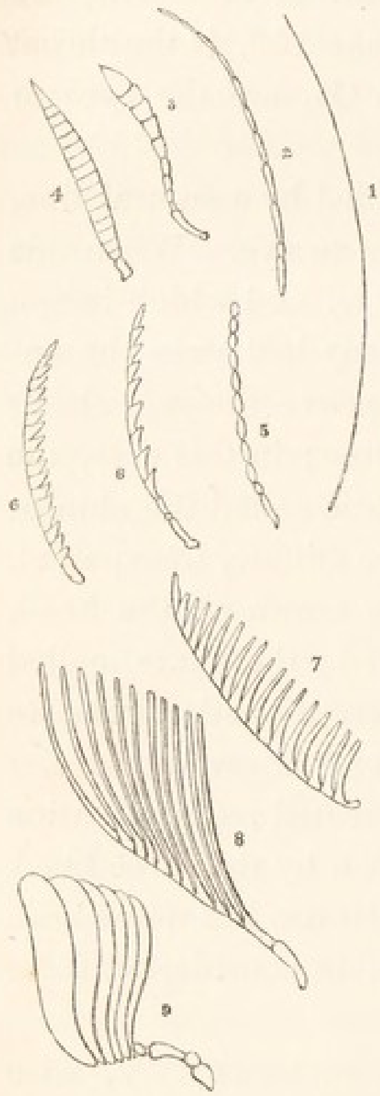
## ON THE HEAD, LEGS AND WINGS OF INSECTS.

Having described the shell, frame, or skeleton of an insect, and its division into segments, we must next give our attention to those parts which, though strictly portions of the skeleton, may be conveniently treated as its appendages, and we will examine these in the order in which they occur, beginning with those of the first segment. Previously however to describing the appendages of the head, it may be useful to take a cursory view of the head itself. Looking at the above figure, we shall observe it possesses a considerable similarity to the skull of some quadrupeds; the arched top may be considered to represent the crown of the head; the space in front, Æ, the forehead; the lateral spaces, Œ Œ, the eyes: the plate below the forehead, æ, represents the nose, and is so called by Kirby, the lower extremity of it being termed by Mr. Kirby the *rhinarium* or nostril-piece, probably from its frequently covering the base of the antennæ, y y, which in situation are precisely similar to the nostrils of vertebrate animals: below this plate is the upper lip, *a*, and immediately under this is the aperture of the mouth, the space on each side of the nose is analogous to a cheek. Mr. Kirby's nomenclature of the parts of insects is drawn from these analogies with similar parts in superior animals, but so many of his presumed analogies appear fanciful or far-fetched, that his nomenclature has been universally rejected.

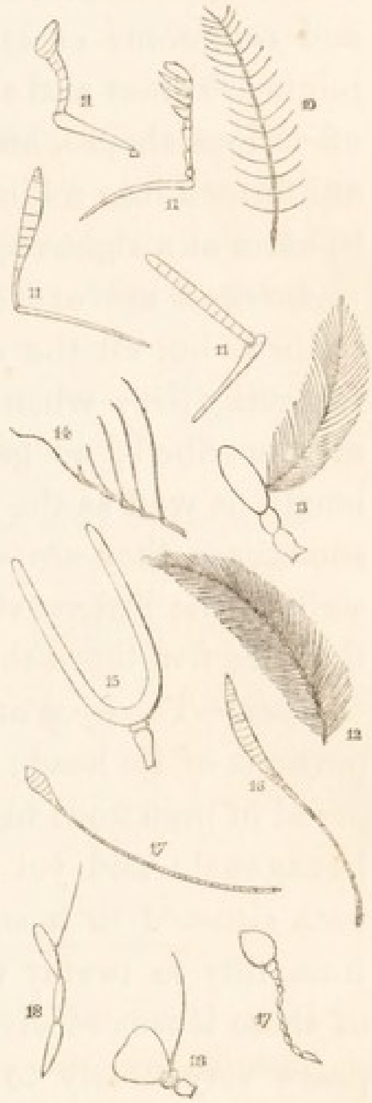
It is supposed that the head of insects, like the following segments, is composed of four smaller portions or sections; in this instance, however, they are not merely distinguished by sutural lines, but perfectly separated and freely articulated: these are the skull or *cranium*, the upper and lower lips—*labrum* and *labium*, the feeler-jaws or *maxillæ*, and the jaws or mandibles, *mandibulæ:* the lips, jaws, and feeler-jaws, constitute the mouth of an insect. If we were to assign to these parts names in accordance with those of the *pro- meso-* and *metathorax*, we should call the jaws the *præscutum*, the feeler-jaws the *scutum*, the lips the *scutellum*, and the skull the *postscutellum*. Some writers have suggested that the divisions of the head are of equal importance with the following segments, and allowing three or sometimes four segments for the head, have increased the total number to fifteen or sixteen. Each section of the head has a tendency to produce two feelers: on the last—the mandibles—they are obsolete; on the skull, lips, and feeler-jaws, they are very distinct: in the lobster and other animals resembling it, which are closely related to insects, the mandibles are furnished with distinct feelers. The skull consists of four portions; the superior arched upper surface, A, is the crown, *epicranium* or *vertex*, the inferior surface, *B*, in the figure at page 153, is the throat or *gula*, and the lateral surface, Œ Œ, are the eyes or *oculi*.

The *epicranium* is frequently divided by a sutural line, passing across the forehead from eye to eye. When this is the case, the portion so separated, æ, and which immediately covers the mouth, and in many instances the antennæ also, is called the shield or *clypeus ;* the *gula* also is often separated by a similar sutural line; in this case, the anterior portion adjoining the mouth is called the chin or *mentum*. There are one, two, or three minute, transparent, highly convex lenses situated on the crown of the head, into which they are closely soldered; these are called simple eyes or *ocelli :* all insects, except beetles, seem to possess them more or less perfectly, and in several species even of beetles *ocelli* have been detected ; the situation and comparative size of these is shown by the three black spots in the skull of *Ripipteryx ;* their use has never been ascertained, but entomologists agree in considering them organs of vision.

*Antennæ.*—The cranial feelers or *antennæ*, y y, arise from the skull in front of the *ocelli*, between the eyes, sometimes above and sometimes below the *clypeus ;* they are freely articulated with the skull, and moveable in every direction; they are composed of numerous joints. In length, stoutness, shape and clothing, the *antennæ* of insects are very various; their variations are the subject of nomenclature; and, moreover, afford excellent characters for descriptions. *Antennæ* are called setaceous (fig. 1), *attenuantes*, when they are long, throughout slender, and yet taper gradually to the apex, and the union of the joints takes place without any marked indentation or protuberance: filiform or *filiformes* (fig. 2), when stouter and shorter, and preserving throughout a uniform substance: incrassated or *accrescentes* (fig. 3), when resembling the last, excepting that they gradually increase in substance towards the apex: fusiform or *fusiformes* (fig. 4), when stoutest at the middle and tapering very gradually to each end: moniliform or *moniliformes* (fig. 5), differing from the filiform in one character only; each separate joint is oval or globose, and the portion connecting it with the next joint is very slender; the joints thus resembling beads on a string: serrated or *serratæ* (fig. 6), having each joint produced on one side at the apex, so that together they resemble the teeth of a saw: pectinate or *pectiniformes* (fig. 7), in which the joints are still more produced, or rather, are furnished on one side with slender processes, resembling, in some degree, the teeth of a comb: flabellate or *flabelliformes* (fig. 8), having the processes of the joints still longer, very thin, and, when at rest, lying flat on each other, like the folds of a fan; the antennæ of some insects are flabellate throughout, others have only the apical portion flabellate: in the latter case they are termed lamellate or *lamellatæ* (fig. 9); this form is not uncommon, the whole of the Linnean genus *Scarabæus*, possessing this structure, and thence being now



universally termed Lamellicorns or *Lamellicornes;* this form of antennæ is subject to great variation, and the variations afford excellent characters for distinguishing the genera into which the Linnean *Scarabæi* are now divided: ciliate or *fimbriatæ* (fig. 10), in primitive structure, are setaceous; but each joint is furnished on each side with a single hair: elbowed, kneed, or broken, technically *fractæ* (fig. 11), have one joint, usually the second from the base, very long, and the remaining joints attached to it at a right angle: pilose or *pilosæ,* when covered entirely with a soft down: setose or *setosæ* (fig. 12), when furnished throughout with irregular, harsh, bristly hair: plumose or *plumosæ* (fig. 13), when setigerous, but furnished with long downy hairs, which give them the appearance of a feather: ramose or *ramosæ* (fig. 14), when of setaceous or moniliform structure, but having several joints near the base produced into long branches, sometimes nearly equalling the antenna itself in length: bifurcate or *bifurcæ* (fig. 15), when composed of three joints, of which the apical one is very long, bent double, and attached at its centre to the second joint: clavate or *clavigeræ* (fig. 16), when terminating in a gradual club, the shaft being generally long, slender, and filiform: capitate or *capitatæ* (fig. 17), in which the knob is more abrupt, and strongly marked; the knob is some-

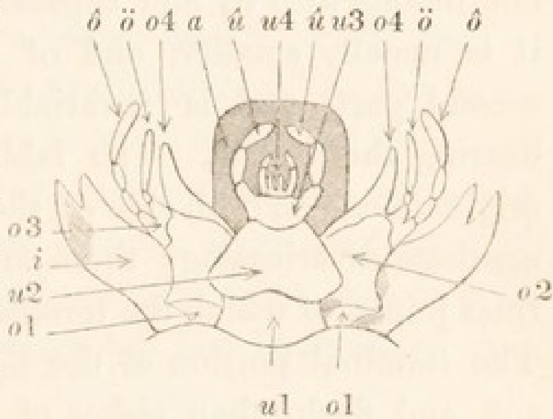


times solid, sometimes consisting of a single joint, sometimes composed of many joints: perfoliate or *perforatæ*, in which a portion of each joint is dilated and flattened, and the remaining portion being cylindrical and slender, appears like a thread on which the dilated portions are strung: and setigerous or *setigeræ*, (fig. 18), in which the basal joints are stout and short, the third being much the largest, of various shapes, and having the remaining joints, which are formed into a kind of bristle, attached on one side of it, often at a right angle.

*Antennæ* are of various kinds besides those here described, but all the common forms may be found in the foregoing list: when other forms occur, their peculiarities are described; no general name is applied to them. The length as well as the structure of *antennæ* is very various; sometimes they are so short as to be concealed from the sight in the little cavities in which they stand; sometimes they are five times the length of the body.

*Eyes.*—The eyes of an insect commonly form the lateral portions of its head; they are two in number, and are composed of numerous highly convex lenses; these lenses are hexagonal; and yet not fitting closely to each other, but each situated in a square. The number of lenses varies from fifty to twenty thousand in a single eye. Every one of these lenses receives the image of an object, and appears very nearly to correspond in properties with the crystalline lens of the human eye, so that a butterfly may, without exaggeration, be said to possess forty thousand eyes. Many of our commonest insects have each of the eyes divided horizontally by a line, which is sometimes obviously elevated, thus giving them the appearance of being double; in such instances the insect appears to have four eyes: the lenses in the upper division are larger than those in the lower; the object of this structure is to enable the insect to see objects immediately below it with the small or more convex lenses, and objects at a greater distance with the upper or larger ones: this wonderful provision is one of those numberless instances of design which render the anatomy of insects of such surpassing interest. Petiolated eyes are those which are placed at the end of distinct stalks, which are situated one on each side of the head: this is a very rare and remarkable character in the eyes of insects; it occurs in a peculiar genus of flies called *Diopsis*. The form of eyes is very various; the variations are expressed by the usual descriptive terms of shape, as round, oblong, kidney-shaped, &c.

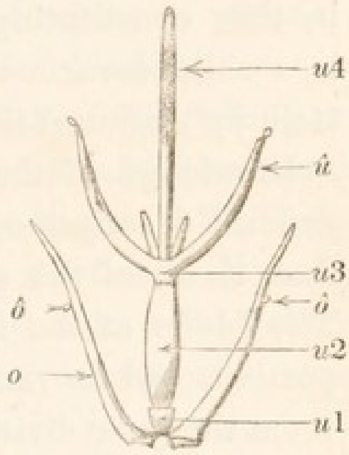
*Mouth.*—The mouth of an insect is situated below the head, and generally projects slightly forwards. It consists of an upper and lower lip, two mandibles, two feeler-jaws, and a tongue. The upper lip or *labrum*, *a*, shaded in the figure, corresponds closely with the same organ in vertebrate animals: it is a solid, horny plate, which arises from beneath the *clypeus* and projects beyond it: it is articulated at its junction with the head, moving freely in a vertical direction, and closing the mouth above: its appearance is more uniform than that of any other organ of the mouth. The uvula or *hypopharynx* is a valve attached to the interior surface of the upper lip; its office is to close the throat. The *hypopharynx* is not to be discovered in the generality of insects; it is, however, particularly prominent in some kinds of wild bees. The throat or *pharynx* is the opening immediately below the *hypopharynx*; it is the only passage for the food into the stomach.



Mouth of Ripipteryx.

The lower lip or *labium, u,* closes the mouth below, as the upper lip does above: it is a much more complicated organ than the upper lip, and its variations afford excellent characters for descriptions: it consists of four distinct parts, which are obviously separated by sutural lines. The insertion of the lower lip or *insertio, u* 1, is usually concealed by the *mentum* below it, but occasionally projects considerably beyond it, and becomes a part of some importance. The true lip or *labium proprium, u* 2, is a solid, horny plate, corresponding in character with the upper lip: its variations are of great assistance to entomologists, in determining the genus to which an insect belongs. The third portion of the lip or *palpiger, u* 3, appears mostly to rise from behind the second part, but is not unfrequently continuous with it, and separated only by a sutural line; it is usually smaller, and of softer substance than the second part, and is invariably to be distinguished by bearing the feelers. The labial feelers or *labipalpi, û,* originate one on each side of the *palpiger*, from which they continue divaricating: these are composed of several distinct joints, of which the terminal one varies much in form. The terminal portion of the lip or *ligula*, is always more soft and fleshy than either of the preceding parts: it is remarkable for the infinite variety of forms which it assumes, and is the most certain guide in ascertaining insects from description.

An entire *ligula* or *ligula integra*, is when its termination is simple and undivided; an entire *ligula* is either *obtuse* or *acute*, *truncate* or *rotundate*, *elongate* or *abbreviated*. A bifid *ligula* or *ligula bifida*, is when there is a deep notch down its centre, thus making the termination double: a bifid *ligula* is usually very obtuse. A trifid *ligula* or *ligula trifida*, is when it has three distinct terminations; this *ligula* is more variable in form than the foregoing: the three terminations are sometimes obtuse lobes, sometimes long setiform processes. A quadrifid *ligula* or *ligula quadrifida*, is when it has four distinct terminations; this *ligula* has usually the appearance of having really but three lobes, with the central lobe deeply cleft. A setiform *ligula* or *ligula setiformis*, is when the central lobe of a trifid *ligula* is very long, slender, and pliable; the lateral lobes being very small, or merely rudimental: these small lateral lobes have been called *paraglossæ*. A palpiform *ligula* or *ligula palpiformis*, is bilobed or quadrilobed; and the two or four lobes, as the case may be, are jointed in the same manner as the feelers.



Lower Lip of a Bee.

The tongue or *lingua*, is usually attached to the inner surface of the lower lip, very near its base. In the locust the tongue is very prominent and remarkable, assuming nearly the form of the human tongue: in some bees it is distinguishable, but not prominent: in most insects it is difficult to be found: the tongue has also been called *epipharynx*.

The feeler-jaws or *maxillæ*, *o*, are situated immediately above the lower lip. They have great variety of form and motion, but are at once to be distinguished from the mandibles by the possession of feelers; they are divided by sutural lines into four parts,—the insertion, the disk or stalk, the feeler-bearer, and the blade: they also bear the helmet and maxillary feelers. The insertion or *insertio*, *o* 1, is mostly hidden by the neighbouring portions of the skull when the *maxilla* is at rest; but, on the least motion, a portion of it becomes visible on each side of the lower lip; it is of a softer and more cartilaginous substance than the part which succeeds it. The disk or stalk of the feeler-jaw or *maxilla*, *o* 2, is divided from the insertion by a sutural line; it is hard, glabrous, and of various formations. The feeler-bearer or *palpifer*, *o* 3, is usually placed above the stalk of the feeler-jaw, but is often parallel with it, thus constituting its exterior portion; in either case it is a solid corneous part, and distinctly divided from the stalk by a sutural line. It may be useful to observe, that a knowledge of these parts is not essential to accurate generic description, their variations being less available than those of the succeeding portions of the feeler-jaw. The blade of the feeler-jaw or *lacinia*, *o* 4, is its apical portion, and its variations are of great importance, for on them the great divisions of insects are principally founded.


Feeler-jaws of a Moth.

A convolute blade of the feeler-jaw or *lacinia convoluta*, is when it is rolled up below the head in the manner of the main-spring of a watch, or the Ionic volute in architecture. When bearing this form it is exceedingly long, slender, and pliable; and the blades of each feeler-jaw being internally grooved, unite and form a honey-sucking tube: it has this form in butterflies and moths. A lanceolate blade or *lacinia lanceolata*, is when it is straight, flat, decreasing gradually to a sharp point, incapable of any horizontal motion, and employed by being thrust vertically into the object on which its possessor feeds: it has this form in blood-sucking gnats and flies. A leathery blade or *lacinia coriaria*, is when it is composed of a tough, strong, and flexible substance; when this is the case, it usually is very long, without horizontal motion, parallel with the *ligula*, and unites with that part of the mouth in forming a sucking tube: it has this form in bees. An obtuse blade or *lacinia obtusa*, is when it has no character conspicuous or active, but terminates the feeler-jaw in a rounded and apparently undeveloped form. A falcate blade or *lacinia falcata*, is when its point is acute and bent over towards the opposite blade: this kind of blade has its interior edge *hirsute*, *dentate*, or *simple;* its point *bifid* or *simple*. An articulated blade or *lacinia articulata*, is when it unites with the disk of the feeler-jaw by means of a distinct and free joint instead of a sutural fixed line: it has this form in the tiger-beetles. The helmet or *galea*, *ö* in the figure at p. 159, is situated on the back of the feeler-jaw, behind the blade and before the feeler; its variations are very numerous, and, consequently, very useful in assigning characters to insects. A palpiform helmet or *galea palpiformis*, *ö*, page 159, is when it is perfectly distinct from the blade, and composed of one, two, three, or four cylindrical joints, like those of the feelers or *antennæ:* it has this form in carnivorous beetles. An obtuse helmet or *galea obtusa*, is when it appears simply as a shapeless mass; it assumes this form frequently when the *lacinia* is also obtuse, and much resembles it in appearance. An obsolete helmet or *galea obsoleta*, is when it is closely united to the blade: sometimes a mere sutural line, and occasionally not even that, denotes any separation between them. The maxillary feeler or *maxipalpus*, *ô* in all the figures, rises from the feeler-bearer immediately behind the helmet; its principal variations are in the number, form and proportion of its joints: the descriptions of these are very simple, and easily understood, without the employment of any set terms. The mandibles or *mandibulæ*, *i* in the figure at p. 159, are situated immediately below the upper lip, and immediately above the feeler-jaws, one on each side of the mouth, meeting and sometimes crossing in front: when possessed of motion, they move horizontally. Rudimental mandibles or *mandibulæ incipientes*, are those which are perfectly without motion and apparently without use; they are small, scale-like processes adhering to the skull, and are utterly incapable of gnawing solid substances: they have this form in butterflies. Linear mandibles or *mandibulæ lineares*, are those which are of uniform size and substance;—which are perfectly straight, parallel, and approximate; they are always without the horizontal motion, and utterly incapable of gnawing solid substances: they have this form in many flies. Tubulate mandibles or *mandibulæ tubulatæ*, are those which are hollow, and perforated at the extremity to admit the passage of the blood of other insects, on which the insects possessing such mandibles always feed: the mandibles possess this form in the *larvæ* of some carnivorous beetles, and in that of the ant-lion. Falciform mandibles or *mandibulæ falciformes*, are when they are long and much curved, in the shape of a sickle; they move horizontally with great ease, are hard and acute, and, when closed, cross each other: insects possessing these mandibles bite severely, and prey on other insects. Bifid mandibles or *mandibulæ bifidæ*, are when the extremity is terminated by two distinct points of equal length and similar appearance, otherwise one of them would be called a tooth.


Mandible.

Toothed mandibles or *mandibulæ dentatæ*, are when the internal mandibles are beset with teeth: when this is the case, they are hard and bony, have a rapid and powerful horizontal motion, and are capable of grinding very hard substances. Setiform mandibles or *mandibulæ setiformes*, are when they are very slender, flexible, thread-like, without horizontal motion, and often completely enclosed in a sheath, which sheath is generally supposed to be the lower lip.

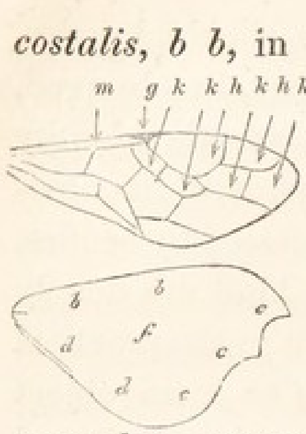
To understand the structure of the head of an insect, it is essential to examine it,—to handle it,—to dissect it,—then the foregoing description will probably prove useful; but no description, without ocular demonstration, can be made perfectly clear. The structure of an insect's mouth will be pretty well understood by a comparison with our own, if we suppose it possible for both our upper and lower jaw to be divided down the middle, and the two halves of each to move from side to side, meeting in front, the lips and tongue remaining as they are. Our upper lip corresponds, then, precisely to the *labrum* of insects; our lower lip to the *labium;* our upper jaw, divided, to the mandibles; our lower jaw, divided, to the *maxillæ;* our tongue, to their tongue; and, when both mouths are closely shut, the parts in each occupy similar places. The mouth of *Ripipteryx* at p. 159 aptly illustrates this.

*Wings and Legs.*—The wings and legs of insects are situated in equal numbers on each side of a right line drawn down the back; they constitute five pairs, four wings and six legs.

The fore wings or *proalæ* arise from the sides of the *mesothorax;* they vary in composition, covering and form, and their variations afford excellent distinguishing characters: fore wings are called scaly or *squamosæ,* when they are membranaceous, and covered with a coat of minute scales placed in rows; the edges of the scales in one row covering the insertions of those in the next, like the scales of a fish, or the tiles of a house: these wings are used principally in flight; the wings have this character in the butterfly: they are membranaceous or *membranaceæ* when composed of a delicate transparent membrane, which is upheld and moved by various strong nervures, traversing it in various directions: in the fly, these fore wings alone perform the office of flight; in the bee, they have the assistance of a second similar pair; a portion at the base of membranaceous wings is called the winglet or *alula:* they are called crustaceous or *crustaceæ* when composed of a hard, brittle substance, incapable of being bent or folded without injury; incapable also of being used in flight, and serving only as a protecting cover to the more delicate hind wings; the fore wings possess this character in all beetles, and in descriptions are usually called wing-cases or *elytra:* they are called leathery or *coriaceæ* when composed of a tough, leathery substance, which will bend readily without breaking, but which never folds naturally; such wings are seldom of much service in flight, yet are occasionally used for that purpose; they have this character in the locust: they are said to be half-leathery or *semi-coriaceæ* when they have the basal portion composed of the leathery substance just described, and the apical portion membranaceous and transparent; plant-bugs have this kind of fore wings: and lastly, reticulated or *reticulatæ* is the term employed when they are covered by an infinity of nervures crossing each other in every direction; these nervures give the wings the appearance of beautiful net-work; dragon-flies have wings of this character.

The hind wings or *metalæ* possess the characters of being scaly, membranaceous, or reticulated, the same as the fore wings; but they are never crustaceous, leathery, or half-leathery. The hind wings rise from the sides of the *metathorax*, one behind each of the fore wings; they occasionally possess characters which the fore wings have not: they are said to be petiolated or stalked when they have ceased to bear the appearance of wings, and have become mere knobs, placed at the extremity of a short foot-stalk; in this form they are usually termed *poisers* or *halteres*, and are possessed by all flies and gnats: and setaceous or *setiformes* when they have ceased to bear the appearance of wings, and have become simple bristles, totally useless in flight. It should, however, be observed, that some authors have expressed doubts as to the identity of these undeveloped and imperfect wings, with the obviously perfect and complete hind wings possessed by beetles, butterflies, bees, &c. Questions of this kind are deeply interesting to the abstruse physiologist, but to the practical entomologist are of little or no value. The main object of a describer is to make himself clearly understood, and of a reader clearly and quickly to understand; and, to both these classes, it is almost a matter of indifference whether the two fully developed wings of gnats and flies are equivalent to the fore or hind wings of the bee.

The nervures in membranous wings divide the membrane into small compartments, called cells or *cellulæ:* these cells are very constant in their form and proportion in the same genus of insects; consequently their variations distinguish one genus from another. The strong nervure which runs along the upper edge of each wing, either on the extreme edge or just below it, is called the costal nervure or *nervura costalis;* and the portion of membrane, if any, above this nervure, is the costal cell, or if divided by minor nervures, the costal cells or *cellulæ costales, m.* The incrassated portion of this nervure, *g,* which is frequently observable at about two-thirds of the distance from the body, towards the apex of the wing, is called the *stigma,* both in English and Latin descriptions. The cells immediately beyond the *stigma,* towards the extreme point of the wing, are called the marginal cells or *cellulæ marginales, h h;* these are generally two or three in number; and the cells immediately below these, the submarginal cells or *cellulæ submarginales, k k k k.* The wings of all insects present a somewhat triangular figure. The upper portion of this triangle is called the costal region or *regio* *costalis*, *b b*, in the lower figure; the outer portion, the exterior region or *regio exterior*, *c c c*; the lower portion, the inferior region or *regio inferior*, *d d*; and the central portion, the central region or *discus*, *f*. These regions have no precise or definite limits, bounded by a constant and uniform margin or nervure, but are somewhat vague and ideal, yet must be readily understood by a glance at the accompanying figure, a little attention to which will render most descriptions of the numerous cells and regions intelligible. The author should perhaps state, in order to justify in some degree this very meager nomenclature of the parts of the wing, that the nomenclature of the nervures and cells is at this hour in such a state of unintelligible confusion, that it would occupy more space than this entire volume to unravel the entangled synonymy, and render the subject intelligible to a beginner; he has, therefore, given only those terms and definitions which, though confessedly meager, cannot lead the reader into error.

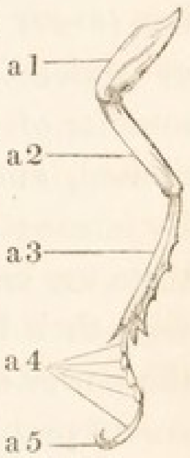



*Legs.*—The legs of insects do not undergo the same degree of variation as the wings; they are of a more uniform structure, not only as regards different kinds of insects, but as regards the legs of the same insects: they are six in number, or three pairs; the fore legs or *propedes*, which are the pair nearest to the head; the middle legs or *mesopedes;* and the hind legs or *metapedes*. The natural position of the legs in most insects, when perfectly at rest, is for the fore legs to point forwards; the middle legs either forwards or backwards, and this dependant a good deal on the will of the insect; and the hind legs backwards; in most beetles the fore legs alone pointing forwards.

The legs are so nearly of uniform structure, that the description of one serves for the six; trifling variations, where they occur, being easily pointed out in descriptions. The legs of an insect consist of four parts, called the hip, thigh, shank and foot.

The hip or *coxa*, a 1, is a short often nearly globular joint: it either moves with perfect freedom in a socket, purposely excavated in the *sternum* of the insect, or is anchylosed in the socket, and a greater power of motion possessed by the next joint: in the first instance the *coxa* is called free or *coxa libera*, and in the second, fixed or *coxa fixa*.

The thigh or *femur*, a 2, is a long and stout joint, moving with great freedom; it is composed of three pieces, the separation of which is marked by strong sutural lines: these are called the first, second, and third joint of the *femur*,—*femoris caput; femoris trochanter; femoris scapus*:—when two parts only are discernible, they are the second and third parts: when only one, it is the third part, and is alone called the thigh or *femur*.



Leg of a Beetle.

The shank or *tibia* is a single piece, generally of about equal length with the *femur*, but occasionally differing greatly in this respect: it is frequently three-sided. The *tibia* is called winged or *alata* when it is furnished with an attenuated dilated process, much resembling the extended membrane which constitutes the wing of a bat, but not so flexible. It is called corbiculate or *corbiculata* when it is furnished with a brush of stout hairs, for the purpose of brushing the pollen from the anthers of flowers, and conveying it to the nest, as in bees. The *tibia* in almost all insects is furnished with stiff spines or bristles, which are called spurs or *calcaria*.

The foot or *tarsus* consists of five joints, called the first, second, third, fourth, and fifth joints of the *tarsus*, or *planta*, *metaplanta*, *allux*, *arthrium* and *ungula*; the *planta* being nearest to the *tibia*, the others in regular succession. In pedunculated insects the five joints of the *tarsus* are almost invariably present; in other insects one, two, or three of them, are frequently missing: when an insect has four joints to the *tarsus*, the *arthrium* is wanting; when only three, the *arthrium* and *allux* have disappeared. The *ungula* is armed at its extremity with one, two, or four sharp curved claws or *unguicula*, a 5: in the stag-beetle a sixth joint of the *tarsus* called the *plantula* arises from between the claws, and this joint is furnished with two other claws. The under surface of the joints of the *tarsus* is very frequently covered with soft cushions or *pulvilli;* these are composed of an almost infinite number of minute hairs, which, at their ends, are slightly dilated, and constantly exude an adhesive gummy matter. By means of these gummy *pulvilli*, insects possessing them are enabled to walk freely on smooth surfaces, even with their backs downwards, against the power of gravity: the power of overcoming the laws of gravity seems to have sorely perplexed our philosophers, ancient and modern; some thought the act perfectly supernatural, and the effect of a charm or enchantment; others, with equal gravity, attributed it to suction, and imagined an insect carried a kind of air-pump in each foot, to exhaust the air between the foot and the surface to which it adhered; and, until lately discovered by Mr. Lister, the true cause of the phenomenon was unknown. We often thus content ourselves with any theoretical mode of accounting for a phenomenon, and fondly cling to a fiction savouring of the wonderful, rather than take the pains to seek a rational and intelligible explanation. There are other insects whose *pulvilli* exude an oily or greasy matter, and these not only run with ease and safety on the surface of water, but, if forced beneath the surface, their *pulvilli* are such admirable repellants of wet, that they enable and compel the insect to rise to the surface as soon as the depressing power is removed: beetles inhabiting the water are provided with an oily down, more especially to be observed in the region of the breathing apertures, which effectually prevents the entrance of water. At the end of the *ungula*, between the claws, there is in the locust, and some other insects, a small soft ball called the little cushion or *pulvinulus:* this is a part of some importance for distinguishing characters.

There are attached to the *telum*, or last segment of the abdomen, many very singular appendages; the uses of some of these are known, of others unknown. The appendages of which the uses are ascertained are these,—the sting or *aculeus*, as in bees; the external ovipositor or *ovipositor exertus*, as in the *Ichneumon;* the tubular retractile ovipositor or *tubulus*, as in the bot-fly; and the saw or *terebella*, with which female insects bore a hole to deposit their eggs. The appendages, of which the uses are unknown or doubtful, are the leaflets or *foliolæ;* pincers or *forceps*, as in the earwig; and tails or *caudæ* and *caudulæ*, as in the cockroach and cricket.

It may be proper to observe, that insects have many external parts here undescribed, and many yet unnamed; but sufficient are now noticed to enable a reader to describe any insect he may meet with, or to understand any description he may read.

*Of Surface.*—Although this chapter has extended to an unusual length, the description of the skeleton will scarcely be complete without detailing those characters of its surface, by which vast numbers of species are readily and almost instantaneously distinguished from each other. The variations in surface are of two kinds,—form of surface, and colour of surface :—the variations of form are admitted on all hands to be more important than those of colour, for whilst form is generally uniform throughout every individual of a species, colour is known to undergo a great and almost unaccountable change : in beetles which have wing-cases of a pale brown, with a metallic gloss on them, we shall be sure to find individuals of a brilliantly metallic blue or green, without a trace of brown; and those of which the usual colour is a brilliant metallic green, are sure occasionally to produce varieties of pure black: colour must therefore be taken as a corroborative, rather than a primary character; it must be carefully noticed, and its changes will often be found of great interest and importance, but it must not be regarded as a positive and definitive character.

*On Colour.*—On the subject of colour many vague and crude ideas have prevailed, and much that appears very nonsensical has been written. Latreille is the *least* theoretical writer on the subject, and he, for some reason not clearly explained, excludes *green* from the list of colours. Without however criticising the views of others, the author will, in a few words, explain his own.

Black in all its varieties appears to proceed from the absence of colour, and can be produced by the exclusion of light: different hues of black may be produced by throwing shade on other colours: a deep shade thrown on blue will produce an indigo ; on red will produce a brown, &c.; thus blacks and browns originate in nature in a deficiency of light.

White is the presence of light, and the completeness and perfection of colour; other colours are subsidiary to it, and component parts requisite to its perfect development.

The component parts of white are six,—Red, orange, yellow, green, blue, and violet:—if these colours be ranged round a circle, it will occur at once to persons acquainted with optics, that this location of colours is in accordance with nature.

RED.

VIOLET. ORANGE.

WHITE.

BLUE. YELLOW.

GREEN.

In tracing these colours round the circle it will be evident that there is no gap: neither of the six could be omitted, or its place occupied by another: it will also be noticed that red, yellow and blue are of greater integrity than orange, green, and violet, which are indebted for their characters to the colour on either side of them: further it will at once be admitted that white is equally related to all; it partakes of the characters of all, and is composed of all, besides having a perfection and superiority peculiar to itself.

The following list of the principal variations of these colours, as developed on the surface of insects, will be found useful in reading technical descriptions.

Blacks:—piceous or *piceus*, the colour of pitch: atrous or *ater*, the colour of liquid ink; it is also occasionally written *aterrimus:* nigrous or *niger*, the colour of lamp black: fuliginous or *fuliginosus*, the colour of soot: blackish or *nigricans* is an impure black: smoky or *fumeus*, as if tinged with smoke.

Browns:—fuscous or *fuscus*, the colour of the otter: bay or *badius* and chestnut or *castaneus* are nearly identical; they both imply a colour like that of seasoned mahogany, or a bay horse, or a horse-chestnut: testaceous, *testaceus* or *lateritius*, are synonymous, but used with rather a diversity of meaning, from authors being unacquainted with the uses of the words in Latin; the colour to which they should properly be confined is that of brick-dust: ferruginous or *ferrugineus* is rust-coloured, or brown with a good deal of red in it.

Reds:—rufous or *rufus*, the colour of copper: sanguineous or *sanguineus* is the colour of blood: rubrous or *ruber* is a clear unmixed red: miniatous or *miniatus*, the colour of red lead: coccineous or *coccineus* is the most brilliant red, the colour of the blossom of the horse-shoe geranium: roseous or *roseus* is the colour of the rose: puniceous or *puniceus* is a red inclining to orange.

Yellows:—golden yellow, orange or *aureus*, the colour of an orange: croceous or *croceus*, the colour of the blossom of a crocus, rather brighter than orange: flavous or *flavus*, a pure unmixed yellow, the colour of the blossom of the sun-flower: stramineous or *stramineus*, paler than the last, the colour of straw, but rather brighter and purer: sulphureous or *sulphureus*, a pale delicate yellow, the colour of powdered brimstone: luteous or *luteus*, the colour of the yolk of an egg: lutose or *lutosus*, the colour of yellow clay: tawny or *fulvus*, the colour of the lion.

Greens:—glaucous or *glaucus* is that pale grey green which is the usual colour of the sea: prasinous or *prasinus* is the colour of the leaves of leeks: olive or *olivarius* is the colour of olives, a dull green or green with brown in it.

Blues:—cæruleous or *cæruleus* is the colour of the sky: cyaneous or *cyaneus*, a pure bright blue, the colour of the blossom of *Centaurea Cyanus;* this colour has been erroneously described as that of indigo: cæsious or *cæsius* is an impure greyish blue: violaceous or *violaceus* has a mixture of red in it, and is precisely the colour of the purple violet: frosted or *pruinosus* expresses that appearance which objects possess when covered with a slight coat of hoar frost; it may be said to approximate to a blue grey.

Whites:—albous or *albus* is a pure white: whitish or *albidus* is a dirty or impure white: grey or *canus*, the colour of grey hair, and more properly confined to descriptions of hair: cinereous or *cinereus*, the blue grey colour of ashes: cretaceous or *cretaceus*, the white of chalk, or white with a slight tint of yellow ochre: niveous or *niveus* is a brilliant snowy white.

Besides these there are various metallic colours common in insects, as silvery or *argenteus*, brassy or *aheneus*, likewise written *æneus*, and then used to imply a bright gold green; the Latin word *smaragdinus* implies a still more intense degree of the same colour: coppery or *cupreus*, and steel blue or *chalybeus*.

The degree of intensity in a colour is usually implied by the addition of an adjective; thus *saturatus* implies that a colour is very deep and full; *dilutus* implies that it is pale: again, *lætus* very bright, and *obsoletus* very dull or indistinct, are contrasted in the same manner, and may, by altering the termination, be used adverbially; thus *lætè cupreus, obsoletè glaucus: saturatus* and *dilutus* do not allow this change.

*Of Distribution of Colour.*—A diversity of colour occurs very frequently in the same insect, and the shape or limit of a colour is expressed by a descriptive word; as a spot or *macula* signifying a roundish or angular mark, not elongated in any direction: a stripe or *plaga* is the term used when the spot is more elongate: a fillet or *vitta* is a longitudinal stripe, and a band or *fascia* is a transverse one.

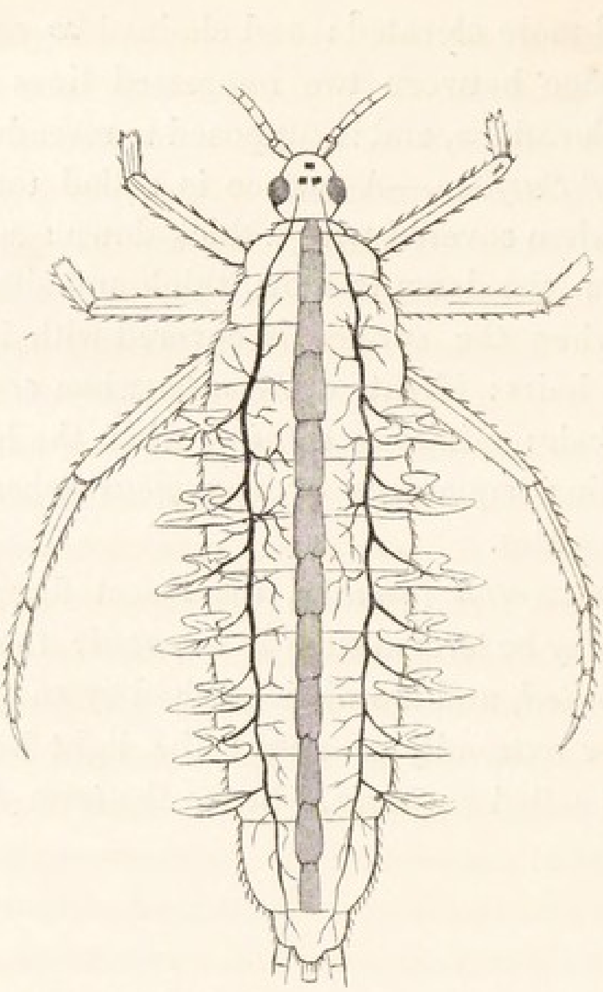
*Shape.*—The terms used to express shape should be precisely in accordance with those employed by the Latin authors: their copious language may readily be applied to any figures with which we may meet, and technical nomenclature in this branch of the subject involves the description in obscurity instead of elucidating it.

*Sculpture of Surface.*—The characters impressed on the surface of the skeleton are highly important, and afford us excellent guides for the discrimination of species: a more minute detail of these appears indispensible: the following are the principal variations.

Smooth, *lævis* or *lævigatus,* is when the surface is perfectly smooth, without depressions or elevations: shining, *nitidus* or *lucidus,* when the surface is polished as a mirror: rough, *asper* or *scaber,* when covered with an irregular rugosity: pustulose or *pustulosus,* when covered with pustules resembling those occasioned by the small-pox: muricated or *muricatus* is when these pustules are pointed, and *echinatus* when they are produced into spines: verrucose or *verrucosus,* when covered with tubercles resembling warts: punctured or *punctus* is when the surface has the appearance of having been thickly punctured by the point of a pin, the pin not passing through, but simply making impressions: punctured in lines or *strio-punctus* is when these punctures are arranged in longitudinal lines: reticulate or *reticulatus,* when tolerably smooth, yet covered with something like net-work: vermiculate or *vermiculatus,* when covered with tortuous markings, like worm-eaten wood: striate or *striatus* is when marked with longitudinally impressed lines, and *puncto-striatus* is when these lines are themselves punctured: canaliculate or *canaliculatus* is when the impressed lines are coarser and deeper than the foregoing, and sulcate or *sulcatus* is when they are still deeper, resembling furrows: lineate or *lineatus* has lines in the same degree as *striatus,* but the lines, instead of being impressed, are raised above the surface: keeled or *carinatus* is when these raised lines are fewer and more elevated: and chained or *catenatus* is when the space between two impressed lines is divided into oblong elevations, and is supposed to resemble a chain.

*Clothing of Surface.*—A surface is called tomentose or *lanuginosus* when covered with a thick down: sericeous or *sericatus* when the down is short, thick and silky: villose or *villosus* when the surface is covered with longer and more distinct hairs: hirsute or *hirsutus* when covered with long shaggy hair: crinite or *crinitus* when the hair is very long and thin: squamous or *squameus* when covered with distinct scales.

In the *Pteracantha fasciata*, the insect figured below, the antennæ may be termed slightly *serrated;* the elytra are slightly *carinated*, and are distinguished by an acute spine at their lower extremity or apex: the light band across the *elytra* is called a *fascia*,—hence the term *fasciata.*



Larva of *Ephemera marginata*, magnified. The central shaded line represents the great dorsal channel of the blood. The lateral branched lines the tracheæ.

# CHAPTER III.

## ON THE INTERNAL ANATOMY OF INSECTS.

*Of the Muscles of Insects.*—Muscle is a substance which yields to the touch: it consists of two parts; the body of the muscle, which is fleshy; and the extremities and coating of the muscle, which are tough, strong, and elastic, and are designated as *tendon*. The surface of muscle is a beautiful microscopic object: it presents a series of exceedingly fine transverse lines, which, in contraction, assume an undulated form. The fibre of muscle is much the same in every animal, from man to the most minute animalcule. The attachment of muscle is solely to the osseous plates or bones, which constitute the external covering of an insect; in these they originate precisely in the same manner as the muscles in the human frame are attached to, and originate in, the bones.

The bulk and form of muscles in insects are beautifully apportioned to the offices they are required to perform; and unusual bulk in any part of an insect generally implies the presence of unusually developed muscle, and the object for which it is developed may frequently be ascertained. We have before seen, that the fore wings arise from the *mesothorax*, and the hind wings from the *metathorax*: these segments vary greatly in size, and this variation depends so precisely on the powers of flight possessed by each pair of wings, that an insect anatomist, on regarding these two segments alone, would at once decide on the relative power of the wing which they had borne. In flies, the fore wings alone are used in flight; the hind wings are rudimental; the whole bulk of muscle, therefore, required for flight, is placed in the *mesothorax*: in beetles the hind wings alone are used in flight, and the bulk of muscle is consequently transferred to the *metathorax*. It happens in some moths, that one sex flies and the other does not; and in these the different size of the wing-bearing segments proves the provision of muscle to be for the purpose of flight. In the common ant, the little worker never leaves the ground; wings, therefore, would be an incumbrance to it. We find that its *pro- meso-* and *metathorax* are very small and insignificant segments, while the *mesothorax* of the productive female is the largest segment in her body, because it is one of her duties to perform a long flight, and to use the wings which that segment bears. The muscles in those wing-bearing segments which do not employ their wings for flight, are probably not absent, but repose in a rudimental state; while the muscles, whose active uses are required in the neighbouring segments, are increased at their expense.

The form of muscles in insects is as various as their size, and depends on the motion required of them: every muscle is precisely of the shape, as well as size, best adapted for the office it has to perform. The muscles which serve to raise a leg and lift it forwards, and all similar simple movements, are linear or cylindrical when at rest, but in contraction become fusiform, the extremities attenuating, the centre incrassating, and the whole being abbreviated. The muscles which serve to perform the wriggling undulating motion, so common in larvæ, especially those which are without legs, are triangular, and in motion contract alternately each side of the triangle, so that each angle becomes acute and obtuse in turn.

Muscles in insects more frequently cross and intersect each other than in vertebrated animals: in some instances, where connected with the organs of respiration and circulation, they are excessively minute, and appear actually interwoven, crossing in every direction, like multitudes of slender threads. It is in such situations that dominant motion exists; motion altogether independent of, and uninfluenced by, the will.

The principal muscles in insects are generally in pairs; that is, each principal muscle has an antagonist muscle, which, after any given movement, has the power to restore the original position. The muscles destined for the government of the limbs are all of the linear or cylindrical form, and all in pairs, a flexor and extensor muscle being found in each joint of the legs, &c.

*Nerves.*— In vertebrated animals the brain is situated in the head. Brain is supposed to be the seat of mind: all the nerves originate in the brain : the nerves are the organs of sensation. We find that in insects there is no part positively ascertained to be the brain : we discover nerves throughout the body, and we trace these to large masses or knots, situated at intervals throughout the whole length of the insect.

Experience has shown us that, on the brain of vertebrated animals being separated from the body, or even greatly injured, both sensation and active vitality at once cease ; but in insects the separating of the head or of the parts containing either of these masses of nerves, produces no immediate or ascertainable effect on sensation or vitality. This shows us, *first*, that mind or volition is, in vertebrated animals, situate in the brain ; *secondly*, that in insects it is not exclusively confined to any part. These conclusions lead to the probability of a third, that brain and nerve are but different states of the same system of organs. The vitality, therefore, concentrated in a brain, may be diffused through the nerves when there is no brain, and each mass of nerves may be the seat of that small power of mind which insects possess.

The nervous cord extending, as described, from one end of the insect to the other, is compared to, and has been called, the *spinal marrow ;* its first knot or incrassated portion, the *brain ;* the following knots, *ganglions :* this nomenclature appears arbitrary, as we have seen that no particular portion exercises exclusively the functions of a brain. It appears better to consider each of the little knots a separate and independent centre of volition, as it undoubtedly possesses the characters of such, giving out its various nerves in the same manner as the human brain.

All anatomical operations succeed best with the larvæ of insects, because the constant and obvious division of the body of larvæ into thirteen segments, affords us more ready means of describing the result of observation ; whereas, in perfect insects, several segments are liable to become united, and the exact boundaries of each are thus rendered subjects of doubt. It must also be observed, that the internal systems of organs following and adapting themselves to the wonderful changes on the surface, require the utmost caution in the anatomist who attempts to characterize them. Let us then examine the caterpillar of a common butterfly, and trace its system of brains and nerves : in this we have the advantage of being able to examine it in all its stages, and to compare and ascertain, with tolerable certainty, both the mode and extent of change.

In the larva of a butterfly the spinal cord has thirteen knots, one in each of its segments ; these knots, from their similarity in office to brain, may be called cerebroids or *cerebroidæ ;* and each one may be distinguished by the name of the segment in which it is situated. The first cerebroid or *capitis cerebroida*, is composed of two hemispheres ; from these arise, in perfect insects, several pairs of nerves ; there are two optic nerves or *nervi oculorum ;* two antennary nerves or *nervi antennarum ;* two mandibulary nerves or *nervi mandibularum ;* two maxillary nerves or *nervi maxillarum ;* and two labial nerves or *nervi labii*. To return, however, to the caterpillar, the first cerebroid is situated above the cavity of the mouth ; from each hemisphere of the cerebroid a cord proceeds ; these unite on leaving the head, just above the opening of the throat, forming the second cerebroid or *prothoracis cerebroida ;* they then again divide, and, passing one on each side of the gullet, reunite below it, and enclose it in a ring. At the union they form the third cerebroid or *mesothoracis cerebroida ;* and from this arise four principal nerves, two of which, the *mesopedum nervi*, descend to the feet, and two others, the *prothoracis nervi dorsales*, ascend to the back; the cord then again separates, to reunite in the *mesothorax*, where it again gives rise to four nerves. After forming the fourth, fifth, and sixth cerebroids, separating in the same way between each, the cord proceeds, single and united, to the *propodeon*, and through the other segments to the *telum*, leaving a distinct mass or cerebroid in each segment, which invariably gives out four nerves, two of which ascend to the back and the other two descend, some entering the prehensile legs with which most caterpillars are furnished. In the *telum* is situated the thirteenth and last cerebroid or *teli cerebroida*, and this gives off no less than eight nerves, most of them permeating the organs of generation: thus the number of main nerves arising from the whole of the cerebroids in this caterpillar, is sixty-two.

The twelfth and thirteenth cerebroids are attached and sessile without any intervening cord; the spaces between the others vary very rapidly as the insect approaches perfection. In the first place, the second cerebroid enters the head, and becomes united with the first; then the fifth and sixth approach and unite; then the third and fourth; lastly, in the pupa, the seventh and eighth wholly disappear, and eight only are to be found in the perfect butterfly. The nerves, after leaving the cerebroids, divide and ramify almost infinitely, being more particularly abundant in the head and *tarsi;* they do not appear to penetrate the ossified skin, although they are found close beneath it.

The nerves are the means by which the circumstances of matter are conveyed to the mind, and also the means by which the commands of mind are conveyed to matter: in the former capacity they are the organs of the senses. The senses of insects are, properly speaking, seven: love, touch, taste, smell, hearing, sight, and the commanding and governing sense, called volition, mind, thought, or instinct. Love is that sense which ensures obedience to the great command, " Increase and multiply :" its gratification seems the main object of an insect's life, after having arrived at maturity : its seat is in the organs of generation. Touch is a most invaluable sense to insects; they have two antennæ and four feelers attached to the mouth, which appear provided purposely for the exercise of this sense : the *tarsi* are also employed to ascertain qualities by touch ; but the other parts of the body appear insensible to feeling, either as regards the ascertaining of qualities or the sensation of pain. Taste is undoubtedly possessed by insects in an eminent degree ; and they seem to have the same preferences for animal or vegetable food which are evinced by vertebrated animals. Smell appears to be the sense by which insects are led to discover strongly-scented substances at a great distance, where it is quite impossible that sight should aid them; its seat, however, is wholly unknown. Hearing seems also to be possessed by insects, or to what purpose would the merry cricket sing his evening song, if there were none of his kind to listen to and admire it? The seat of this sense is also wholly unknown. Sight is a sense of which we have abundant evidence; it is seated in two large compound eyes, often occupying nearly the whole head, and also occasionally in three minute simple eyes, situated in a triangle on the crown of the head.

The mind of insects is more wonderful than our own : it has neither speculation, retention, judgment, nor power ; it is, in fact, an existence which comes perfect from the Creator: the new-born bee is perfectly mistress of architecture; she is heaven-instructed : the mind is not only the ruling sense, but is a distinct immaterial element.

*The Alimentary Canal.*—The alimentary canal in insects, as in higher animals, consists of three principal parts, the gullet, the stomach, and the intestines. The gullet or *œsophagus* is the part which most nearly approaches the head, and the external opening of which is the throat or *pharynx* already described; it is of various length; and in this particular it appears more influenced by the variation of external form than by the quantity or quality of food consumed. The gullet is called simple or *simplex* when it is merely a tube of uniform size extending from the *pharynx* to the entrance of the stomach: this is the usual structure. It is ventricose or *ventricosus* when it dilates into a large bag or crop before its union with the stomach, and detains the food in its passage to that organ. It is said to be compound or *compositus* when it has a long pear-shaped cell opening from it, and extending beneath the stomach and intestines, yet having no communication with either; this is the case in all the flies and gnats which feed on blood, and many of the same tribes which subsist on other fluids: the blood sucked is at once received into it; and, as enough is frequently swallowed at a single meal to last for days, it returns slowly to the gullet as required, and then passes to the stomach for digestion.

The stomach or *ventriculus* receives the food immediately from the gullet, digests it, and passes it on to the intestines. The food immediately on entering the stomach, combines with, and is pervaded by, some fluid secreted by the stomach; this fluid probably serves to assist in digesting the food, for it immediately undergoes a change in consistence as well as colour. The stomach varies greatly in the form and nature, both of its main cavity, and of the numerous appendages with which it is occasionally furnished. It is termed simple or *simplex* when it is a mere continuation of the gullet in an enlarged form, being slightly constricted at the union with the gullet, and more so at its junction with the intestines, where an elastic ring is placed, which, when contracted, nearly closes the aperture. It is said to be double or *duplex* when it is divided into two distinct portions, one preceding the other: in this instance the anterior portion seems to be the principal organ of digestion, and in form, as well as office, frequently appears to resemble the gizzard of birds: the posterior portion corresponds with the stomach in its usual simple form. The stomach is triple or *triplex* when it possesses three separate divisions following each other longitudinally; it sometimes, but rarely, has four or more of these divisions: and finally, it is called compound or *compositus* when it throws off two or more minor stomachs or *cæca*, resembling little purses, at or near its union with the gullet; these are particularly observable in the voracious herbivorous insects, which have the anterior portion of the stomach in the form of a gizzard.

The stomach varies also in the character of its interior surface; it is sometimes perfectly smooth, and sometimes covered with a pilosity more or less shaggy; this pilosity has been said to consist of minute tubular processes, which secrete the fluid for digestion.

The stomach, at its posterior extremity, unites with the intestines; these consist of two portions, the small intestines or *intestina parva*, and the terminal intestine or *rectum*.

The whole of the alimentary canal, from its anterior to its posterior opening, is frequently little more than a direct tube or cylinder; the intestines are never subject to the convolutions so general in vertebrated animals; the passage of the food is excessively rapid, and the change it undergoes very slight. There are, originating from the stomach, at or near its union with the intestines, several long tortuous filiform appendages, which are said to be bile vessels, and to correspond with the liver of vertebrated animals.

*Organs of Circulation.*—In vertebrated animals the heart is situated in the anterior part of the trunk; through the heart the whole of the blood contained in the body is supposed to pass: all the arteries and veins originate or terminate in the heart: the arteries and veins are the organs of circulation. We find, that in insects, there is no part positively ascertained to be the heart; but we discover blood circulating throughout the body, and we trace it to a series of large reservoirs, which form a connected line or channel the whole length of the insect.

The blood of insects is a thin, transparent, and almost colourless fluid; it contains a quantity of oval particles which appear perfectly consistent, yet are as transparent as the fluid portion: a small portion of the blood dried on a glass presents a crystallized appearance. The best objects in which to observe the circulation of this blood, are transparent aquatic larvæ, more particularly those of *Ephemeræ;* and these being distinctly divided into the usual thirteen segments, afford us also the means of establishing a nomenclature. The number of reservoirs composing the great channel in *Ephemera* is twelve, one to each of the segments, except the head; these, not having been hitherto named, may be called little hearts or *corcula*, and each one may be designated by the name of the segment in which it is situated, as the *corculum* of the *telum* or *teli corculum*, but it must be distinctly understood that the number of *corcula* by no means invariably agrees with that of the segments; on the contrary, it has been established beyond question, that the number of *corcula* is, in most perfect insects, inferior to that of the segments. In this case the anterior portion of the channel being without divisions, has been supposed analogous to the *aorta*, and called by that name. Each *corculum* is somewhat pear-shaped, the smaller or pointed extremity being directed towards the head of the insect, and fitting into a cavity in the *corculum* above it, which cavity exactly corresponds, except in its being somewhat deeper and more pointed, to what is called the eye of a pear: twelve pears thus placed in a line, each closely touching the one above it, would give a general idea of the twelve *corcula*. Each *corculum* has a most distinct, tough and elastic coat, like that of an artery; the interior appears to be wholly filled with blood. The apertures of each *corculum* are two, one of them at each extremity; the posterior aperture is occasioned by the pressure of blood from below, causing the point of the *corculum* to open: the aperture itself is surrounded by an elastic ring, which expands and closes with each pulsation.

Mr. Bowerbank, who has paid great attention to this highly interesting branch of insect physiology, and whose observations have been attested by the author, has described in the 'Entomological Magazine' (Vol. I., p. 239), the phenomena of the circulation of blood, in nearly the following words.

"The great dorsal vessel extends nearly the whole length of the body, and is of great comparative magnitude. It is furnished, at regular intervals, with double valves, about equal in number to the sections of the body. Both above and below each of these sets of valves is a pair of singular looking appendages. They are probably nervous ganglions, auxiliary to the motions of the vessel, but so exceedingly pellucid as scarcely to be defined with the highest power which can be applied to them. The action of the valves is a most interesting and beautiful sight. While in their greatest state of collapse, the point of the lower valve is seen closely compressed within the upper one. At the commencement of the expansion of the artery, the blood is seen flowing in from the lateral apertures, and, at the same time, the stream in the artery commences its ascent. When it has nearly attained its greatest state of expansion, the sides of the lower valve are forced upwards by the increased flow of the blood from the section below the valve, the lateral openings are closed, and the main current of the blood is projected through the two valves.

"It is not easy to see this beautiful structure of the valves of the great dorsal vessel, for it is only when the insect is in a state of great exhaustion, or has been just so much compressed as to destroy voluntary motion without entirely depriving it of life, that it is possible to subject it to a power sufficiently high to discern these extremely delicate and transparent tissues; and even then, to see them to the greatest advantage, recourse should be had only to such as are in the last three or four segments of the body.

"The structure of the upper valve appears to be a reflecting inwards and upwards of the inner coat or coats of the artery; and of the under one, to be a contraction and projection of the like parts of a portion of the artery beneath, so as to come within the grasp of the lower part of the valve above it. The exterior portion of the artery may be seen as an exceedingly fine line, connecting the parts above and below the valves.

"The blood does not appear to be confined within any specific vessels, previously to its entering the lateral openings before-mentioned, as when they open, the particles are seen converging towards them, from all the adjacent parts of the cavity of the abdomen. The whole of the blood received throughout the course of this vessel is conveyed to the extremity of the anterior part of the body, where the vessel makes a curve inwardly, is lost to view, and apparently discharges the entire volume of the blood into the cavity of the body, for it is seen pursuing its course downwards, in a wide spreading stream, on each side and beneath the great dorsal vessel. As it descends, portions are again received by the valves of the dorsal vessel, and at the same time, cavities passing down each side of the body convey another portion of the blood to its lower extremity. These are properly cavities or portions of the great abdominal cavity, their boundaries not being clearly definable. They communicate at each junction of the sections of the body with the great abdominal cavity, as a portion of the blood they convey is discharged at these points, and supplies the place of other portions received through its valves into the great dorsal vessel.

"The circulation is also strikingly and beautifully exhibited in the tail. Here the ascending and descending canals, like vein and artery, accompany each other; and, at the same instant that the blood is seen to pass up the one, with the usual pulsatory motion, it descends in the other in a similar manner. This is the more apparent, as the sides of the canals are well defined, and each perfectly distinct from the other.

"Although the blood passes with the same pulsatory motion through these minute canals as it does in other parts of the body, yet no pulsation of either the ascending or descending canals themselves can be detected. The motion, therefore, seems to be entirely dependant on the action of the great dorsal vessel, which evidently performs in the insect, the same functions that the heart does in vertebrated animals.

"Upon fixing the insect so as to obtain a side view, the great dorsal vessel presents a very interesting appearance. It is seen continually and regularly oscillating backwards and forwards, upwards and downwards, and at the same time the main current of the blood in the great abdominal cavity winds its way in all directions towards the hinder extremity of the insect. Scarcely any larvæ exhibit the circulation of the blood in so beautiful a manner as the one described, although there are few in which it is not more or less to be seen, as I have been able to detect the great dorsal vessel in almost all I have examined.

"Next to the larva of the *Ephemera marginata*, that of *Agrion* affords the best view of the blood and its circulation. In all the species of these *larvæ* I have yet examined, I have found it as nearly similar as possible in appearance to that which we observe in the *Ephemera*, and, in some instances, it has afforded even more satisfactory results. The head of this larva is much more transparent than that of the *larva* of the *Ephemera*, we therefore have a better view of the circulation of the blood in the head of this insect than can possibly be obtained in the other. In this object the blood is seen rushing like a beautiful intermittent fountain towards the mouth, and dividing, right and left, into two jets, a portion of each of which flows within a given boundary past the back of the eye, whilst the remainder winds its way through other channels, deep in the side of the head, and returns again into the body. The antennæ of this insect also afford another beautiful instance of the circulation being carried forward within well-defined vessels. They are each composed of six joints, up four of which the blood is seen to take its course, and after turning round the extremity of the fourth joint, it returns by a distinct canal into the head.

"In the leg, likewise, the circulating fluid and its canals are clearly and distinctly to be traced, even to the very extremity of the *tarsus*, where, as in the antennæ, the particles of the blood are seen to descend on the one side of the leg, and, turning the extreme point, to return up the contrary side to the one by which they came down."

*The Tracheæ.* — In vertebrated animals, the lungs are situated in the anterior part of the trunk: the whole of the air that is appropriated to the uses of the body must be inspired by the *trachea*, which ascends from the lungs to the mouth and nostrils: the *trachea* and lungs are the organs of respiration. We find that in insects there is no part appropriated solely to the organs of respiration, but that they permeate every part of the body, mixing with the blood vessels, and, as we might say, seeking the blood, in order to aërate it, instead of the blood seeking the organs of respiration by rushing into the lungs, as it does in vertebrated animals. The organs of respiration in insects consist of simple tubes, which communicate externally with the air, and internally with the blood: the utility to all animals of imbibing air appears to be owing to its action on, or incorporation with, the blood.

The air tubes of insects or *tracheæ* communicate with the air by means of apertures which occur at intervals along the sides of insects; these apertures, which are called spiracles, are very various in their form, size, and number. The spiracles or *spiracula* are sometimes furnished with moveable lips, which the insects can close at pleasure, and thus exclude all injurious substances: sometimes they are furnished with a fringe of delicate hair, which answers the same purpose; and sometimes they are constantly open, and without any kind of protection. The spiracles in those instances in which they are furnished with moveable lips, open and close with great regularity, the body at the same time expanding and contracting; a certain evidence that the motion of the spiracles is connected with respiration. The spiracles are commonly oblong in their shape, but there are instances of circular, linear, quadrate, ear-shaped, and crescent-shaped spiracles.

The number of spiracles is generally eighteen, nine on each side; this number is possessed by almost all butterflies, moths, beetles, &c.; in flies there are not so many; in these, moreover, the number is not uniform. The names of the spiracles depend wholly on the segment in which they happen to be situated, as the right spiracle of the *prothorax* or *prothoracis spiraculum dextrum:* the fact of a segment possessing or not possessing spiracles is of importance in classification. In the figure of the caterpillar of the privet moth, at page 82, a spiracle may be observed under each of the oblique bands which ornament its sides; and in the *pupa* or *chrysalis* of the same insect, figured at page 196, the same spiracles are still to be traced. These breathing apertures are so very obvious in the majority of caterpillars that they can scarcely have escaped the notice of the most unobserving.

From each spiracle a single *trachea* enters the body; this single *trachea* is invariable; but the systems of *tracheæ* within are on various plans; the principal are the detached *tracheæ*, and connected *tracheæ*. They are called *detached* when, after entering the body as a single cylindrical tube, they separate, diverge, and ramify, throughout the region in their immediate vicinity, without any obvious connexion with the *tracheæ* of the adjoining spiracles; and *connected* when there is a grand longitudinal *trachea* traversing each side of the body throughout its length, into which each spiracle sends its particular *trachea*, sometimes as a single tube, sometimes after a slight ramification.

Whether the *tracheæ* possess the detached or connected form, their minute branches may be traced wandering over to the opposite side of the insect, and uniting with similar minute branches emanating from that side, so that the system of respiration is always connected, and acts by uniformity of impulse. The ramifications of the *tracheæ*, to our perception, appear infinite; they pervade the skin, muscles, nerves, stomach, intestines, legs, wings, and all the organs of sensation; the organs of respiration are therefore more generally diffused in insects than in other animals The blood of animals, in order to maintain its vital powers, requires supplies of oxygen, which is a principal ingredient of atmospheric air: an animal, therefore, in breathing the air, divides the oxygen from the other constituent parts, appropriates the former, and rejects the latter.

*General Summary.* — In the changes which insects undergo, not only is the external appearance altered, but the organs of support, motion, sensation, digestion, and generation are also altered, and frequently those of respiration. The organs of support in insects are mostly external; they are not bones, but perform the functions of bones; no experiments have yet proved that they possess the least sensitiveness to touch, except in a few parts in which the nerves obviously ramify to the surface. The organs of motion in insects are enclosed within, and attached to, the organs of support: they are evident muscles, partly fleshy, partly tendinous, and differ in no material character from the muscles of vertebrated animals.

The organs of sensation in insects are distinctly and decidedly nerves, and in most respects resemble the nerves of vertebrated animals; they do not, however, originate in a common or concentrated brain, but in numerous incrassated bundles of nerves, which are now termed cerebroids. The usual animal senses are possessed by insects; most of them obviously. Of hearing, we find slender proof, and its seat is altogether unknown; we also rather presume than know that insects possess smell; its seat is also unknown.

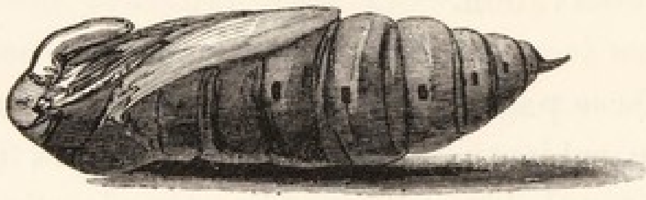
The organs of digestion in insects are peculiarly simple: the alimentary canal is very short, and the intestines generally without convolutions; the food passes very rapidly, and undergoes but little alteration.

The organs of circulation are these: a longitudinal series of little hearts, now termed *corcula*, which receive blood by lateral apertures from the cavities of the body: the blood is transparent and colourless, it contains numerous consistent oat-shaped particles; it flows very regularly, and in many parts of the body with a distinct pulsation.

The organs of respiration are tubes permeating the whole body, and communicating with the air by means of lateral spiracles or openings in the sides of the insect.

Insects are long in proportion to their breadth: they are transversely divided into thirteen segments; each segment seems to possess in itself a distinct vitality. Insects are excessively tenacious of life, even to so great a degree, that heads separated from the body have eaten voraciously for hours, the food passing completely through them; and bodies without heads have occasionally flown, and have repeatedly walked about for days. Insects appear to possess no mental power; to be incapable of memory; to assume the winged state in the plenitude of perfection; to perform the acts their parents performed without the possibility of tuition or observation.

The author is aware that several repetitions occur in the course of these pages, but they appeared to him essential to make the subject perfectly clear; he hopes that those who do not see their necessity will yet pardon them. Some of these highly interesting subjects lose nothing by repetition; for the mind in youth—and for such this volume is more particularly designed—is too apt to wander from the immediate subject before it, if of a somewhat abstruse character, and requires constantly to be reminded of those important, yet often uninviting truths, which must be received before any real progress can be made in science. It is the author's particular wish to instruct as well as please: to amuse by a recital of the extraordinary acts which insects perform, and to improve the understanding by showing how the parts of insects are adapted for those acts: to point out clearly the evidence of design in the structure of these apparent atoms: to demonstrate how and for what purpose one structure differs from another: to induce a reverential reflection how far above us and our limited powers of comprehension must be that Being, whose infinite and all-pervading intelligence could plan such a multiplicity of structures, each so beautifully adapted to peculiar appetites and peculiar habits, those very appetites and habits being given to the possessor in order that it should perform some important office in the economy of nature.



THE

# GRAMMAR

OF

# ENTOMOLOGY.

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## BOOK IV.

### ON SYSTEM, OR CLASSIFICATION OF INSECTS.

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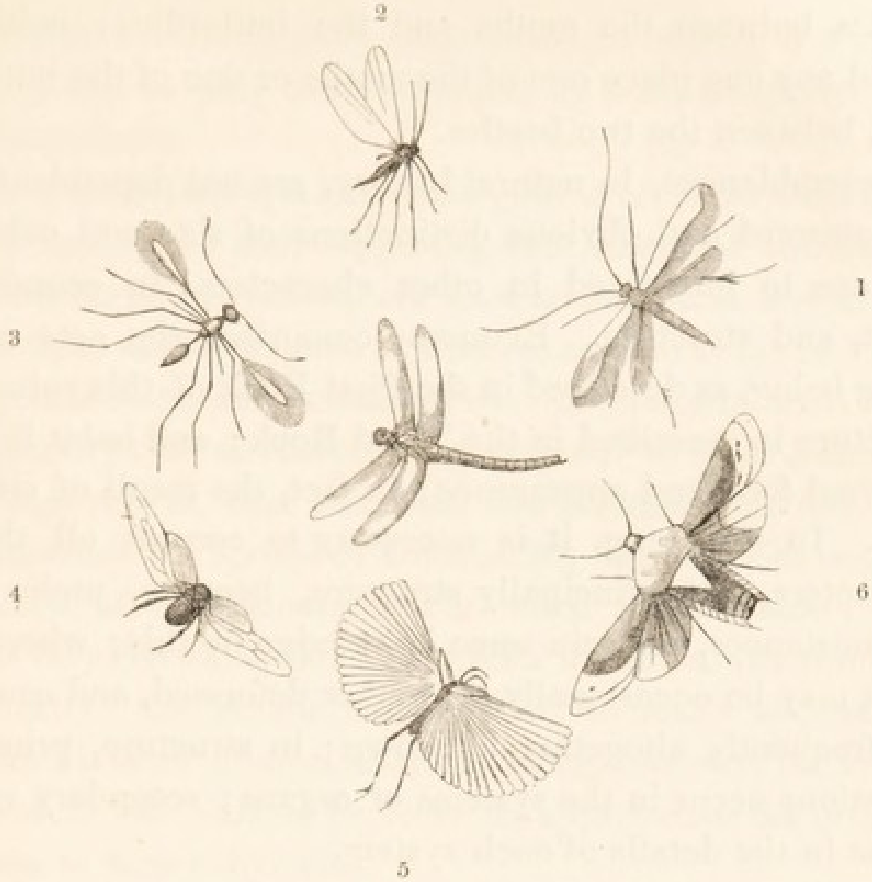
Vast chain of being! which from God began,
Natures ætherial, human, angel, man,
Beast, bird, fish, insect; what no eye can see,
No glass can reach: from infinite to thee,
From thee to nothing! On superior powers
Were we to press, inferior might on ours:
Or in the full creation leave a void,
Where, one step broken, the great scale 's destroyed;
From Nature's chain whatever link you strike,
Tenth or ten thousandth, breaks the chain alike.

Pope.




The classes of Insects : — 1. Lepidoptera. 2. Diptera. 3. Hymenoptera. 4. Coleoptera. 5. Orthoptera. 6. Hemiptera. In the centre, Neuroptera.

# CHAPTER I.

## CLASSIFICATION OF INSECTS IN GENERAL.

Every one must have observed that there is a greater resemblance between some two of the various insects with which he is acquainted, than between some other two : thus a butterfly more nearly resembles a moth than a moth resembles a beetle, or than a butterfly resembles a beetle. Again, two different kinds of butterfly more nearly resemble each other, than either of them resembles a moth ; the same with two moths ; and the same with two beetles. Now no one with the slightest idea of similarities would place the beetles between the moths and the butterflies; neither would any one place one of the moths or one of the butterflies, between the two beetles.

Resemblances, in natural history, are not dependent on the outward and obvious distinctions of size and colour, but are to be traced in other characters; in economy, habit, and structure. Economy comprises the acts of a living being, as described in the First Book of this volume; structure is described in the Third Book; and habit is the external form and appearance; in fact, the result of structure. In arranging, it is necessary to consult all these characters, but principally structure, because, under all circumstances, we gain some knowledge of this; whereas, habit may be occasionally altogether deformed, and economy frequently altogether unknown: in structure, primary variations occur in the systems of organs; secondary variations in the details of each system.

In all animals the bones, or organs of support, and the covering of the surface of the body, as skin, hair, feathers, or scales, afford the most ready characters by which to distinguish different kinds of animals from each other: now, in insects, we have seen that the organs of support are on the surface of the body, and, therefore, present greater facility to the describer. When the known animals shall be so arranged that each one is placed nearest to the one which it most resembles, and a series thus formed from which none shall be excluded, then the arrangement will be perfect, and the natural system will be discovered: this has been the ultimate object of naturalists in all ages.

In any abstract science, there is an evident advantage in being able to determine the names of every object, or group of objects; and so to allude to either, in speaking or writing, as that all persons possessing a moderate knowledge of the science may at once form a definite idea of what is meant.

The power of intelligibly designating an object, or a group of objects, is only to be attained by a close attention to nomenclature.

In nomenclature, it is a sound plan to revert to some standard authority; and, supposing that described and named objects be at any subsequent time re-described and named as new, to strike out such new names as soon as the fact shall be pointed out, and substitute the old names in their right of priority: in all instances subsequent to such authority, the best rule is, that the name first published be received. Naturalists are agreed in considering Linneus the original founder of our admirable binominal nomenclature, and, with very few exceptions, they refer to him as the standard authority: the author has adhered, as nearly as possible, to the Linnean nomenclature, altering, however, the termination of the names, in order to appropriate the original names to minor divisions.

For convenience, we make catalogues of all known animals: it is the object of every compiler of such catalogues to make as near an approach to nature as he is able. These catalogues or arrangements are not limited to a simple list of single names or kinds of animals, called *species*, but many species are grouped together under a second name, and called a *genus;* a number of genera are united, and called a family or *familia;* a number of families are united and called an order or *ordo*. From orders we mount upwards to *stirpes;* from *stirpes* to *classes;* from classes to tribes or *tribus;* from tribes to provinces or *provinciæ;* from provinces to kingdoms or *regna;* and, from kingdoms to universal nature.

Universal nature is divisible into material and immaterial: the material is divided into organic and inorganic; the organic is divided into animal and vegetable: these are called kingdoms or *regna*, and the whole of the animals thus constitute the animal kingdom: the inorganic division, like the organic, is double: of the immaterial we all are ignorant. The animal kingdom is distributed under four great divisions, distinguished from each other by organization. One of these is a single group, the other three are each double groups; that is, they each contain two groups, both of which possess the essential characters of the division, but which, nevertheless, widely differ in some subordinate character. These divisions, whether considered as four or seven, may be termed provinces; they are these:—

Vertebrated animals or *Vertebrata*. In this division, which is that of man and of the animals most resembling him, the brain and principal trunk of the nervous system are enclosed in a bony envelope formed by the *cranium* and *vertebræ;* to the sides of this intermedial column are attached the ribs and bones of the limbs, which form the frame-work of the body; the muscles generally cover the bones, whose motion they occasion: this is a single group.

Molluscous animals or *Molluscata*. In this division there is no skeleton; the muscles are merely attached to the skin, which constitutes a soft contractile envelope, in which, in many species, are formed stony plates, called shells. The nervous system is contained within this general envelope, and is composed of several scattered masses connected by nervous filaments: this is a double group.

Annulated animals or *Annulata*. In this division the nervous system consists of long cords, running longitudinally throughout the body, and dilated at intervals into knots or ganglions. The covering or envelope of the body is divided by transverse folds into a certain number of rings, whose teguments are sometimes hard, sometimes soft; the muscles are situated internally: this is a double group.

Radiated animals or *Radiata*. The organs of sensation and motion, in the preceding divisions, are symmetrically arranged on the two sides of an axis; in this division, these organs are disposed like rays round a centre; their respiratory organs are seated on the surface of the body: many animals of this division are a mere homogeneous pulp: this is a double group.*

It will be evident to every one who has read the preceding Book, that insects must belong to the third of these divisions—the annulated animals. This division comprises two very distinct groups: *first*, worms or *apoda*, which have soft bodies without legs; *secondly*, condylopodes or *condylopoda*, which have their bodies in a hard case, and have articulated legs. The province of *condylopoda* is divided into tribes by the number of legs, thus:—insects or *hexapoda* have six legs; spiders or *octopoda* have eight legs; shell-fish, as crabs or *anisopoda*, have from ten to eighteen legs; and centipedes or *myriapoda*, have from twenty to two hundred legs.

Insects are divided into two tribes, by the circumstance of possessing wings or wanting them; those which have wings are termed winged insects or *tetraptera;* those which are without wings are termed wingless insects or *aptera.* The winged insects are again divided into *four* classes, founded on the mode of metamorphosis; that is, on the degree of similarity which the larva and pupa states bear to the perfect state: as in the preceding higher division, three of these are double classes, and one is a single class. In a former chapter it has been said that insects are termed amorphous or *amorpha*, in which there is no resemblance between the pupa and imago; necromorphous or *necromorpha*, in which there is a similarity, though imperfect; isomorphous or *isomorpha*, in which the similarity

* The characters of the four provinces of animals are from Cuvier's 'Règne Animal.'

is complete; and anisomorphous or *anisomorpha*, in which there is great variation of metamorphosis, although a general similarity of structure in the perfect state. The winged insects are also divided into *seven* classes: the amorphous insects comprise two of these minor classes, called *Lepidoptera* and *Diptera;* the necromorphous insects comprise two classes, *Hymenoptera* and *Coleoptera;* the isomorphous insects comprise two classes, *Orthoptera* and *Hemiptera;* and the anisomorphous insects have only a single class, *Neuroptera*.

It is of great importance to adhere to some fixed nomenclature of divisions, and to understand the various steps as we mount from *species* to *kingdoms*. To recapitulate, they are these:—1. Species; 2. Genus; 3. Family; 4. Order; 5. Stirps; 6. Class; 7. Tribe; 8. Province; 9. Kingdom: and be it recollected, the number of the minor groups constituting a major group, need make no variation in the name of either group.

It may be remarked, that all divisions have a tendency to subdivide into the numbers four and seven; in other words, to contain four groups, three of which shall be double groups, and one single group: this circumstance has led to much argument as to the superiority of the particular numbers,—two, four and seven. Some writers have also contended for the numbers three and five. The relative position in which the objects of nature stand, has been also the subject of great discussion; some authors contending that the system of nature is represented by a straight line; others, by the branches of a tree; others, by the circumference of a circle. No decision on either number or position has yet been made by naturalists; indeed, it is the general opinion, that no particular number or position is constant in nature.

The author ventured to suggest, in a little essay called

'Sphinx Vespiformis,' published some time since, that seven was the predominant number; and that, in every group of seven, whether the group be large or small, one of the seven is central, and the other six surround it, and are each connected with it. As a specimen of this arrangement the following location of the seven classes may suffice.

| | | |
|---|---|---|
| | LEPIDOPTERA. | |
| HEMIPTERA. | | DIPTERA. |
| | NEUROPTERA. | |
| ORTHOPTERA. | | HYMENOPTERA. |
| | COLEOPTERA. | |

This septenary system is now making evident progress, after having been written against with what the author thinks unnecessary severity ; unnecessary, because temperate argument and persevering enquiry do more to elicit truth, and fair, moderate statements more to establish it, than angry words and flat contradictions. The author has never met with a single argument, either in print or in the course of conversation, to shake his steadfast belief that the septenary system is the system of nature. Almost every new form of insects that we receive from distant countries,—almost every newly ascertained fact in metamorphosis, adds an additional link to the evidence already recorded on this interesting subject; whereas, were the system ideal or applicable only to the comparatively small number of insects with which we are acquainted, each new form must prove an argument against its truth, and consequently a barrier to its reception.

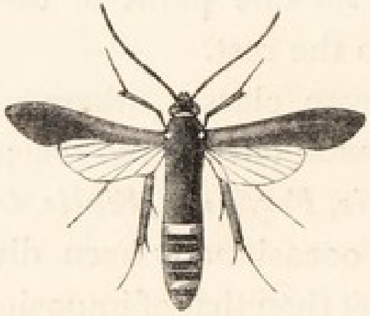
They who have only superficially glanced at this system find a ready argument against it in the obvious difficulty of resolving all groups into any uniform number of divisions, and thus they set a stumbling-block at the very threshold of the enquiry. The preponderance of the number seven is apparently the effect of the centrality of types, precisely as the hexagonal cells of a bee-hive result from the pressing together of circles. But neither in the centrality of types, nor in the mystic number seven, is the *test* of the septenary system. Systematists have always insisted on some one or two characters which they conceived to be of greater value than certain other characters: thus Swammerdam believed that in the preparatory states of an insect was to be found the clew to its natural situation: Linneus, whose name is familiar to every child who has ever sought out the name of an animal or plant, believed that difference in the structure of the wings afforded the best divisional characters: and lastly, Fabricius, discarding the ideas of Swammerdam and Linneus, insisted that in the variations of the mouth was to be found the key to natural arrangement. Thus we have three systems; that of Swammerdam, or the "metamorphotic," that of Linneus, or the "alary," and that of Fabricius, or the "maxillary." All naturalists have acknowledged the merits of one or other of these systems, and the numbers in favour of each may be said to be nearly balanced. Latreille, the great master of modern Entomology, not knowing to which of the three to give the preference, proposed a fourth, in which he attempted to combine the other three; but in this he failed, owing to his adherence to the belief that no arrangement otherwise than in a right line could be in accordance with the plan of nature: Latreille's system was called the "eclectic."

Now although the metamorphotic, alary and maxillary systems are so carried out as to be at variance with each other, and although the various advocates of each have in set terms denounced the others; yet the septenary system is in perfect and exact accordance with each of them and depends on them as the best tests whereby its truth may be made manifest: for whether we avail ourselves of the approved characters of metamorphosis, wings and mouth, or draw up fresh characters from other prominent parts yet untested, as the *pro- meso-* and *metathorax*, we shall find the variations of each and all perfectly in accordance with the septenary system: no arrangement dependent on metamorphotic or structural variation can ever interfere with it.

The position of Lepidoptera at the head of this system is merely for the sake of convenience; the *relative* position of the classes must be preserved, but they are supposed to constitute a circle, no one point of the circumference of which is superior to the rest.

Besides these seven classes others under the name of orders have been made out for the reception of single genera, as *Sirex*, *Aphis*, *Forficula*, *Sialis*, *Coccus* &c., and the larger classes have occasionally been divided, without any other apparent object than that of imposing new names. The leading entomological writers of all ages, Aristotle, Linneus, Fabricius, Latreille, Straus-Durckheim, Burmeister, &c., &c., have preferred adhering as nearly as possible to the most simple and obvious primary division of insects. The last-named of these authors observes, "The subdivision of insects into many orders, which the English are especially fond of, certainly merits no recognition; only where nature has set true limits let them be divided, and let us not wilfully destroy the beautiful picture of harmony she every where presents us with." The scientific world seems to agree with this dictum, for the new names of orders are very rarely transplanted from the pages in which they originally saw the light.

The name of '*Sphinx Vespiformis*' has little connection with the subject of the essay further than its being the original name of the insect selected as an object whose place in a natural system the author proposed to find. Concerning the insect to which the name was strictly applicable some doubts appeared to exist, and the author attempted to show that it was synonymous with the *Ægeria Asiliformis* of our cabinets. The insect is figured below.



The Spurge Hawk-moth sucking the blossom of Honey-suckle.

## CHAPTER II.

### OF THE CLASSIFICATION OF LEPIDOPTERA.

CHARACTER amorphous: *i. e. larva* and *pupa* bearing no resemblance in external appearance to the *imago: pupa* perfectly quiescent, having the limbs and parts of the mouth enclosed with the body, in a hard brittle skin or case. *Larva* with strong corneous mandibles, moving horizontally, and six articulated feet, situated in pairs on the second, third and fourth segments: the fifth, sixth, eleventh and twelfth segments invariably without feet: the other segments each subject to the possession of a pair of fleshy prehensile feet: feeds on the leaves, bark, wood, or roots of vegetables, and rarely on other *larvæ*. *Imago* with short, undeveloped, immoveable *labrum* and mandibles: *maxillæ* elongate, palpigerous, slender, flexible and tubular; when at rest, convoluted between the labial feelers; *labium* triangular, bearing two erect conspicuous feelers: all the wings fully and nearly equally developed, and, together with the body, clothed with scales: feeds on the honey of flowers, and on fruit. The class Lepidoptera contains seven *stirpes* or principal divisions, but the characters will be given minutely in detail, as characters of orders.

Hawk-moths or *Sphingites*. *Larva* naked, of uniform substance, with ten prehensile legs, and a stout, corneous, recurved horn on the *paratelum*. *Pupa* smooth, rounded, generally quite naked; changes in or on the ground. *Imago* with the *antennæ* incrassated in the middle: the tips furnished with a recurved hook composed of fine bristles; wings narrow; hind wings small; body stout; flight rapid and well sustained; diurnal or nocturnal. British genera, *Sesia*, represented at page 101, *Macroglossa*, *Smerinthus*, *Sphinx*, of which the caterpillar is represented at page 82 and the *pupa* at page 196, *Acherontia*, *Deilephila*, the caterpillar of which is represented at page 90, and the perfect insect at page 209.

Skippers or *Hesperites*. *Larva* generally naked, stout in the middle and attenuated at the extremities, with ten prehensile legs. *Pupa* stout, smooth, unangulated; changes in a loose web among the leaves on which the *larva* feeds, attached by the tail and a thread round the middle. *Imago* with the *antennæ* partially clavated; sometimes nearly filiform, hooked at the extremity; the hind wings of the insect, when at rest, reposing in a nearly horizontal position; the fore wings nearly erect: flight diurnal, brisk and bustling. *Hesperia*, *Thymele*.

Butterflies or *Papilionites*. *Larva* sometimes naked, but generally covered with down, hair, or spines: with ten prehensile legs. *Pupa* naked; mostly angulated, always attached by the tail; changes in the air. *Imago* with clavated *antennæ* not hooked; all the wings erect, and meeting above the back when at rest. *Polyommatus*, *Lycæna*, *Thecla*, *Amaryssus*, *Colias*, *Pontia*, *Apatura*, represented at page 85, *Limenitis*, *Hipparchia*, *Vanessa*, represented at pages 112 and 113, *Argynnis*.

Loopers, slender bodies or *Geometrites*. *Larva* naked, slender, and very elongate, with four prehensile feet: in consequence of the length of body without feet, its back is arched in walking. *Pupa* smooth, rounded; situation of change, various. *Imago* with *antennæ* tapering to a point; in the males often highly pectinated: wings ample, expanded; body very slender; flight in the evening, silent, feathery. *Geometra*.

Looper Caterpillar.

Half-loopers or *Phytometrites*. *Larva* naked, elongate, less slender than the preceding, with six prehensile feet; in walking its back is arched, but not so decidedly as in the preceding. *Pupa* smooth, rather pointed at the tail; changes in a slight web. *Imago* with filiform *antennæ*; wings deflexed; body moderately stout; beautifully coloured; often with brilliant metallic markings; flight at all hours; in the hottest sunshine, and at midnight. *Plusia*, *Ophiusa*, *Heliothis*, *Acontia*, *Erastria*, *Phytometra*.

Full-bodied moths or *Noctuites*. *Larva* generally naked, cylindrical, robust, with ten prehensile feet: rolls in a ring when touched. *Pupa* smooth; mostly changes in the ground. *Imago* with filiform *antennæ;* occasionally pectinated in the males; wings small, deflexed; body stout and heavy; colour dusky; flight very rapid; nocturnal. *Noctua*, subdivided into numerous genera.

Millers or *Arctiites*. *Larva* very hairy; sometimes with bunches, brushes, or fascicles of hairs; with ten prehensile legs; rolls in a ring when touched. *Pupa* more or less hairy; changes in a cocoon composed of silk, in which the hairs of the *larva* are always intermixed. *Imago*, the males with somewhat slender bodies and more or less pectinated *antennæ;* active, often flying by day; the females very heavy, sluggish, and often apterous. *Acronycta*, *Spilosoma*, *Arctia*, the caterpillar of which is represented at page 8, *Hypercampa*, *Lithosia*, *Hypogymna*, *Laria*, *Orgyia*.

Eggars or *Bombycites*. *Larva* elongate, cylindrical, of equal substance, hairy; with ten prehensile feet; rolls in a ring when touched. *Pupa* in a silken cocoon, more compact than the preceding. *Imago* with pectinated *antennæ* in both sexes; males with slender bodies, very active, and fly by day; females heavy, sluggish, and seldom fly; predominating colour, fulvous. *Eriogaster*, *Odonestis*, *Gastropacha*, *Lasiocampa*.

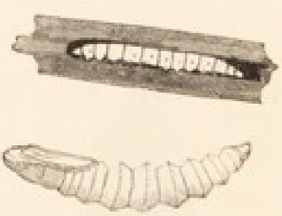
Emperor-moths or *Phalænites*. *Larva* obese, with fascicles of bristles disposed in rings on each segment. *Pupa* short, obtuse, flat, with bristles at the tail; changes in a tough pear-shaped cocoon, of which the smaller end remains partially open. *Imago* with highly pectinated *antennæ* in both sexes; wings amazingly expanded; the fore wings more or less falcate; beautifully coloured, and ocellated; body short and small; flight of the males diurnal; of the females rare, and mostly in the evening. *Saturnia*, the caterpillar of which is represented at page 130.

Prominents or *Notodontites*. *Larva* generally naked; sometimes slightly downy; attenuated towards the tail; with eight prehensile feet; the two posterior ones being mostly wanting, and the segment usually bearing them elevated in the air. *Pupa* smooth, obese, compact; mostly changes in a cocoon or web, but occasionally on or in the ground. *Imago* with the *antennæ* of the males more or less pectinated; wings deflexed; flight, with few exceptions, in the evening. *Endromis*, *Cerura*, *Stauropus*, *Platypteryx*, *Cilix*, *Notodonta*, *Pygæra*, *Clostera*.


Prominent Moth.

Wood-eaters or *Xyleutites*. *Larva* depressed, rather attenuated towards either extremity; naked, except a few scattered hairs; *prothorax* flat and corneous; ten prehensile feet; feeds on the bark, solid wood, pith, or roots of vegetables. *Pupa* furnished with a double row of short spines on each segment; it changes in a tough cocoon amongst its food, after remaining through the winter in the *larva* state. *Imago* with the *antennæ* of the males more or less pectinated: flight nocturnal. *Hepialus*, *Xyleutes*, *Zeuzera*.

Clear-wings or *Ægeriites*. *Larva* and *pupa*, in habit and economy, precisely as in the preceding. *Imago* with *antennæ* incrassated externally, and the tip furnished with a slightly recurved hook, consisting of a few bristles; in the males ciliated; wings narrow, mostly transparent; body elongate, slender, and tufted at the extremity; flight diurnal, in the hottest sunshine, and eminently graceful. *Ægeria*, represented at page 208.


Caterpillar and chrysalis of the Currant Clear-wing.

Burnet-moths or *Glaucopites*. *Larva* obese, hairy, with ten prehensile legs. *Pupa* smooth, very glossy; changes in a close gummy cocoon, pointed at both ends, and attached generally to a blade of grass. *Imago* with clavate *antennæ;* slightly pectinated in the males. *Zygæna, Ino.*

Pearl-moths or *Pyralites. Larva* rather more slender than the foregoing, slightly hairy, with ten prehensile feet. *Pupa* elongate, very lively; changes in a silken cocoon. *Imago* with filiform *antennæ;* wings somewhat triangular, deflexed; legs very long, and furnished with long spurs. *Ennychia, Pyrausta, Hydrocampa, Botys, Scopula, Pyralis, Polypogon, Hypena.*

Veneer-moths or *Crambites. Larva* elongate, naked, with ten prehensile feet. *Pupa* elongate; changes in a slight cocoon. *Imago* with very prominent labial feelers; *antennæ* filiform, sometimes pubescent; wings ample, folded round the body; flight in the evening. *Crambus,* and allied genera.

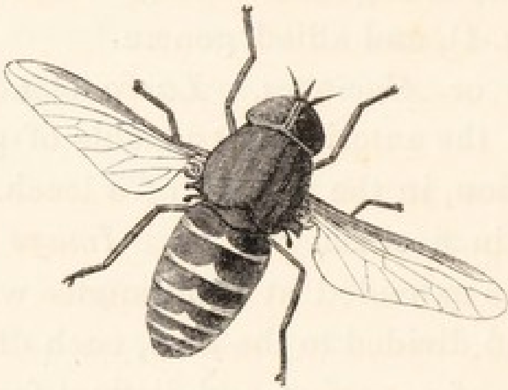
Ermine-moths or *Yponomeutites. Larva* elongate, slightly hairy, with ten prehensile feet; gregarious, spinning a web; if touched, runs backwards, falls and suspends itself by a thread. *Pupa* elongate, smooth; changes in a cocoon amongst its food. *Imago* with filiform *antennæ;* wings folded round the body, often beautifully dotted and marked with black. *Yponomeuta,* and neighbouring genera.

Bell-moths or *Tortricites. Larva* more obese than the foregoing, slightly hairy, with ten prehensile feet; gregarious, spinning a web; if touched, runs backwards with a rapid twisting motion, and falls, hanging by a thread. *Pupa* elongate, attached by the tail; changes in a silken cocoon, generally amidst the web of the *larva. Imago* with filiform *antennæ;* the fore wings with a prominent shoulder, which gives the insect, when at rest, precisely the shape of a bell. *Tortrix,* and allied genera.

Bell-moth.

Clothes-moths or *Tineites*. *Larva* elongate, with ten prehensile legs; concealed in a sack constructed by itself, which it enlarges from time to time as it increases in bulk; feeds on woollen cloths, hair, and decayed animal and vegetable substances. *Pupa* elongate; changes within the sack. *Imago* with filiform *antennæ*, and narrow wings; flight gregarious, rising and falling. *Tinea*, represented at page 199 (fig. 1), and allied genera.

Plume-moths or *Alucitites*. *Larva* slender, with ten prehensile feet; the anterior part capable of great attenuation and extension, in the manner of a leech. *Pupa* elongate; changes in a silken cocoon. *Imago* with filiform *antennæ;* wings extended at right angles with the body; very narrow, and divided to the base, each division having the appearance of a perfect and distinct feather. *Pterophorus*, *Alucita*, represented below.



*Tabanus bovinus.* The common gad-fly.

# CHAPTER III.

## OF THE CLASSIFICATION OF DIPTERA.

In the second class, Diptera, the metamorphosis, as in Lepidoptera, is amorphous. *Larva* with minute corneous mandibles, moving horizontally; without articulate or prehensile feet; feeds on recent or decaying animal and vegetable substances. *Imago* of Diptera with the parts of the mouth variously developed; the mandibles never possessing the horizontal motion, or masticatory power; the fore wings fully developed; the hind wings undeveloped; assuming the appearance of small pedunculated knobs, and denominated *halteres* or poisers; *tarsi* five-jointed.

Wheat-flies or *Cecidomyites*. *Larva* elongate, feeds on the blossoms of wheat and other grain, the leaves of plants, &c., causing excrescences. *Pupa* changes in the same situation, in a tough case. *Imago* usually with moniliform *antennæ*, as long as the body, composed of about twelve or thirteen joints in the female, and twice as many in the male : maxillary feelers four-jointed ; *ligula* short, obtuse, and tomentose ; wings wide, as long as the body, which they cover horizontally ; female furnished with a long oviduct. *Cecidomyia*, *Campylomyza*.

Crane-flies or *Tipulites*. *Larva* stout, very soft, attenuated anteriorly, abruptly terminated posteriorly ; feeds on the roots of corn, grass, and other vegetables, or occasionally on decayed wood. *Pupa* changes in the same situations ; it has often two remarkable recurved horns, porrected from its head, through which it is said to breathe ; and the segments of the body are mostly armed with spines. *Imago* with *antennæ* thirteen to seventeen-jointed ; frequently pectinated in the males ; *ligula* fleshy, bilobed, dilated ; maxillary feelers five-jointed, curved, the points turning outwards ; *ocelli* none. *Ctenophora*, *Pedicia*, *Tipula*, *Erioptera*, *Limnobia*.

Fungus-flies or *Mycetophilites*. *Larva* elongate, glabrous ; feeds on decaying *fungi*. *Pupa* changes in the same situations. *Imago* with *antennæ* sixteen-jointed, sometimes very long, moniliform, and simple in both sexes ; *ligula* and other organs of the mouth obscurely developed or obsolete ; *ocelli* three ; wings rather wide, covering the body horizontally ; body very slender, the same length as the wings ; legs long. *Bolitophila*, *Macrocera*, *Synapha*, *Mycetobia*, *Platyura*, *Sciophila*, *Leia*, *Mycetophila*, *Molobrus*, *Lestrema*, *Zygoneura*.

*Rhyphites*. *Larva* very elongate, smooth, cylindrical, encompassed by eleven corneous shining rings ; head furnished with two hooks; tail with four short cylindrical tubes: inhabits the earth and cow-dung. *Pupa* changes in the earth. *Imago* with filiform, sixteen-jointed *antennæ*, rather longer than the head; *ocelli* three; maxillary feelers four-jointed; *ligula* distinctly bilobed, other parts of the mouth not fully developed; wings broad, lying horizontally on the body, which they much exceed in length. *Rhyphus.*

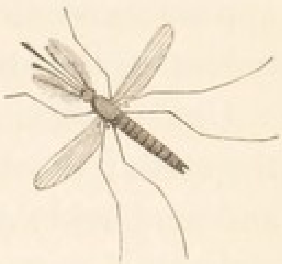
*Bibionites.* *Larva* elongate, attenuated at each extremity; divisions of the segments deeply marked and fringed with hairs; head furnished with two obtuse hooks: inhabits earth, on which it appears to feed. *Pupa* changes in the earth. *Imago* with short, nine-jointed *antennæ;* maxillary feelers four or five-jointed; *ligula* pubescent and bilobed, the other parts of the mouth obsolete; head and eyes large in the male, small in the female; *ocelli* three. In the spring and autumn every lane and meadow swarms with these insects, either sailing in the air like balloons, or settled on vegetables. *Bibio*, *Dilophus.*

*Scatopsites.* *Larva* elongate, fusiform, apod, having two short spines at the sides of the *prothorax* and abdominal segments; the body is terminated by two elongate divergent *setæ.* *Pupa* unknown. *Imago* with *antennæ* cylindric-conic, acute, twelve-jointed; *ligula* small, pubescent, and bilobed; maxillary feelers very short, exarticulate. Inhabits flowers; is sluggish in its movements. *Scatops.*

Musquitoes or *Simuliites.* *Larva* aquatic; supposed to feed on vegetable substances; elongate, cylindrical, incrassated posteriorly, semi-transparent. *Pupa* also aquatic, but quiescent; ovate, gibbous, brown-coloured, clearly exhibiting all the parts of the future *imago.* *Imago* with *antennæ* eleven-jointed, very short; maxillary feelers elongate, incurved, composed of four distinct joints, the fourth very long and pointed; the *labrum*, mandibles, and *max-*

*illæ*, sharp and wedge-shaped; the *ligula* fleshy and bilobed; *ocelli* none; wings very wide, with stout and nearly parallel costal nervures; *mesothorax* globose, very prominent; body short and small, colour black. Inhabits woods, feeding on the blood of man and animals. *Simulia*, represented at page 5.

Gnats or *Culicites*. *Larva* elongate, carnivorous, active, aquatic. *Pupa* equally active, but rather shorter, and the head and *prothorax* much incrassated. *Imago* with fourteen-jointed *antennæ*, plumose in the males, hairy in the females; *ligula* slender and elongate, forming, together with the mandibles, *maxillæ*, tongue and *labrum*, a porrected blood-sucking apparatus; the maxillary feelers are long, divaricating, and clavate; all the organs of the mouth exceed the *antennæ* in length; *ocelli* none; wings linear, covering the body; body narrow, linear, elongate; legs very long. Inhabits woods, &c., often entering houses: feeds on the blood of man and quadrupeds. The zanquedoes, gallinippers, &c., of the American continents, and the musquitoes of many writers belong to this order. *Culex*, *Anopheles*, *Chironomus*, *Tanypus*.



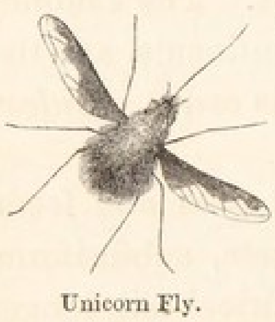
Blood-sucking Gnat.

Moth gnats or *Psychodites*. *Larva* inhabits and feeds on dung, putrescent *fungi*, &c.; elongate, subfusiform, depressed, with a slender, straight, cylindrical tail, longer than the preceding segment. *Pupa* changes in the same situation; it has two short appendages, thickened at the tips, behind the head. *Imago* with *antennæ* filiform and perfectly simple, alike in both sexes; *ligula* short, entire, somewhat pointed; wings deflexed, very hairy, enveloping the body laterally, and their inner margins uniting above it. *Psychoda*.

Bald-headed flies or *Cyrtites*. *Larva* and *pupa* unknown.

*Imago* with *antennæ* seven-jointed, entirely concealed, so that the head appears perfectly globular; the basal joint is short and small, the second stout, and the remaining five united into one, which is very acute at the *apex*, and somewhat incrassated at the base: *ligula*, a slender tube; *ocelli* three; wings longer than the body, but too narrow to cover it; *alulæ* large; *prothorax* and body very globose. Inhabit white-thorn, furze, rushes &c.; very seldom fly, and appear exceedingly sluggish. The body is so soft as to indent on the slightest pressure. *Henops*, *Acrocera*.

Unicorn flies or *Bombyliites*. *Larva* and *pupa* inhabit the earth; the latter has the back much arched, the front and underside of the head armed with strong spines; the abdominal segments furnished at the sides with long curved *setæ*, dorsally with transverse series of strong hooks; the leg-cases extend considerably beyond the wing-cases, and the case which encloses the *proboscis* lies between the legs; the extremity of the body is also spined. *Imago* with *antennæ* composed of seven joints; the basal and second joint short; the apical portion long, linear and consisting of five united joints, of which the terminal one is acute; *ligula*, very long rigid and porrected like a horn; *ocelli* three; wings widely divaricating, narrow, variegated; *alulæ* small; legs long, slender; body short, globose, very hairy. Inhabits lanes and woods, hovering over flowers, &c. *Bombylius*.



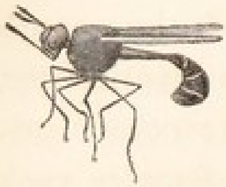
Unicorn Fly.

Gad-flies or *Tabanites*. *Larva* inhabits the earth; is elongate, cylindrical; head corneous, linear, elongate, and furnished with two hooks. *Pupa* changes in the earth; has two tubercles anteriorly, and six sharp points near the posterior extremity. *Imago* with *antennæ* composed of seven joints, the basal joint long and rather stout, the second minute, the remaining five of various dimensions and sizes, differing in the different genera; *ligula* large, bilobed, porrected; and the other organs of the mouth very perfectly developed; *ocelli* none; wings divaricating, as long as the body; *alulæ* large; body flat; colour griseous: male feeds on the pollen of flowers; females suck the blood of man and quadrupeds. *Tabanus*, represented at page 216, *Hæmatopota*, *Chrysops*.

Painted winged flies or *Anthracites*. *Larva* parasitical on some species of bees, slightly elongate; head corneous, and furnished with two hooks. *Pupa* changes in the nest of the bee; has the back much arched; the head corneous, and armed with spines. *Imago* with the *antennæ* composed of seven joints; the basal joint long and stout, the second globular, and the remaining five frequently united into one; *ligula* large, fleshy, bilobed, and rather porrected; *ocelli* three; wings somewhat divaricating, long, extending beyond the body, beautifully variegated with black or brown; *alulæ* small; body flattened, truncate at the extremity. Inhabits the borders of woods and heaths, settling on flowers. *Anthrax*, *Stygia*.

Piercing flies or *Stomoxites*. *Larva* and *pupa* unknown. *Imago* with the *antennæ* six-jointed, the basal and second joints short, the third produced inferiorly, pendulous, and received into a cavity in front of the head; the remaining joints forming a *seta* which is often plumose; *ligula* very elongate, and porrected in front of the head; wings slightly divaricate; *alulæ* very large; body stout; colour griseous or mottled. Inhabits woods, meadows, houses, &c., feeding on the pollen of flowers, and the blood of man and quadrupeds. *Stomoxys*, *Bucentes*.

Wasp flies or *Conopites*. *Larva* elongate; feeds in the bodies of humble bees. *Pupa* changes in the same situations. *Imago* with *antennæ* placed on a distinct pedicle, six-jointed; basal joint long, second and third long and incrassated, the remaining ones short and decreasing to a point; *ligula* long, porrected; wings narrow, divaricating; *alulæ* obsolete; body elongate, narrow, recurved. Inhabits woods, feeding on composite flowers, and occasionally, it is said, sucking the blood of cattle. *Conops.*



Wasp Fly.

Bots, breeze-flies or *Œstrites.* *Larva* oblong; feeds in the stomachs, frontal cavities, or backs of quadrupeds; when full fed it falls to the ground. *Pupa* changes in the earth, or, if the *larva* inhabit the stomach, in the dung of the animal it has preyed on. *Imago* with six-jointed *antennæ;* basal and second joints short, scarcely distinct; third large, globose; the remaining three forming a *seta,* which is incrassated at the base; organs of the mouth obsolete; wings divaricating; *alulæ* moderately large; body pilose, short, stout. Inhabits meadows and commons, flying about cattle in order to deposit its eggs. *Œstrus,* represented in all its states at page 24.

Ant-lion flies or *Leptites.* *Larva* elongate, rather attenuated at the anterior end; inhabits funnel-shaped holes, which it constructs in loose sand, to serve as a pitfall to small insects, on which it feeds. *Pupa* changes in the same situation. *Imago* with *antennæ* five-jointed; the basal, second, and third joints short and somewhat globose, but varying much in the genera; the fourth and fifth closely united, and forming a long, slender *seta; ligula* large, membranous, bilobed; the maxillary feelers long, two-jointed and porrected; *ocelli* three; wings long, divaricating, often spotted; *alulæ* obsolete. Inhabits moist hedges; preys on small insects. *Leptis, Atherix, Rhagio.*

Downy flies or *Therevites.* *Larva* very elongate, with two air-tubes at the posterior extremity, and the divisions of its segments very distinct; inhabits moist sand, mud, and moss. *Pupa* changes in the same situations. *Imago* with the *antennæ* composed of seven joints; the basal joint longer than the second, the remaining five united into one, which is acute at the *apex;* the *ligula* is short, linear, and bilobed; the wings cover the body; *alulæ* obsolete; body very hairy. Inhabits the sand of the sea-shore, roads, &c., making short flights: preys on small insects. *Thereva.*

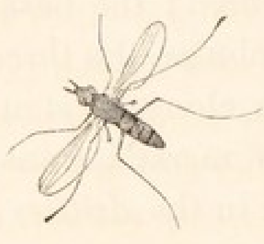
Tiger flies or *Asilites.* *Larva* inhabits the earth; it is elongate, cylindrical, slightly depressed, very smooth, and has a corneous head, which is armed with two hooks: feeds on the minute insects which abound near the surface of the ground, especially at the roots of grass. *Pupa* smooth, anteriorly cylindrical, posteriorly conical; the body laterally, and at the extremity, is furnished with small spines. *Imago* with the *antennæ* five-jointed; the basal and second joints moderately long, the three forming the apical portion always distinct; the terminal joint acute, but not setiform; *ligula* large, cylindrical, and corneous; *ocelli* three; wings as long as the body, which they cover horizontally; *alulæ* obsolete; body elongate, hairy. Inhabits heaths, &c., settling on the ground, and preying on other insects. *Dasypogon, Asilus, Gonipes.*

Midas flies or *Midasites.* *Larva* supposed in one instance to be parasitical on a species of *Prionus.* *Pupa* unknown. *Imago* with the *antennæ* five-jointed; the basal joint long, the second short and nearly globular, the three forming the apical portion united into an elongate, stout club, on which the union of the joints is marked transversely; *ligula* longer and more acute than in the *Asilites;* *maxillæ* and mandibles acute; *ocelli* nearly obsolete; wings as in the *Asilites;* legs and body hirsute. Inhabits woods and forests, settling on leaves, &c., preying voraciously on insects, particularly *Hymenoptera.* *Dioctria, Laphria.*

Bird's-beaked flies or *Empites*. *Larva* inhabits the earth, elongate, incrassated posteriorly. *Pupa* elongate, has four long bristles on the head; the segments of the abdomen are also furnished at the extremity with rows of bristles. *Imago* with *antennæ* five-jointed; the basal joint oblong, the second nearly globular, the three forming the apical portion often united, of different proportions in different genera; *ligula* very long, slender, recurved, containing elongate, acute *maxillæ*, &c., and resembling very much the beak of a bird; *ocelli* three; wings large, particularly wide in the female; *alulæ* small or obsolete; body rather hairy, linear, slender. Inhabits woods, lanes, and gardens, preying on other insects. *Hilara, Gloma, Empis, Rhamphomyia, Hybos.*

*Tachydromiites*. *Larva* and *pupa* unknown. *Imago* with *antennæ* five-jointed; the basal and second joints oblong, the third elongate and robust, the fourth and fifth forming a *seta*, which is bent nearly at a right angle with the third; *ligula* short, bilobed; *ocelli* three; wings very large and wide, lying horizontally on the back; body rather pilose, short, stout, pointed. Inhabits woods, preying on minute insects; black, brown, or fulvous. *Hemerodromia, Tachydromia, Platypalpus, Drapetis, Lonchoptera.*

Silvery flies or *Dolichopites*. *Larva* attenuate at the extremities, elongate; inhabits moist earth and mud. *Pupa* changes in the same situations. *Imago* with the *antennæ* five-jointed; the basal, second, and third joints robust, the fourth and fifth forming a *seta; ligula* very stout, short, and bilobed; *ocelli* three; wings very large, lying horizontally over the body; *alulæ* obsolete; legs very long, and often having the *tarsi* adorned with a plume of hairs; body short and small; green, with a silvery pilosity.—



Silvery Fly.

Frequents damp places, preying upon small insects. *Porphyrops, Chrysotus, Dolichopus, Medeterus.*

Wood-eating flies or *Xylophagites. Larva* elongate, inhabits decaying wood. *Pupa* changes in the same situations: in a cocoon. *Imago* with the *antennæ* ten-jointed; the basal and second joints are short, moderately robust, and hairy; the portion corresponding to the apical *seta* of the *Muscina* is robust, and composed of eight distinct joints; *ligula* large, fleshy and pilose; *ocelli* three; wings horizontally covering the body; *alulæ* none; hind *tarsi* often dilated in the males; body linear, very depressed. *Xylophagus, Actina, Beris.*

Chameleon flies or *Stratiomites. Larva* very elongate, attenuated at the anterior end, composed of twelve very distinct segments, besides the head; posterior extremity radiated; inhabits the water. *Pupa* changes on the surface of the water and continues floating: no material alteration in the form takes place. *Imago* with the *antennæ* eight-jointed; the basal and second joints are uniformly robust and hairy; the *ligula* is large, fleshy, and bilobed; *ocelli* three; wings narrow, reposing one on the other, and seldom wholly covering the body, which appears on each side; *alulæ* obsolete; body very flat, short and wide. Flies in the sunshine, settling on leaves and flowers. *Stratiomys, Odontomyia, Oxycera, Nemotelus, Sargus.*

Golden-banded flies or *Chrysotoxites. Larva* and *pupa* unknown; the former supposed to feed on the roots of corn, &c. *Imago* with the *antennæ* six-jointed; basal and second joints long and slender, third very long and more robust, the remaining three forming a slender and perfectly uniform *seta*, which arises from near the base of the third; *ligula* large, much dilated, bilobed; wings divaricating, covering the body; *alulæ* small or obsolete; body very stout, convex above. Inhabits woods, &c.; flies briskly in the sunshine. *Microdon, Chrysotoxum.*

Aphidivorous flies or *Syrphites*. *Larva* flat, capable of great elongation anteriorly; inhabits the leaves of plants, feeding on *Aphites*. *Pupa* changes adhering to the leaf. *Imago* with *antennæ* six-jointed; the first and second joints minute, the third stout and somewhat globose: the remainder forming a *seta* attached to the third, near its base; *ligula* stout, dilated, bilobed: wings as in the *Chrysotoxites;* body glabrous, brown, banded with brighter colours. Flies in the sunshine, settling on flowers. *Ascia, Sphegina, Baccha, Eumerus, Psilota, Pipiza, Cheilosia, Scæva, Syrphus.*

Sun-loving flies or *Helophilites*. *Larva* obese, generally furnished with a long tube at the posterior extremity, through which it breathes; inhabits mud, and all kinds of semi-liquid filth. *Pupa* changes in the air, attached to walls, &c. *Imago* with *antennæ* and mouth nearly as in the preceding order; *ocelli* three; body more linear; hind *femora* often incrassated and curved; colours brilliant. Flies in the sunshine, settling on flowers. *Helophilus, Xylota, Myolepta, Eristalis.*

Bee-flies or *Volucellites*. *Larva* less elongate, spined at the posterior extremity; inhabits the nests of humble bees, feeding on the wax. *Pupa* changes in the same situation. *Imago* with *antennæ* six-jointed; the portion forming the *seta* plumose; parts of the mouth nearly as in the two preceding orders: *ocelli* three; body obese, often very hirsute. Flies in the sunshine, settling on flowers. *Criorhina, Sericomyia, Volucella.*

Volucella plumata.

Long-tongued flies or *Rhingiites*. *Larva* and *pupa* unknown. *Imago* with *antennæ* six-jointed, the third joint somewhat cordate; the portion forming the *seta* perfectly naked: *ligula* slender, bifid, and capable of great elongation; *ocelli* three; body obese, naked, resembling in appearance the *Muscites*. Flies in the sunshine, settling on flowers. *Rhingia, Brachyopa.*

Flies or *Muscites*. *Larva* obese; feeds on dung, putrid flesh and vegetables, bark and roots of trees, *fungi*, &c. *Pupa* changes in similar situations, oblong, perfectly uniform and rounded as though turned in a lathe. *Imago* with the apical *seta* of the *antennæ* triarticulate; *ligula* elongate, dilated at the extremity, retractile; *alulæ* of the wings distinct and conspicuous; body hairy; form obese; colour black, brown, or grey, with metallic green and blue. *Phasia, Gymnosoma, Phania, Miltogramma, Gonia, Trixa, Tachina, Echinomyia, Melanophora, Leucostoma, Metopia, Exorista, Eriothrix, Ocypteryx, Dexia, Mesembrina, Sarcophaga, Musca, Anthomyia, Cœnosia, Lispe.*

Dung-flies or *Scatophagites*. *Larva* inhabits dung, *fungi*, putrid substances, and the pith of plants. *Pupa* as in the *Muscites*. *Imago* with the apical *seta* of the *antennæ* obscurely triarticulate; *ligula* elongate, slightly recurved, scarcely dilated, retractile; *alulæ* of the wings very minute; body very hairy; form oblong; colour yellow. *Scatophaga, Dryomyza, Sapromyza.*

*Tetanocerites*. *Larva* inhabits moist plants, fruit, putrid substances, also mud at the banks of ponds, rivers, and all wet places. *Pupa* as in the *Muscites*. *Imago* with the apical *seta* of the *antennæ* exarticulate; *ligula* short and broad; *alulæ* of the wings wanting; wings narrow; form elongate, often very slender: glabrous or slightly hairy; colour black, black with yellow spots, brown or yellowish. *Ortalis, Sepsis, Lonchæa, Lauxania, Ulidia, Piophila, Psila, Calobata, Micropeza, Tetanocera, Loxocera, Heteromyza, Platycephala, Sciomyza, Lucina, Chryliza, Lissa, Platystoma, Sepedon, Dorycera.*

Variegated flies or *Tephritites*. *Larva* inhabits galls or excrescences on the bark and leaves of plants. *Pupa* as in the *Muscites*. *Imago* with the apical *seta* of the *antennæ* exarticulate; *ligula* large, fleshy, bilobed and pilose; *alulæ* of the wings wanting; wings rather wider than in the preceding order, beautifully variegated, striped and spotted with different shades of black and brown; body glabrous, or with a slight pilosity, of moderate length and stoutness, and, in the females, furnished with a large, exserted and conspicuous ovipositor. *Tephritis.*

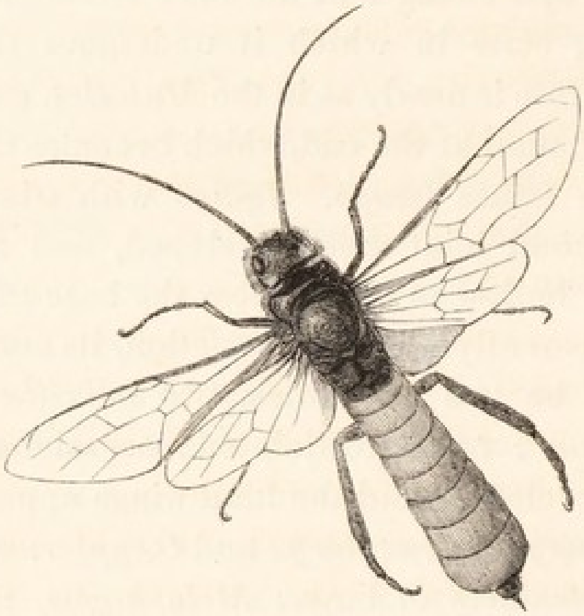
Tephritis cornuta.

*Phytomyzites.* *Larva* inhabits the interior of plants and fruits, and sometimes putrid substances. *Pupa* as in the *Muscites.* *Imago* with the apical *seta* of the *antennæ* exarticulate; *ligula* large, fleshy, clavate; *alulæ* of the wings wanting; wings as wide as in the preceding order; the body very delicate, often very slender, glabrous; colour black, or black variegated with yellow. *Phytomyza, Chlorops, Meromyza, Agromyza, Discomyza, Gymnopa, Asteia, Drosephila, Ochthiphila, Opomyza.*

*Phorites.* *Larva* inhabits the flowers and seeds of vegetables, and the *larvæ* of other insects. *Pupa* as in the *Muscites.* In the *imago* the apical *seta* of the *antennæ* is composed of four joints, the three basal ones being very short, the apical one very long; *ligula* very short; *alulæ* of the wings wanting; wings very wide, extending beyond the body, which is very small, acute at the extremity, and in colour inclining to black or yellow. *Phora.*

*Borborites.* *Larva* inhabits putrid animal and vegetable substances. *Pupa* as in the *Muscites.* *Imago* with the apical portion of the *antennæ* perfectly simple and exarticulate, sometimes orbicular; *ligula* large, membranous and bilobed; *alulæ* of the wings wanting; wings very large and wide; body very small, and of a black colour. *Borborus, Ochthera, Ephydra, Notiphila, Homalura, Orygma, Cœlopa.*

Horse-flies or *Hippoboscites*. *Larva* apod and nearly spherical, is nourished and attains perfection in the ovary of its parent. *Pupa* changes in the same situation, and is produced in the state in which it undergoes the final change ; its structure is nearly as in the *Muscites*, excepting an evident indentation at the end, which becomes the lower extremity of the future *imago*. *Imago* with triarticulate *antennæ*, the second joint most developed, and the third originating in a hollow or socket near the base of the second ; mouth apparently adapted for suction, its component parts appear to be two mandibles, two *maxillæ*, and a sheath-like *labium* ; *tarsi* five-jointed ; occasionally with the fore wings developed, and the hind wings appearing as poisers. *Ornithomyia*, *Stenepteryx* and *Oxypterum*, which live among the feathers of birds : *Melophagus*, the well-known sheep-tick, frequents the wool of sheep : *Hippobosca*, the horse-fly, runs over the softer uncovered parts of the horse's skin, causing so intolerable an itching that horses unaccustomed to the fly become perfectly ungovernable, and have often been known to throw their riders and gallop headlong over fields or commons regardless of danger.



*Sirex gigas*; an insect which, in the larva state, is very destructive to fir timber.

# CHAPTER IV.

## OF THE CLASSIFICATION OF HYMENOPTERA.

THE metamorphosis in the third class, Hymenoptera, is necromorphous. The *larva* bears no resemblance to the *imago;* it has small corneous mandibles, moving horizontally; in seven orders it has six articulate, and from twelve to sixteen prehensile feet; in the remaining orders it is without feet. *Pupa* quiescent, having the organs of locomotion and manducation confined by a shell-like skin; yet displaying all the limbs and organs, placed in order by the sides of the body, and detached from it, except at the usual points of connexion. *Imago* with the mandibles strong, moving horizontally, and masticatory; the other organs of the mouth fully developed; *ocelli* three; wings all developed, the fore wings exceeding the hind in size, membraneous, and used in flying; the *mesothorax* largely developed at the expense of the *pro-* and *metathorax;* the *podeon* mostly restricted; the *tarsi*, with few exceptions, five-jointed. Food very various.

Social ants or *Formicites*. *Larva* an inactive, obese, voracious maggot, residing entirely in the earth, and dependant for food on the care of the perfect insects. *Pupa* changes in a tough leathery cocoon; these cocoons are commonly known as "ants' eggs." *Imago* with the *antennæ* composed of about thirteen joints, often elbowed, slightly incrassated exteriorly; mandibles somewhat triangular, toothed; *maxillæ* obtuse; *labium* short, obtuse, its *ligula* not produced; maxillary and labial feelers fully developed and distinctly articulate; fore wings ample; hind wings small; lives under ground in immense societies, consisting of three kinds of individuals, males, females and abortive females. *Formica*, represented at page 41, *Myrmica*.

Solitary ants or *Mutillites*. *Larva* and *pupa* unknown. *Imago* with *antennæ* composed of about thirteen joints, not elbowed, rather attenuated exteriorly; mandibles long, dentate at the *apex; maxillæ* obtuse; *labium* short, obtuse, its *ligula* not produced; maxillary and labial feelers fully developed and distinctly articulate; *ocelli* indistinct or wanting; wings possessed by the males only; females usually with the *pro- meso-* and *metathorax* equally developed; abortive females none. Inhabits sandy situations, and is solitary. *Mutilla*, *Myrmosa*, *Methoca*.

*Scholiites*. *Larva* an elongate, inactive maggot; inhabits a burrow or hole made in the sand by its parent, and feeds on *larvæ* or occasionally on perfect insects which she has provided for its sustenance. *Pupa* changes in a silken cocoon spun by the *larva* at the bottom of its domicile.

*Imago* with *antennæ* composed of about thirteen joints, very short, recurved, almost forming a ring; mandibles short, strong, dentate; *maxillæ* long, their feelers also long; *labium* longer than in the *Formicites;* its *ligula* trilobed; *ocelli* three, distinct; wings alike in both sexes; legs short, stout, spiny; female with a pungent sting. Solitary; inhabits sandy districts, settling occasionally on umbellate flowers; feeds on insects. *Tiphia.*

*Sapygites.* *Larva* and *pupa* supposed to be as in the preceding order. *Imago* with *antennæ* composed of about thirteen joints, exteriorly incrassated, particularly in the males, longer and more robust than in the preceding order; mandibles, *labium,* &c., nearly as in the *Scholiites;* *ocelli* three, distinct; wings alike in both sexes; legs short but slender, and without spines; female with a sting. Solitary; female inhabits walls, palings and posts; male settles on umbellate flowers. *Sapyga.*

Sapyga prisma.

Sand-wasps or *Pompilites.* *Larva* and *pupa* as in *Scholiites,* the food of the former consisting frequently of spiders provided by its parent. *Imago* with *antennæ* composed of about thirteen joints, more long and slender than in the two preceding orders, attenuated exteriorly, and mostly recurved; mandibles long, and dentate at the *apex;* *labium* short, with its *ligula* short and trilobed; *ocelli* three, distinct; wings alike in both sexes; legs long, spiny; female armed with a sting. Inhabits sunny banks in sandy situations, running among grass, &c. with great activity, and continually vibrating its *antennæ* and wings; feeds on insects. *Ceropales, Pompilus, Aporus.*

Sphexes or *Sphecites.* *Larva* and *pupa* as in *Scholiites,* the food differing only in the kind of insect provided. *Imago* with the *antennæ* composed of thirteen joints, short and recurved in both sexes; mandibles very long, acute; *maxillæ* very long, obtuse at the *apex* of their *lacinia; labium* with its *ligula* elongate, bifid and flexible; *ocelli* three; *podeon* elongate and very slender, whereas in the three preceding orders it is very short; legs long. Inhabits sandy situations, flying heavily, but running with agility, and feeding on insects. *Ammophila*. *Chlorion*, a foreign insect divided from the genus *Sphex*, is figured at page 145.

*Larrites*. *Larva* and *pupa* as in the *Scholiites*, the former frequently feeding on *Cimicites*, provided for it by its parent. *Imago* with *antennæ* composed of thirteen joints, shorter in the females than the males, and often incrassated exteriorly; mandibles less elongate than in the *Sphecites*, and bifid at the *apex; maxillæ* very obtuse; *labium* short, its *ligula* short, obtuse, and bilobed; *ocelli* three; *podeon* generally short and indistinct; legs moderately long. Inhabits sandy situations, frequently settling on stones and leaves and occasionally on umbellate flowers; feeds on insects. *Gorytes, Psen, Larra, Lyrops, Dinetus, Trypoxylon, Oxybelus, Astata*.

False wasps or *Crabronites*. *Larva* and *pupa* as in the *Scholiites*, excepting that in this order many are frequently found in the same burrow. *Imago* with *antennæ* thirteen-jointed, short, and slightly incrassated externally; mandibles long, acute, and terminating in a single point; *maxillæ* obtuse; *labium* elongate, its *ligula* short, dilated, obtuse, and terminating in four lobes; *ocelli* three; head very large, square; legs short and stout, fore legs often patellated; body, with its greatest diameter about the ninth segment, very glabrous, black, or black and yellow. Inhabits sandy banks, settling on leaves, stones and umbellate flowers.—*Cerceris, Philanthus, Crabro, Rhopalum, Stigmus*.

Wasps or *Vespites*. *Larva* an obese, inactive maggot, inhabiting a cell provided by its parent, who supplies it with food, consisting of honey, pollen, &c. *Pupa* changes in a silken cocoon, which the *larva* spins in its cell. *Imago* with *antennæ* composed of twelve joints in the female, thirteen in the male, slightly elbowed at the second joint; eyes somewhat reniform, the indented portions facing each other; *ocelli* three; upper wings folded longitudinally; *podeon* slender, but short; eighth segment largest, both as to length and breadth. Live commonly in societies composed of three kinds of individuals, males, females, and abortive females: inhabit all climates and all situations, building in the ground, or suspending from branches or amid the twigs of trees, large and somewhat circular nests, composed of a material much resembling whity-brown paper: in these the combs are arranged horizontally in several tiers. *Vespa*, *Eumenes*, *Odynerus*, *Epipone*.

Carpenter-bees or *Osmiites*. *Larva* an obese, inactive maggot, deposited as an egg in the midst of a semi-fluid substance, composed of honey and pollen, collected by its parent, and stored in cells which are constructed for the purpose, mostly in timber which is going to decay. *Imago* with *antennæ* twelve-jointed in the female, thirteen-jointed in the male; they are slightly elbowed at the second joint, which is much longer than the others; the blade of the *maxillæ* is elongate and somewhat falcate; the maxillary feelers are minute, and generally composed of six indistinct joints; the *labium* has its *ligula* variously developed; it is always trilobed, but the central lobe, though always elongate, varies in the proportion it bears to the labial feelers; the lateral lobes are very minute, short, and acute; the la bial feelers have the basal joint long, the second longer the third and fourth short, somewhat conical, and forming an angle with the second; the hind *tibiæ* are not formed for collecting pollen, but the body of the female is clothed beneath with a thick covering of hair, which serves for this use. *Anthidium, Megachile, Osmia, Heriades, Chelostoma, Ceratina.*

Flower-bees or *Panurgites. Larva* and *pupa*, as far as the British genera are concerned, unknown. *Imago* with *antennæ* twelve-jointed in the females, thirteen-jointed and somewhat moniliform in the males; *maxillæ* with the blade lanceolate and of moderate length; the maxillary feelers of equal length, and six-jointed; *labium* with the *ligula* trilobed, the central lobe about equal to the true lip in length, the lateral lobes very short and acute; the labial feelers with four joints, varying but slightly in length from each other; the feelers exceed the *ligula* in length; wings large, flight slow; insect inactive; body rather stout; black, hairy. Inhabits in immense abundance Cichoraceous flowers on heaths, &c., in autumn. *Panurgus.*

Burrowing-bees or *Andrenites. Larva* inhabits a long tortuous burrow, formed by its parent in the ground; a small heap of earth, produced in excavating the burrow, may almost invariably be observed at its mouth; feeds on a globular pellet of pollen, collected, moistened, and kneaded into a consistent mass, by the parent. *Pupa* changes in the earth. *Imago* with *antennæ* twelve-jointed in the female, thirteen-jointed and of much greater length in the male, elbowed, particularly in the females, at the second joint; *maxillæ* with the blade somewhat obtuse and no longer than the maxillary feeler, which is distinctly six-jointed; *labium* with the *ligula* very short and quadrilobed, the lateral lobes usually equalling the internal ones in length; hind *tibiæ* formed for collecting pollen. Inhabits sunny banks. Two kinds of individuals only, males and females. *Colletes, Dasypoda, Andrena, Halictus, Sphecodes.*

Dasypoda Swammerdamella.

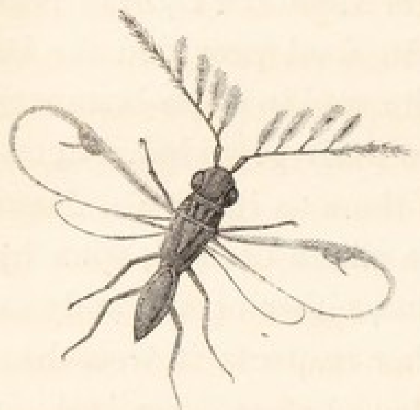
Mason-bees or *Melliturgites*. *Larva* inhabits nests constructed by its parent, either in the ground or against a bank or wall, and consumes pollen provided by its parent, and stored up at the time the egg is deposited. *Pupa* changes in a silken cocoon in the same situation. *Imago* with *antennæ* twelve-jointed in the female, thirteen-jointed in the male, elbowed at the second joint; *maxillæ* with the blade lanceolate, elongate; the maxillary feelers six-jointed and setaceous; *labium* with its *ligula* trilobed, central lobe very long, obtuse, pubescent, lateral lobes not more than a fourth of its length, very acute; *ligula*, labial feelers, and blade of *maxillæ*, nearly corresponding in length; hind *tibiæ* formed for collecting pollen; body short, robust; wings small. Two kinds of individuals only, males and females. *Saropoda*, *Anthophora*.

Social-bees or *Apites*. *Larva* inhabits a cell usually hexagonal, and made of wax by the *imago*, which feeds it with honey or a preparation of pollen. *Pupa* changes in a silken cocoon within the cell. *Imago* with the *antennæ* twelve-jointed in the female, thirteen-jointed in the male, elbowed at the second joint; *labium* with its *ligula* trilobed, the central lobe elongate, hirsute, extending beyond the labial feelers, the lateral lobes very short and obtuse; the labial feelers with the basal joint twice the length of the second, the third and fourth minute, short, and seated on the back of the second, rather before its extremity; blade of the *maxillæ* lanceolate, nearly as long as the labial feelers; maxillary feelers minute, apparently exarticulate; hind *tibiæ* with brushes for collecting pollen. Lives in large societies composed of three kinds of individuals, males, females and abortive females; the latter perform the laborious offices of the commonwealth. *Apis*, the honey-bee, represented in all its states at page 40: *Bombus*, the humble-bee, represented in the imprint on the title-page.

Cuckoo-bees or *Apathites*. *Larva* hatched from an egg, deposited by its parent in the nests of all the preceding bees at the time when their own eggs are laid; when it hatches, being stronger and larger than the rightful possessor of the cell, it consumes the food provided for its companion, and starves it to death; and in those instances in which fresh supplies of food are daily provided, it continues to receive and appropriate them as its own. *Pupa* changes in the same situation, in a silken cocoon, spun by the *larva*. *Imago* has no apparatus, either on the body or legs, for collecting honey; in other respects it resembles in structure each of the orders of bees before described; it enters their nest with perfect familiarity, and seems to be quite unsuspected of intrusion; it collects no pollen or honey, never builds a nest of any kind, nor takes any care of its young, but spends its time among flowers, or hovering about sandbanks in which other bees have fixed their habitations. *Apathus*, *Cœlioxys*, *Melecta*, *Stelis*, *Epeolus*, *Nomada*.

Golden-wasps or *Chrysidites*. *Larva* and *pupa* as in the *Apathites*, the former preying on the food destined for other insects, particularly *Hymenoptera*. *Imago* with the *antennæ* thirteen-jointed in both sexes, the second joint elongated, and forming a slight elbow; *maxillæ* obtuse, dilated, their *palpi* five-jointed; *labium* with the *ligula* obtuse, entire; labial *palpi* three-jointed; *ocelli* three; body convex above, flattened or sometimes concave beneath, furnished in the females with a tubular retractile oviduct, but without a sting; colours excessively brilliant, red, green and blue, with a metallic gloss; abundant in fine sunshiny weather, settling on walls, sandbanks, posts, railings, &c., running with activity, and a vibrating motion of the *antennæ*. *Hedychrum*, *Elampus*, *Chrysis*, *Cleptes*.

*Proctotrupites*. *Larva* inhabits and feeds on the *larvæ* of other insects. *Pupa* changes in the same situations. *Imago* with *antennæ* composed of ten to fifteen joints, elongate in the males, shorter and often clavated in the females; mandibles somewhat elongate, their extremity generally bifid; *maxillæ* with the blade dilated, rounded, feelers generally three-jointed; *labium* with its *ligula* seldom produced, entire, feelers minute, often exarticulate; *ocelli* three; fore wings with a single principal nervure; hind wings without nervures; oviduct of the female tubular and retractile, being simply an elongation of the body. Inhabits grass under trees, &c., during the greater part of the year. *Cinetus*, *Psilus*, *Proctotrupes*, *Platygaster*, *Teleas*, *Ceraphron*, represented in the margin, *Sparasion*, *Dryinus*.



Egg parasites or *Mymarites*. *Larva* inhabits and feeds on the eggs of Lepidopterous insects. *Pupa* changes within the shell of the egg. *Imago* with the *antennæ* nine- to thirteen-jointed, sometimes twice the length of the body in the male, in the female elbowed and clavated: mandibles tridentate at the *apex;* the other organs of the mouth are obsolete or undiscovered; fore wings pedunculated, with one short basal nervure, strongly ciliated; hind wings most commonly a mere *seta;* legs long: *podeon* elongate, slender; ovipositor very slender, concealed beneath the body in a groove. Inhabits grass under trees. *Ooctonus*, *Litus*, *Anagrus*, *Polynema*, *Mymar*, represented at page 199 (fig. 3), *Eustochus*.

Burnished parasites or *Chalcidites*. *Larva* inhabits and devours other insects in all stages, particularly the *larvæ* of *Lepidoptera* and *Diptera*. *Pupa* usually changes within the skin of its victim. *Imago* with the *antennæ* generally composed of thirteen joints, the second long, forming an elbow, the remaining joints generally incrassated towards the *apex;* mandibles obtuse; *maxillæ* with the blade rather produced, but obtuse; maxillary *palpi* four-jointed; *labium* with its *ligula* always produced, but short and entire; labial *palpi* three-jointed; *ocelli* three; head very large, square; fore wings with a single nervure, often ciliated; hind wings nerveless; body short and depressed in the males, more elongate and pointed in the females; oviduct of the female slender, mostly concealed; colour mostly brilliant. *Perilampus*, *Smiera*, *Chalcis*, *Callimome*, *Pteromalus*, *Encyrtus*, *Eulophus*, *Spalangia*, *Eucharis*.

Oak-gall flies or *Cynipites*. *Larva* causes and inhabits the excrescences we observe on the trunks, twigs, leaves, &c., of trees, particularly the oak, and commonly known as "galls," feeding on the sap or substance. *Pupa* changes in the cavity made by the *larva*. *Imago* with the *antennæ* composed of thirteen to fifteen joints, increasing in size exteriorly, but never clavated; mandibles obtuse; *maxillæ* dilated, obtuse, feelers often five-jointed; *labium* short, with its *ligula* produced, generally as long as the feelers, entire; feelers mostly three-jointed; wings with many nervures; head rather small, somewhat retiring; *mesothorax* large and convex; *podeon* short, very slender; body compressed; *decaton* in the female very large; ovipositor curved or spirally convoluted beneath the body. Beaten out of trees and off grass, in the summer. *Cynips*, *Figites*, *Ibalia*, *Anacharis*.

*Evaniites*. *Larva* inhabits the *larvæ* of *Sphecina*, and occasionally of *Blattina*. *Pupa* changes within the cocoon spun by the *larva* of the former of these *stirpes*. *Imago* with *antennæ* thirteen-jointed, of uniform thickness and very straight; mandibles short, stout, acute and bifid;

*maxillæ* dilated and obtuse, feelers six-jointed; *labium* with the *ligula* very short, quadrilobed, the lateral lobes very minute, feelers long, often robust, four-jointed; wings with many nervures; *podeon* slender. Found in summer, flying over flowers and about sand-banks, in which the *Sphecina* have formed their burrows and provided for their young. *Evania, Brachygaster, Fœnus.*

Ichneumons of the second line or *Braconites. Larva* more obese, without distinct markings and divisions; feeds often in company, on the *larvæ* of *Lepidoptera* and other insects. *Pupa* changes within the skin of the Lepidopterous *larva*, or in small silken cocoons, attached to the hair or body of its prey, &c. *Imago* with the *antennæ* ten- to twenty-jointed; mandibles short, generally bifid; *maxillæ* obtuse, feelers six-jointed, elongate; *labium* short; *ligula* obtuse and entire; feelers four-jointed; *ocelli* three; fore wings with fewer nervures than the following order; hind wings with still fewer; *podeon* slender and short; oviduct with two protecting appendages. Inhabits grass, &c. *Bassus, Rogas, Alysia, Bracon, Microgaster, Microdus, Sigalphus, Aphidius.*

Ichneumons or *Ichneumonites. Larva* elongate, with the divisions of the segments clearly defined; solitary; inhabits and devours the fleshy parts of other insects. *Pupa* changes sometimes within the shell of the *pupa* of the Lepidopterous insects, sometimes in the ground, in a tough, close, leathery cocoon, spun by the *larva*. *Imago* with long filiform *antennæ* composed of about forty joints; mandibles short, stout, acute and bifid; *maxillæ* dilated and obtuse, their feelers six-jointed and often very long; *labium* short, its *ligula* short and bilobed, its feelers generally four-jointed; *ocelli* three; fore and hind wings with numerous nervures; *podeon* always slender, seldom or never elongate; oviduct generally defended by a setaceous appendage on each side, thus appearing to be triple: varies greatly in length. Inhabits vegetables of all kinds throughout the summer. *Ichneumon*, *Anomalon*, *Ophion*, *Banchus*, *Peltastes*, *Alomya*, *Cryptus*, *Pimpla*, represented depositing its egg in a caterpillar at page 8, *Xylonomus*.

*Sirecites*. *Larva* cylindrical, with six rudimental articulate legs; head corneous; *paratelum* incrassated; inhabits timber. *Pupa* changes in the same situation. *Imago* with *antennæ* filiform, attenuated exteriorly, composed of fifteen to thirty joints, the number varying in different individuals of the same sex and species; mandibles strong, trifid; *maxillæ* rather elongate, soft, flexible, obtuse, their feelers very minute, exarticulate; *labium* somewhat triangular; *ligula* short, entire, dilated; feelers three-jointed, the terminal joint long and incrassated; *ocelli* three; wings ample with many strong nervures; *prothorax* fully developed, broader than the head, its anterior and posterior margins concave; the following segments fully and equally developed; ovipositor exserted, composed of three *setæ*. Inhabits fir plantations. *Sirex*. The male of *Sirex gigas* is represented at the head of this chapter.

*Xyphidriites*. *Larva* perfectly without feet. Inhabits and lives on the dead or dying wood of various trees. *Pupa* changes in the same situations. *Imago* with *antennæ* composed of seventeen or eighteen joints, gradually attenuated towards the *apex;* mandibles small, with four distinct teeth; *maxillæ* short, obtuse, their feelers biarticulate; *labium* short; *ligula* minute, entire; feelers four-jointed; *ocelli* three; head orbicular, large; *prothorax* very long, slender, and neck-like; the remaining segments of uniform size; the oviduct of the female exserted, covered above by a sheath-like appendage. Inhabits posts, decayed willows, &c., flying in the sunshine. *Xyphidria*.

*Xyelites*. *Larva* perfectly without feet. Feeds in the wood of fir-trees, making channels, as in the two preceding orders. *Pupa* changes in the same situations. *Imago* with *antennæ* twelve-jointed, the basal and second joints short, the third very long, and the nine following very short, together scarcely equalling the third in length, elbowed twice at each end of the long joint; mandibles moderately long, acute, and dentate internally; *maxillæ* with the blade small, obtuse, the *galea* biarticulate, the feelers very long and four-jointed; *labium* short, *ligula* hitherto undiscovered, feelers four-jointed; *ocelli* three; wings very ample; legs short; *prothorax* not developed superiorly, the *mesothorax* and head meeting above it; *podeon* as wide as the other segments; oviduct ensiform, exserted, enclosed between two appendages. Inhabits fir-trees, occasionally settling on umbelliferous plants. *Xyela.*

*Oryssites.* *Larva* and *pupa* unknown. *Imago* with *antennæ* eleven-jointed in the male, ten-jointed in the female, short, rather incrassated exteriorly, the joints of various proportions and forms; mandibles dilated, rounded, pubescent; *maxillæ* with the blade obtuse, rounded; the *galea* rather elongate, narrow, and truncate at the *apex;* feelers long, pubescent, and five-jointed; *labium* short, with the *ligula* small, rounded, and entire, and the feelers rather short and three-jointed; *ocelli* three; fore and hind wings moderately large, with numerous nervures; legs short; *prothorax* with very little development superiorly; *podeon* as wide as the other segments; ovipositor spirally convoluted beneath the body. Inhabits fir and horn-beam trees. *Oryssus.*

Common saw-flies or *Allantites.* *Larva* cylindrical, of uniform substance, with six articulated and twelve or fourteen membranaceous feet. Inhabits vegetables, feeding upon their leaves in the manner of *larvæ* of *Lepidoptera.* *Pupa* sometimes changes in a cocoon, fixed in a curled leaf of the plant the *larva* feeds on, but most commonly on or in the ground. *Imago* with *antennæ* nine-jointed, of uniform substance, or attenuated towards the *apex;* mandibles short, strong, very acute at the *apex*, and having one internal tooth; *maxillæ* with the blade acute, the *galea* obtuse and exarticulate, the feelers long and six-jointed; *labium* short, with the *ligula* distinctly trilobed; wings ample; *podeon* equally developed with the other segments; oviduct with teeth like a saw. Abundant in the spring and summer in woods, &c., on leaves and flowers. *Nematus*, *Cladius*, *Crœsus*, *Emphytus*, *Dolerus*, *Dosytheus*, *Allantus*, *Fenusa*, *Asticta*, represented in the margin, *Selandria*, *Athalia*.

Asticta Ianthe.

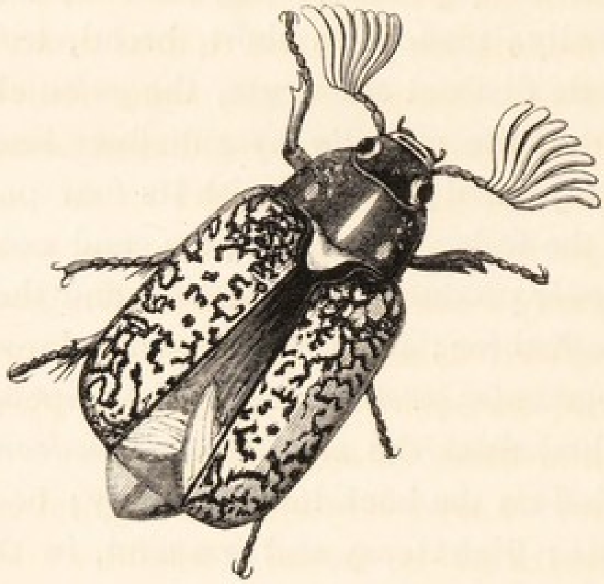
*Hylotomites*. *Larva* cylindrical, rather attenuated towards the extremities, with six articulated and fourteen membranaceous legs. Inhabits and feeds on the leaves of vegetables. *Pupa* changes mostly on the surface of the ground. *Imago* with the *antennæ* three-jointed; the basal and second joints very short, the third very long, ciliated, and often double, or having two shafts in the manner of a fork; mandibles corneous, acute, with a small internal tooth; *maxillæ* with the blade acute, the *galea* robust and obtuse, the feeler long and six-jointed; *labium* short, with the *ligula* small, but distinctly trilobed; feelers four-jointed; *ocelli* three; body with the segments and oviduct as in the *Allantites*. Settles and feeds on umbellate flowers. *Schizocerus*, *Hylotoma*.

Club-horned saw-flies or *Tenthredinites*. *Larva* mostly shagreened, cylindrical, with six articulate and twelve prehensile legs. Feeds on the leaves of trees. *Pupa* changes in a case composed of a glutinous matter, which becomes very hard when exposed to the air; the case is attached to a slender twig of the plant on which the *larva* feeds; in this case the *larva* remains unchanged during the months of autumn, winter and spring. *Imago* with *antennæ* seven-jointed, of which the third joint is always elongate, and the apical ones always form a club; the mandibles are longer than in the preceding order, acute at the *apex*, and internally bidentate; *maxillæ* with the *lacinia* obtuse and hirsute, the *galea* rather obtuse and distinctly articulate, and the feelers long and six-jointed; *labium* short, with the *ligula* distinctly trilobed, the feelers four-jointed; *ocelli* three; segments of the body fully developed; oviduct as in the *Allantites*. Inhabits flowers and leaves; flies in the sunshine. *Abia*, *Zaræa*, *Cimbex*, *Trichiosoma*,

*Lydites*. *Larva* smooth, cylindrical, with six short, articulate, and no prehensile legs. Feeds on the leaves of trees, inhabiting a web of its own making. *Pupa* changes in a silken cocoon on the stem of the trees it inhabits, or on the ground. *Imago* with the *antennæ* composed of seventeen to thirty joints, filiform, and attenuated exteriorly; mandibles long, acute at the *apex*, and having one tooth internally; *maxillæ* with the blade and *galea* obtuse, the feeler long and six-jointed; *labium* short, *ligula* more produced, trilobed; *ocelli* three; head large, orbicular; wings ample, with numerous nervures; legs short; *podeon* fully developed; body short and robust. Inhabits woods, flying in the sun, settling on leaves, and occasionally, but rarely, on flowers. *Tarpa*, *Lyda*. *Lophyrus*, although differing in having the *antennæ* composed of fewer joints and pectinated in both sexes, can scarcely be distinguished as belonging to a separate order: it frequents the spruce fir, spinning its little cocoon on the twigs.

Lophyrus rufus.

*Cephites.* *Larva* elongate, with its feet obsolete or rudimental. Inhabits and feeds on the stalks of corn and the buds of fruit-trees. *Pupa* changes within the stalk. *Imago* with *antennæ* many jointed, long, filiform, slightly incrassated externally; mandibles short, broad, trifid; *maxillæ* with the blade distinct and acute, the *galea* elongate, and separated from the *maxilla* by a distinct line, the feeler long and six-jointed; *labium* with its four parts perfectly developed, the feeler-bearer elongate, and notched at the *apex*, the *ligula* produced and trilobed, and the feeler four-jointed; *ocelli* three; head rather square, broader than the following segments; *prothorax* fully developed, cylindrical, quite detached from the *mesothorax; podeon* fully developed, divided on the back longitudinally; body elongate; legs elongate; flight easy and graceful, in the sunshine. *Cephus,* which settles in abundance on composite flowers by the road-side, and in meadows on *Ranunculi: Janus, Phyllœcus,* which settles on the leaves of trees in woods, is represented below.



The great Fuller-beetle, *Melolontha Fullo.*

# CHAPTER V.

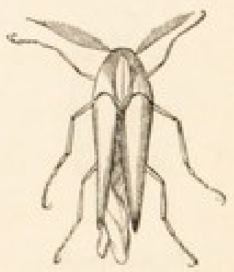
## OF THE CLASSIFICATION OF COLEOPTERA.

THE metamorphosis of *Coleoptera* is necromorphous. *Larva* with corneous mandibles, moving horizontally; a pair of articulate feet, generally on the second, third, and fourth segments; no other feet, unless a prehensile caudal appendage occasionally present can be so denominated. Food very various. *Pupa* of nearly uniform appearance. *Imago* with the parts of the mouth fully developed; the mandibles moving horizontally, and being employed in mastication. Wings fully developed; fore wings hard, crustaceous, not used in flying, when closed meeting with parallel edges, and completely covering the hind wings, to protect which appears their only office; hind wings generally much longer than the body, folded longitudinally and transversely beneath the fore wings. *Prothorax* very large; *mesothorax* small; *metathorax* large. Food various.

Slow-legged beetles or *Blapsites*. *Larva* elongate, cylindrical, with six articulate and one caudal leg. Lives in the dark, feeding on decayed animal and vegetable substances. *Pupa* changes in the same situations. *Imago* with moniliform *antennæ*, the third joint being the longest; mandibles small but strong, bifid at the *apex; maxillæ* with a single tooth internally; wings, particularly the hind pair, frequently wanting. Inhabits cellars, out-houses, decayed trees, &c., shunning the light, and moving by night with a slow, awkward, and disgusting gait; of uniform dark brown or black colour. *Blaps*.

*Helopites*. *Larva* very elongate, cylindrical, frequently with two hooks on the *telum*. Inhabits and feeds on decayed wood. *Pupa* changes in the same situations. *Imago* with filiform *antennæ;* mandibles sometimes bifid, sometimes terminating in a single point; *maxillæ* without the internal tooth; fore wings generally soft and flexible, hind wings generally perfect, adapted for flight. Inhabits decayed woods, flowers, &c. *Melandrya, Cistela, Helops, Œdemera, Diaperis*.

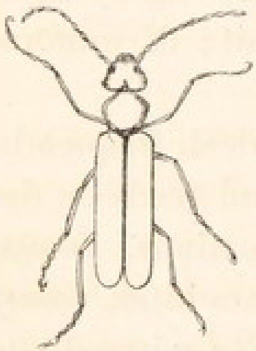
*Mordellites*. *Larva* less elongate, soft, and more fleshy; legs less distinct. Inhabits and feeds on decaying or living wood, and is sometimes parasitical in the nests of wasps. *Pupa* changes in the same situations. *Imago* generally with pectinated *antennæ*, particularly the males; head somewhat heart-shaped, and united vertically to the *prothorax;* fore wings flexible, wide at the base, narrow at the *apex;* hind wings mostly without the longitudinal fold. Inhabits flowers; diurnal, flies and runs with rapidity and ease. *Anaspis, Mordella, Ripiphorus*.



Ripiphorus.

Soldier-beetles or *Pyrochroites*. *Larva* more depressed; head as wide as the *prothorax*; *paratelum* the largest segment; *telum* corneous, and produced into two spines. Inhabits and feeds on decaying wood. *Pupa* changes in the same situations, or in the ground. *Imago* generally with long pectinated *antennæ*; head exserted, triangular, and porrected horizontally, narrower than the *prothorax*; fore wings soft, flexible; diurnal, flying readily in the sunshine. *Pyrochroa*.

Blister-beetles, &c., or *Cantharites*. *Larva* and *pupa* unknown, supposed in some instances to be parasitical. *Imago* with moniliform *antennæ* incrassated about the middle; head larger than the *prothorax*, to which it is attached vertically; fore wings short, their margins in *Melöe* crossing each other, flexible; hind wings often wanting; *tarsi* with the terminal claws double. *Melöe*, *Cantharis*, the blister-beetle of commerce.



Blister-Beetle

Flower-beetles or *Anthicites*. *Larva* and *pupa* inhabit decayed wood. *Imago* with filiform *antennæ* sometimes slightly serrated; body elongate, linear; fore wings soft. Inhabits flowers, flying readily and in the day-time. *Notoxus*, *Anthicus*.

Death-watch beetles or *Ptinites*. *Larva* with the articulate feet distinct, incrassated in the middle, narrower towards the tail, often covered with bristles. Commonly inhabits dry wood, through which it bores in all directions, reducing it to a powder. *Pupa* changes in the galleries made by the *larva*. *Imago* with long *antennæ*, generally filiform, but in some of the males highly pectinated; the mandibles strong and toothed; the head retractile within

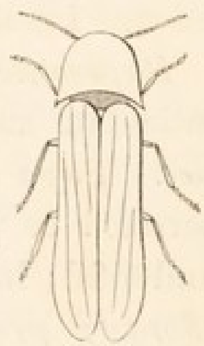
Death-watch.

the *prothorax;* the *prothorax* more or less spherical; the fore wings completely covering the body, and having often an inflated appearance. The insects of this order make the ticking noise known by the name of *death-watch. Ptilinus, Ptinus, Anobium, Mezium, Gibbium.*

Ant-beetles or *Clerites. Larva* in structure like the preceding order, but more elongate, and less commonly hairy. Feeds on the *larvæ* of the preceding order, and occasionally of some *Hymenoptera. Imago* with the *antennæ* incrassated externally; the mandibles bifid; the *maxillæ* obtuse; the *prothorax* is long, slender, cylindrical, and of less circumference than the head or body. *Necrobia, Clerus, Opilus, Thanasimus, Tillus.*

*Melyrites. Larva* elongate, soft, pubescent, gradually incrassated posteriorly; *telum* corneous, produced into two spines. Inhabits and feeds on decaying wood. *Pupa* changes in the same situations. *Imago* with the *antennæ* filiform, tapering to the extremity; mandibles elongate, toothed, bifid at the *apex;* head nearly corresponding in width with the *prothorax*, but rather less; *prothorax* with the margins often dilated; when touched, a red fleshy substance is protruded from several parts of the body and again withdrawn. Inhabits flowers; flies readily, and in the sunshine. *Dasytes, Malachius, Malthinus.*

Glow-worms or *Lampyrites. Larva* composed of thirteen very distinct segments, the divisions between which are deeply marked, giving the back a serrated appearance; legs very perfect, the caudal leg also present. Inhabits old hedges among decayed sticks, found also under stones; feeds on minute snails, &c. *Pupa* changes under ground. *Imago* with the



Male Glowworm.

*antennæ* filiform, moniliform, or pectinated; the mandibles small, soft, and somewhat imperfect; the *prothorax* flattened, dilated at the margins; the fore wings flexible, leathery; females sometimes without wings. Frequently flies by night, emitting from the two last segments a bright phosphoric light. *Lampyris, Drilus, Omalisus.*

Soft-winged beetles or *Cebrionites. Larva* and *pupa* unknown. *Imago* with the *antennæ* very simple, filiform; mandibles imperfect, terminating in a single point; *prothorax* semicircular, the convex, being the anterior margin, completely concealing the head; fore wings and whole body soft and flexible, as though immature; more round and compact in shape than the preceding orders. Inhabits the leaves and flowers of plants in summer. *Dascillus, Elodes.*

Click-beetles or *Elaterites. Larva* elongate, cylindrical, with six articulate and one caudal leg; slothful. Feeds on the roots of wheat, potatoes, &c., also occasionally on decaying timber; is very destructive to crops, and known to farmers as the WIRE-WORM. *Pupa* mostly changes in the ground. *Imago* with moniliform *antennæ*, not unfrequently serrated or pectinated in the males; mandibles bifid at the extremity; head received into the *prothorax; prothorax* with a projecting spine beneath; *mesothorax* with a cavity for the reception of the spine. When laid on its back it rights itself by a spring, in giving which it makes a loud click. Inhabits flowers, &c. *Elater.*

*Buprestites. Larva* very elongate, cylindrical, with six articulate and one caudal prehensile leg. Feeds on timber. *Pupa* changes in the same situation. *Imago* with serrated or pectinated *antennæ;* mandibles short, strong and bifid; head more than two-thirds received into the *prothorax; prothorax* beneath produced posteriorly into a spine; but there being no corresponding cavity in the *mesothorax*, the insect has not, when placed on its back, the power of leaping possessed by the *Elaterites.* Inhabits flowers; possesses the most gorgeous metallic colours; runs and flies with ease and rapidity. *Buprestis.*

Day-chafers or *Cetoniites.* *Larva* with six elongate, weak, articulate legs, and the posterior extremity of the body incrassated, soft, and recurved under the fore part. Inhabits and feeds on decaying wood. *Pupa* changes in the same situations, or in the ground. *Imago* with *antennæ* composed of ten joints, of which the three or four terminal ones are produced laterally, and form a club; *labrum* membranaceous, mostly concealed by the *clypeus;* mandibles and *maxillæ* pubescent and membranaceous; colours various and brilliant; form generally flattened above; diurnal, flies with ease and rapidity. Feeds on the pollen or honey of flowers. *Cetonia*, *Trichius.*

Cock-chafers or *Melolonthites.* *Larva* resembles that of the preceding order. Inhabits the earth, feeding on the roots of vegetables. *Pupa* changes in the ground. *Imago* with *antennæ* composed of nine or ten joints, the six or seven terminal ones produced laterally and forming a flabellated club; *labrum* more corneous than in the preceding order, and not entirely concealed by the *clypeus;* mandibles corneous and masticatory; colour less brilliant; form generally convex above; flight easy, not rapid; mostly nocturnal. Feeds on the leaves of vegetables. *Hoplia*, *Anomala*, *Melolontha*, represented at pages 52 and 247, *Amphimalla*, *Omaloplia*, *Phyllopertha*, *Serica.*

Sand-chafers or *Trogites.* *Larva* resembles that of the two preceding orders. Feeds on decaying animal and vegetable matter found in sand, which it inhabits. *Pupa* changes in the sand. *Imago* with *antennæ* composed of nine or ten joints, the three or four terminal ones forming a small round club; *labrum* and mandibles concealed and membranaceous; colour black. Inhabits sand, particularly by the sea-shore; seldom flies. *Trox*, *Ægialia*, *Psammodius.*

Dung-chafers or *Scarabæites*. *Larva* resembles the preceding. Inhabits and feeds on the excrement of animals. *Pupa* changes in the ground. *Imago* with *antennæ* composed of nine or ten joints, the terminal ones forming a compressed club ; *labrum* generally concealed by the *clypeus;* mandibles sometimes corneous, sometimes membranaceous; colour brown, black, or metallic-tinted black; form oval, convex above. Inhabits and feeds as in the *larva* state ; flight easy, rapid, mostly nocturnal. *Aphodius. Geotrupes, Bolboceras, Onthophagus, Copris.*

Stag-beetles or *Lucanites*. *Larva* resembles the preceding; feeding on decayed wood. *Pupa* changes in the same situations. *Imago* with ten-jointed *antennæ*, the basal joint very long, and the others bending forward from it at a right angle, forming an elbow, the three apical joints forming a club; *labrum* concealed or obsolete; mandibles very long, strong and toothed; *maxillæ* weak and pilose. Flight nocturnal. Feeds on the sap of plants. *Sinodendron, Lucanus, Platycerus.*

Mimick-beetles or *Histerites*. *Larva* rather more elongate than that of the *Lucanites*, in other respects nearly similar in formation. Inhabits and feeds on putrid substances. *Pupa* mostly changes in the ground. *Imago* with clavate *antennæ;* strong, corneous, and projecting mandibles; head retractile within the *prothorax;* fore wings square and very short; legs retractile ; covering excessively hard, highly polished. Inhabits putrid substances; mimicks death when disturbed; flies occasionally in the sunshine. *Hister, Dendrophilus, Onthophilus, Abræus.*

Pill-beetles or *Byrrhites*. *Larva* as in the *Histerites*, but somewhat pilose. Feeds on the roots of vegetables and decaying wood. *Pupa* mostly changes in the earth. *Imago* with moniliform *antennæ* incrassated towards the extremity, but not clubbed ; mandibles corneous, but not projecting ;

form nearly globular; covering downy, not polished; head and legs retractile. Inhabits vegetables, mimicking death if touched; crawls in the day; flies but seldom. *Nosodendron*, *Byrrhus*, *Aspidiphorus*, *Simplocaria*.

*Dermestites*. *Larva* somewhat shuttle-shaped, very pilose. Inhabits and feeds on decayed and dried animal substances. *Pupa* changes in the same substances. *Imago* with short clavated *antennæ;* mandibles short, strong and toothed; form oval; head and legs retractile, but less perfectly so than in the two preceding orders. Inhabits dead animals; when shaken out or disturbed, mimicking death: flight principally nocturnal. *Attagenus*, *Dermestes*, *Megatoma*.

*Ipsites*. *Larva* more elongate, slightly pubescent. Inhabits and feeds on the bark of trees or *fungi*. *Pupa* changes in the bark. *Imago* with clavated *antennæ*, the club not abrupt, but generally formed by a gradual incrassation of the *antennæ* externally; *prothorax* nearly square, generally longer than wide; form elongate: flight only occasional, mostly diurnal. *Lyctus*, *Sylvanus*, *Rhizophagus*, *Nemosoma*, *Ips*, *Tetratoma*, *Triplax*, *Mycetophagus*, *Antherophagus*.

*Nitidulites*. *Larva* pubescent, more active than in the preceding order. Generally inhabits and feeds on decayed animal substances. *Pupa* changes in the same situations or in the earth. *Imago* with clavated *antennæ*, the club abrupt and well-defined, usually composed of three joints: active; flies readily. Inhabits, in great quantities, decayed animal substances, particularly bones, and also strongly-scented flowers. *Catheretes*, *Meligethes*, *Strongylus*, *Nitidula*, *Thymalus*.

Carrion-beetles or *Silphites*. *Larva* glabrous, depressed, attenuated posteriorly; very active. Inhabits putrifying animal substances. *Pupa* changes mostly in the earth.

*Imago* with *antennæ* clavated or moniliform, externally incrassated; mandibles strong, pointed and prominent; head capable of being bent vertically and concealed by the *prothorax*, but not withdrawn into it; *prothorax* as wide as the body. Inhabits putrid animal substances, as dead birds, mice, rats, &c., which it buries in the earth as receptacles for its eggs; flight diurnal and nocturnal; scent very offensive. *Silpha, Necrophorus*, represented in all its stages at page 53, *Choleva, Catops, Ptomaphagus, Scaphidium, Scaphiosoma*.

Globe-beetles or *Spheridiites*. *Larva* inhabits and feeds on the dung of horses and cows. *Pupa* changes in the same situations. *Imago* with *antennæ* clavated; club distinct and abrupt; form nearly spherical or oval. Inhabits and feeds as in the *larva* state; runs and flies with rapidity in the sunshine. *Sphæridium, Cercyon*.

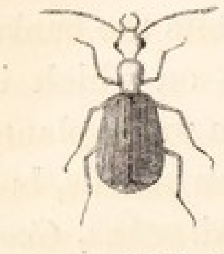
Herbivorous water-beetles or *Hydrophilites*. *Larva* elongate, attenuated posteriorly, active, carnivorous, aquatic; head large, with long curved mandibles. *Pupa* changes in the earth or under dung. *Imago* with clavated *antennæ;* mandibles strong and obtusely toothed; maxillary feelers very strong, and used in the water as *antennæ;* the form oval, the sides and back very convex, the surface glabrous. Inhabits water, swimming with ease, the feet being moved alternately; female covers her eggs with silk, forming a kind of cocoon, which she carries about with her in the manner of some spiders. Feeds on the decaying leaves of water-plants. *Spercheus, Hydrophilus, Hydroüs, Hydrobius, Berosus*.

Diving-bell beetles or *Helophorites*. *Larva* less elongate; sluggish; margins of the segments fringed with hair. Inhabits duckweed, and other plants on the surface and banks of ponds, also the surface of stones, mud, &c. *Pupa* changes sometimes in the same situations, but mostly in the earth. *Imago* with *antennæ* more or less clavated, short, and generally concealed; the maxillary feelers being employed as *antennæ;* form elongate. Inhabits the banks of ponds and rivers, among aquatic plants on which it feeds; enclosed in a bubble of air, it crawls on water-plants and on the surface of water, with the back downwards, but does not swim. *Hydræna, Helophorus, Hydrochus, Georyssus, Elmis, Parnus, Heterocerus.*

Water-fleas or *Gyrinites. Larva* with strong arcuate mandibles; a long fleshy process, fringed with hair, rising from both sides of each segment; carnivorous, aquatic, natatory. *Pupa* changes at the edge of ponds. *Imago* with short clavated *antennæ;* mandibles short and obtuse, but strong; *maxillæ* somewhat obtuse; *galea* palpiform, exarticulate; fore legs long, middle and hind legs short and incrassated; carnivorous. Inhabits water, performing in the sunshine its beautiful and social gyrations on the surface. *Gyrinus.*

Carnivorous water-beetles or *Dytiscites. Larva* with strong arcuate mandibles, perforated at the extremity for suction; carnivorous, aquatic, natatory. *Pupa* changes in the earth, at the margins of ponds, among roots of trees and grass. *Imago* with filiform *antennæ;* mandibles short and strong; *maxillæ* arcuate and very acute; *galea* palpiform and articulate; the fore *tarsi* patellated in the males; the middle and hind legs flattened and ciliated; form oval. Inhabits water, feeding on aquatic animals; swims with great ease and swiftness, moving the corresponding legs simultaneously. *Acilius, Dytiscus, Colymbetes, Noterus, Hydrophorus.*

Ground-beetles or *Carabites. Larva* with strong arcuate mandibles; active and carnivorous. Inhabits roots of grass, rubbish-heaps, decaying vegetables, moss, under stones, &c., in which situations it pursues and seizes its prey. *Pupa* changes in the earth. *Imago* with moniliform *antennæ ;* mandibles moderately short, very strong ; *maxillæ* terminate in a blade, sometimes acute, but never articulated ; *galea* articulate and palpiform. Carnivorous, chiefly nocturnal, and during the day found principally under stones and timber, at the roots of grass, in the sand of gravel-pits, &c. ; sometimes flies, but not to avoid pursuit. *Elaphrus, Bembidium, Harpalus, Carabus, Dyschirius, Brachinus,* figured in the margin, *Dromius, Odacantha, Drypta.*



Bombardier Beetle.

Tiger-beetles or *Cicindelites. Larva* with strong arcuate mandibles, and frequently with two remarkable recurved hooks on its back ; it is carnivorous, and lies in wait for its prey in holes or dens, which it constructs in loose earth or sand, in sunny places. *Pupa* changes in the holes of the *larva. Imago* with strong, long, arcuate and deeply-toothed mandibles, which cross each other at about half their length ; blade of the *maxillæ* acute and articulated ; *galea* palpiform and articulated ; legs very long and slender ; diurnal, carnivorous, of light and elegant form, and brilliant colours. Runs with amazing activity ; flies to avoid pursuit. *Cicindela.*

Devil's coach-horses or *Staphilinites. Larva* with strong mandibles ; active, mostly carnivorous. Found under stones, at the roots of grass, in rubbish-heaps, &c. *Pupa* changes in the same situations, and is remarkable for the compactness with which the limbs are attached, giving it the appearance of the amorphous class. *Imago* with moniliform *antennæ ;* mandibles strong and acute ; *maxillæ* obtuse ; *galea* rounded and never palpiform. These beetles are distinguished at

Pseudopsis sulcatus.

once from all others by their square, short fore wings, naked body, elongate form, and disgusting manner of turning up the tail like a scorpion. Inhabits and devours all putrefying substances, also living insects. *Staphylinus.*

Short-winged moss-beetles or *Pselaphites. Larva* and *pupa* unknown. *Imago* with acute dentate mandibles; *maxillæ* obtuse; *galea* rounded, exarticulate, though somewhat palpiform; maxillary feelers clavated, immensely developed, often equalling the *antennæ* in size; *antennæ* with ten or eleven joints, the last joint incrassated, forming a club; fore wings quadrate and abbreviated; hind wings usually wanting; *tarsi* two-jointed. Very minute; slow in its movements. Inhabits moss and the roots of grass, feeding on the *Acari* which occur in those situations. *Pselaphus.*

Long-winged moss-beetles or *Scydmænites. Larva* and *pupa* unknown. *Imago* with *antennæ* eleven-jointed, moniliform, incrassated exteriorly; the basal joint rather long, the apical one ovate and together with the two preceding, incrassated; maxillary feelers very large, the third joint stout and conical, the fourth and terminal one small, acute; fore wings completely covering the body; *tarsi* five-jointed. Inhabits moss, and under planks near cucumber frames; feeds on *Acari. Scydmænus, Eutheia.*

Fungus-beetles or *Endomychites. Larva* with six distinct articulate legs; head small; middle of the body stout, gradually attenuated to the tail. Principally inhabits and feeds on the interior of *fungi. Pupa* changes in the same situations. *Imago* with moniliform *antennæ*, incrassated externally; mandibles acute; *tarsi* three-jointed; form very convex, oval, glabrous. Inhabits *fungi. Lycoperdina, Endomychus.*

Lady-birds or *Coccinellites. Larva* in structure like that of the preceding order, but rather more elongate and active. Inhabits the leaves of vegetables, feeding on the

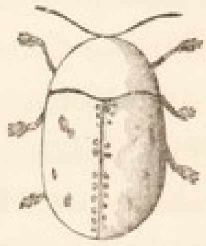
*Aphites* which suck their sap. *Pupa* attaches itself by the tail to a leaf, and changes in that position. *Imago* with short and rather clavate *antennæ;* mandibles acute; *tarsi* three-jointed; form very convex above, nearly hemispherical. Inhabits vegetables, feeding on the *Aphites* which infest them. *Cacicula, Chilochorus, Coccinella.*

Bloody-nose beetles or *Chrysomelites. Larva* still more obese, inactive; legs short. Feeds on the leaves of vegetables. *Pupa* sometimes attaches itself, and changes in the same situations, and sometimes in the earth. *Imago* with moniliform *antennæ,* inserted far from each other; mandibles rather obtuse; *maxillæ* obtuse; *galea* palpiform, exarticulate; head nearly concealed by the *prothorax; tarsi* four-jointed; legs not formed for leaping; form very globose, inactive; flies seldom. Inhabits vegetables, on the leaves of which it feeds. When touched frequently emits a red fluid from the mouth. *Cryptocephalus, Clythra, Chrysomela.*

Flea-beetles or *Alticites. Larva* and *pupa* nearly as in the preceding order, the former rather less obese. *Imago* with the *antennæ* much longer, more filiform, and inserted nearer together; mandibles more acute; *maxillæ* obtuse; *galea* palpiform and articulate; hind legs incrassated, formed for leaping; form less globose. Inhabits and feeds on vegetables; its size is little larger than that of a flea, an insect which it emulates in the activity of its leaps; it is excessively injurious to crops, sometimes causing a total failure of turnips, rape, &c. *Altica.*

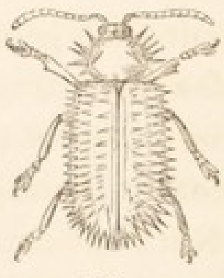
*Galerucites. Larva* and *pupa* nearly as in the *Chrysomelites. Imago* with long filiform *antennæ,* inserted much nearer to each other than in either of the two preceding orders; mandibles acute; *maxillæ* obtuse, with a distinctly articulate palpiform *galea;* legs of similar structure, not formed for leaping; form more elongate. Inhabits and feeds on vegetables; flies more readily than in the two preceding orders, but does not leap. *Galeruca*, *Adimonia*, *Auchenia*, *Luperus*.

Tortoise-beetles or *Cassidites*. *Larva* more obese and obtuse, spiny or radiated round the margin; the tail furnished with a remarkable forked appendage on which the excrement accumulates, forming a kind of umbrella, which protects it in some degree from observation. Inhabits and feeds on vegetables. *Pupa* changes in the same situations. *Imago* with moniliform *antennæ;* mandibles and *maxillæ* obtuse and minute; *galea* palpiform, exarticulate; head completely hidden by the *prothorax;* which, together with the fore wings, form a complete covering, like the *carapax* of a tortoise; *tarsi* four-jointed; form nearly hemispherical. Inhabits vegetables, on which it feeds. *Cassida*.



Cassida.

*Hispites*. *Larva* flattened, having thirteen distinct segments, whereof the head and *prothorax* are somewhat corneous; fifth to eleventh segment inclusive furnished both above and below with a callous transverse spot, covered with minute projections like a rasp: feeds on the *parenchyma* of the leaves of plants, living entirely between the upper and lower *epidermis*, causing brown spots to appear in the leaves where the *parenchyma* has been consumed, and moving about in the cavities with a wriggling motion, and as easily backwards as forwards. *Pupa* changes in the same situations; very active, moving about in the cavities when disturbed. *Imago* with moniliform *antennæ* approximate at the base; head not hidden by the *prothorax*, but standing out distinctly in front; *prothorax*



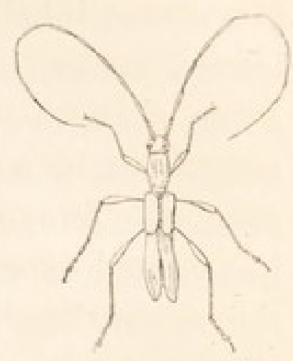
Hispa.

not dilated as in the preceding order, which in many of its characters it very closely resembles. Inhabits vegetables, on which it feeds. A single species, *Hispa atra*, is said to have been found in England. The author is induced, from the observations of Dr. Harris on the economy and structure of the *larva* and *pupa* of *Hispa*, to separate it from the *Cassidites*, a family of which he had previously considered it.

*Criocerites*. *Larva* more linear and elongate. Feeds on the leaves or within the stems of vegetables. *Pupa* generally changes in a silken cocoon, attached to the stems or roots of the vegetables on which it feeds. *Imago* with moniliform *antennæ*, slightly incrassated externally, about as long as in the *Galerucites;* mandibles arcuate, bifid at the *apex; maxillæ* obtuse; *galea* incrassated, but not palpiform; *prothorax* proportionately much smaller than in any cognate order, somewhat cylindrical; *tarsi* four jointed; colours brilliant; flight only occasional, diurnal. Inhabits vegetables. *Crioceris, Donacia, Macroplea.*

Necked capricorn-beetles or *Lepturites*. *Larva* almost entirely without feet, fleshy, linear; inhabits decaying timber. *Pupa* changes in the same situations. *Imago* with filiform *antennæ* usually about the length of the body, inserted between the eyes, but not interfering with their form; the head is elongated at its junction with the *prothorax*, somewhat in the manner of a neck; mandibles terminated generally in an acute point; *maxillæ* obtuse; *galea* obtuse, not palpiform; form elongate, attenuated posteriorly; *tarsi* four-jointed; diurnal. Inhabits flowers, apparently feeding on their *pollen*. *Leptura, Pachyta.*

Neckless capricorn-beetles or *Cerambycites*. *Larva* and *pupa* as in the preceding order. *Imago* with filiform *antennæ*, often much longer than the body, inserted close to the eyes, and partly surrounded by them; the eyes consequently become somewhat kidney-shaped; the head is not elongated at its junction, but is partly received into the *prothorax;* mandibles with an acute point; *maxillæ* and their *galea* obtuse; *tarsi* four-jointed; form elongate, nearly linear, slightly attenuated posteriorly: flight both diurnal and nocturnal. Inhabits the stems of trees, decayed wood, and sometimes flowers. *Heliomanes, Clytus, Callidium, Cylindera, Obrium, Gracilia, Saperda, Lamia, Cerambyx, Prionus.*



Heliomanes.

Flat-bodied-beetles or *Cucujites.* *Larva* with six very short articulate legs; found in decayed timber. *Pupa* changes in the same situations. *Imago* with filiform *antennæ* generally not longer than the *prothorax;* mandibles acute, porrected, and elongate, especially in the males; *maxillæ* obtuse; *galea* pilose; head somewhat triangular, elongated posteriorly into a kind of neck; *prothorax* nearly square, very flat; body very flat; *tarsi* four-jointed. Inhabits timber. *Cucujus.*

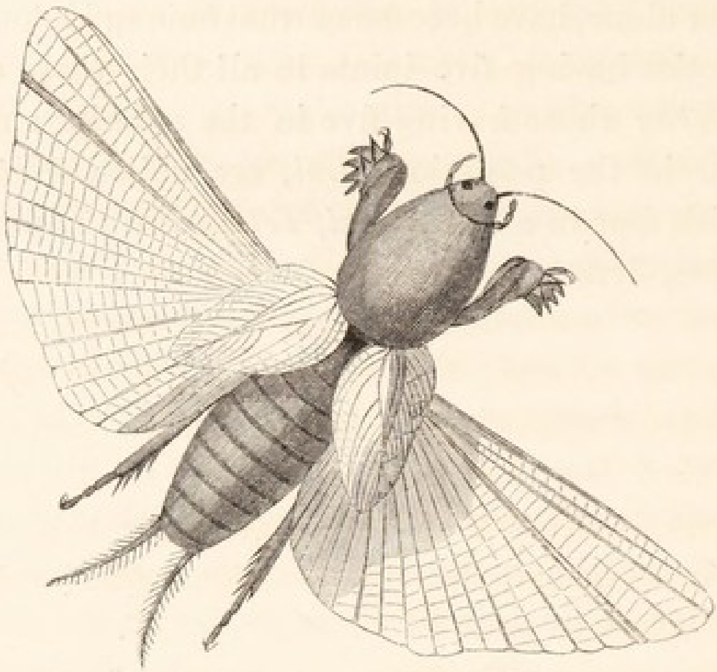
Timber-beetles or *Bostricites.* *Larva* a white maggot, completely without legs; inhabits and feeds on the bark or wood of trees, causing their death with unerring certainty. *Pupa* changes in the same situations. *Imago* with clavated *antennæ;* mandibles generally bidentate; *maxillæ* with their *galea* obtuse; the *prothorax* very convex, and usually as large as the remainder of the body; *tarsi* four-jointed; form cylindrical. Inhabits circular holes, which it bores in the bark and wood of trees, either to escape, after changing, from the *pupa*, or to deposit its eggs. *Cis, Bostrichus, Tomicus, Platypus, Hylesinus, Scolytus, Hylurgus.*

Long-nosed weevils or *Curculionites.* *Larva* without legs, and having occasionally in their place small mammillary processes; inhabits and feeds on the flowers, fruits, seeds, leaves, stalks, bark, wood, pith, and roots of vegetables. *Pupa* changes in the same situations, sometimes naked, sometimes in a hard compact case, sometimes in a silken cocoon. *Imago* with *antennæ* generally twelve-jointed, incrassated externally, the basal joint generally very long, the others bending forwards at a right angle, forming an elbow; these *antennæ* are placed on a long rostrum, which proceeds from between the eyes, and has the mouth at its extremity; mandibles generally obtuse; blade and *galea* of the *maxillæ* united and indistinct; *tarsi* four-jointed. Mostly diurnal; feeds on vegetables. *Curculio: Balaninus Nucum*, a very long-nosed weevil, produced from the well-known grub which infests nuts and filberts, is represented on the opposite page.

Short-nosed weevils or *Anthribites*. *Larva* in form like the preceding; feeds on wood. *Pupa* changes in the channels made by the *larva*. *Imago* with *antennæ* generally twelve-jointed, the basal joint not particularly elongate, therefore not elbowed, moniliform, incrassated externally, not situated on a distinct rostrum, much elongated in the males; mandibles and *maxillæ* nearly as in the preceding order; *tarsi* four-jointed. Inhabits the bark and wood of trees. *Brachytarsus, Platyrhinus, Anthribus.*

False-weevils or *Salpingites*. *Larva* and *pupa* as in the preceding orders; the former feeds on the wood and bark of trees. *Imago* with *antennæ* shorter, moniliform, somewhat incrassated externally, and situated on a rostrum; mandibles and *maxillæ* obtuse; fore and middle *tarsi* five-jointed; hind *tarsi* four-jointed. Found in the same situations as the *larva*, and also among the leaves of trees. *Salpingus, Sphæriestes.*

In every modern classification of *Coleoptera* the number of joints in the *tarsi* has been considered a character of primary importance, and divisional names, founded on this character alone, have become current among Entomologists: thus beetles having five joints in all their *tarsi* are called *Pentamera;* those having five in the anterior and middle, and four in the posterior *tarsi*, are called *Heteromera;* those with four in all the *tarsi*, *Tetramera;* and those with only three, *Trimera*.



The common Mole Cricket. *Gryllotalpa vulgaris.*

# CHAPTER VI.

## OF THE CLASSIFICATION OF ORTHOPTERA, HEMIPTERA, NEUROPTERA, &c.

*Orthoptera.*—The metamorphosis of *Orthoptera* is isomorphous. *Larva* resembling the *imago* in structure, appearance, mode of feeding, &c., wings only being wanted. *Pupa,* or quiescent state, none. *Imago* with the parts of the mouth fully developed; *labrum* large and quadrate; mandibles strong, bony, masticatory, and moving horizontally; *maxillæ* with feelers, and a distinct, palpiform *galea;* fore wings coriaceous, little used in flight; hind wings longitudinally folded; flight weak and badly sustained.

Earwigs or *Forficulites.* The *antennæ* are many-jointed, moniliform, and decrease in size to the extremity; the fore wings square, coriaceous, meeting with parallel edges, very short, and not used in flight; the hind wings ear-shaped, folded, and projecting beyond the fore wings; hind legs not formed for leaping; *tarsi* three-jointed; *telum* furnished with two appendages which meet like forceps; nocturnal insects, feeding on vegetables. *Forficula*, the earwig, its wing is represented at page 11, *Labia*, *Labidura*.

Crickets or *Achetites*. *Antennæ* very long, slender, and composed of many joints; fore wings short, coriaceous, one partially covering the other, not used in flight; hind wings folded longitudinally, and projecting beyond the fore wings; hind legs incrassated, formed for leaping; *tarsi* three-jointed: nocturnal, subterranean insects. *Gryllo-talpa*, represented on the opposite page, *Acheta*, represented in all its stages at page 73.

Grasshoppers or *Gryllites*. *Antennæ* very long, slender, and composed of many joints; fore wings coriaceous, as long as the hind wings, which are folded longitudinally beneath them; hind legs incrassated, formed for leaping; *tarsi* four-jointed; female furnished with an exserted oviduct: diurnal; feed on vegetables. *Gryllus*.

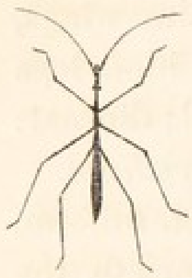
Locusts or *Locustites*. *Antennæ* short, incrassated towards the middle or extremity, consisting of about ten joints; fore wings coriaceous, generally as long as the hind wings, which are folded longitudinally beneath them; hind legs incrassated, formed for leaping; *tarsi* five-jointed; diurnal: feed on vegetables. *Locusta*, *Gomphocerus*, *Acrydium*.

Cockroaches or *Blattites*. *Antennæ* very long, filiform, tapering, and many-jointed; head bending beneath the *prothorax;* fore wings somewhat coriaceous, horizontal, one folding over the other, covering the hind wings, which are folded beneath them; legs alike in structure; *tarsi* five-jointed: nocturnal; voracious; omnivorous; run rapidly; fly badly; do not leap. *Blatta*.

*Hemiptera.* — The metamorphosis of the *Hemiptera* is isomorphous, resembling that of the *Orthoptera. Imago* with the parts of the mouth only partially developed; the mandibles are without any horizontal motion, but elongate and slender, and, together with the *maxillæ* and tongue, are inclosed in a sucker, which is composed of the *labium* principally, but protected above by the *labrum;* this sucker is bent beneath the head and breast, excepting when in use, when it is usually thrust perpendicularly into the rind of vegetables or skin of animals, to extract the sap or blood, which, in this class, constitute the food; the feelers are obsolete.

Plant-bugs or *Cimicites. Antennæ* elongate, conspicuous, four- or five-jointed; fore wings with the basal portion coriaceous, the apical portions which cross each other membranaceous; the legs are of uniform structure, not formed for leaping; the *tarsi* are three-jointed: terrestrial; run fast; fly rapidly, but not far at a time; feed generally on the sap of vegetables, sometimes on other insects, and occasionally, but apparently unnaturally, on the blood of vertebrate animals. *Cimex, Pentatoma, Acanthosoma,* represented at page 199, (fig. 6).

Water-bugs or *Hydrometrites. Antennæ* elongate, conspicuous, four- or five-jointed; fore wings coriaceous, of uniform substance; hind wings membranaceous; all the wings linear; legs of uniform structure, very long, not formed for leaping; *tarsi* three-jointed; body elongate, linear: aquatic, running with ease and rapidity on the surface of water. *Hydrometra, Gerris, Velia.*


Hydrometra.

Water-scorpions or *Nepites. Antennæ* very short, concealed below the head; fore wings coriaceous, crossed at the *apex;* hind wings membranaceous, completely concealed beneath them; fore legs hooked, predatory; *tarsi* with a single joint; middle and hind legs not formed for swimming; *tarsi* two-jointed; tail armed with two long setaceous appendages: aquatic; carnivorous; crawl on aquatic plants, but do not swim. *Ranatra*, *Nepa*.

Water-boatmen or *Notonectites*. *Antennæ* very short, concealed below the head; fore and hind wings as in the preceding; fore legs unarmed, middle and hind legs formed for swimming; all the *tarsi* two-jointed; tail without appendages: aquatic; carnivorous; swim with ease, swiftness, and elegance; cannot crawl on aquatic plants like the preceding. *Naucoris*, *Notonecta*, *Corixa*, *Sigara*.

Water-Boatman.

Frog-hoppers or *Cicadites*. *Antennæ* very short, scarcely projecting beyond the head; fore wings coriaceous, meeting with a straight suture; hind wings membranaceous; hind legs incrassated, formed for leaping; *tarsi* three-jointed: most of the genera leap readily, but fly badly. Inhabit vegetables, on the sap of which they feed. *Cicada*, the only species inhabiting this country was lately discovered in the New Forest by Mr. Weaver; the pupa-case has been found clinging to the stem of the common brakes, on the roots of which the *larva* is supposed to feed; the pupa-case, together with the perfect insect, is represented at the end of the chapter; it is the *Cicada Hæmatodes* of Linneus: *Cercopis*, *Membracis*, *Psylla*.

Gall-insects or *Coccites*. *Antennæ* hirsute, long, moniliform, many-jointed; fore wings semi-coriaceous, of uniform substance; hind wings wanting, or replaced by appendages similar to the *halteres* of *Diptera;* legs of uniform structure, not formed for leaping; *tarsi* two- or three-jointed in the male, with a single joint in the female; tail furnished with two long *setæ*. The females are apterous, and attach themselves to the bark and leaves of trees, on which they deposit their eggs, covering them with their bodies. *Coccus.*

Plant-lice or *Aphites. Antennæ* conspicuous, elongate, seven-jointed; fore wings deflexed, meeting over the back with a straight suture; hind wings much smaller and shorter; all the wings membranaceous; legs of uniform structure, not formed for leaping; *tarsi* two-jointed. Infest all vegetables, sucking the sap: reproduction without union of sexes for many generations. *Aphis.*

Moth-blights or *Aleyrodites. Larva* oval, flat and scale-like. *Pupa* changes within the skin of the *larva;* is quiescent. *Imago* with the *antennæ* filiform, conspicuous and six-jointed; wings equally developed, both as to length and breadth, covered with a white, mealy substance, like the scales of *Lepidoptera;* legs of uniform structure, not formed for leaping. Sits on the under-side of the leaves of the plants on which the *larva* feeds. *Aleyrodes.*

*Neuroptera.*—The metamorphosis of the seventh class, *Neuroptera*, differs in its different orders. *Larva* with strong corneous mandibles moving horizontally, and six articulate feet, situated in pairs on the second, third, and fourth segments; prehensile feet none. *Pupa* various. *Imago* usually with the organs of the mouth perfect; the wings fully developed, and resembling net-work.

Pearl-flies or *Perlites. Larva* with long, filiform, multi-articulate *antennæ;* strong, corneous, masticatory mandibles; *telum* furnished with two long, setiform appendages; active, carnivorous, aquatic. *Pupa* isomorphous. *Imago* with long, filiform, multi-articulate *antennæ;* strong, corneous, masticatory mandibles; wings fully and equally developed, reticulated, recumbent; the hind wings folded; *tarsi* three-jointed. Inhabits the banks of running waters, and is a very favourite food of fish; flight nocturnal. *Perla, Isogenus, Chloroperla, Nemoura.*

Snake-flies or *Raphidiites*. *Larva* with filiform *antennæ*, and corneous, masticatory mandibles; active. Inhabits and feeds on decayed wood. *Pupa* isomorphous. *Imago* with moniliform *antennæ;* corneous, masticatory mandibles; head large, porrected; *prothorax* elongate; wings uniformly and fully developed, recumbent, deflexed, not folded, beautifully reticulated; *tarsi* four-jointed; *telum* with a *seta:* flight diurnal, in the sunshine. *Raphidia*.

Lace-winged flies or *Hemerobiites*. *Larva* with filiform *antennæ;* mandibles and *maxillæ* prominent, corneous; sacciferous, carnivorous. Inhabits the leaves of vegetables. *Pupa* necromorphous; changes within the sack formed by the *larva*. *Imago* with long, moniliform *antennæ;* mandibles corneous, masticatory; wings fully and equally developed, not folded, beautifully reticulated, deflexed; *tarsi* five-jointed; smells fetid; flies mostly in the evening. *Hemerobius, Chrysopa, Osmylus*.

Stone-flies or *Phryganiites*. *Larva* with short *antennæ;* mandibles corneous, masticatory; sacciferous, aquatic. *Pupa* necromorphous, changes in the sack formed by the *larva*. *Imago* with very long, multi-articulate, filiform *antennæ*; mandibles and *maxillæ* obsolete; fore wings deflexed, very hairy; hind wings ample, much folded longitudinally, not so hairy; *tarsi* five-jointed. Inhabits the neighbourhood of water; flies in the evening and during the night, and is a favourite food of fish. *Phryganea*.

Caddew-flies or *Ephemerites*. *Larva* with long filiform *antennæ;* mandibles corneous, masticatory; legs six, articulate; aquatic, carnivorous. *Pupa* isomorphous. *Imago* with short concealed *antennæ;* mandibles and *maxillæ* obsolete; fore wings fully developed; hind wings small or obsolete; all the wings beautifully reticulated, erect, and meeting above the back; *tarsi* four-jointed; *telum* furnished with long setiform appendages: flight in the evening, in company, rising and falling, and is the favourite food of fish. *Ephemera, Baëtis, Cloëon.*

Scorpion-flies or *Panorpites. Larva* and *pupa* unknown. *Imago* with long, filiform, multi-articulate *antennæ ;* mandibles and *maxillæ* corneous, produced into a beak; wings of equal development, horizontally recumbent on the back; *tarsi* five-jointed; *telum* armed with an appendage resembling a lobster's claw: flight weak, of short duration, diurnal. Inhabits abundantly the woods and hedges of England throughout the summer. *Panorpa.*

Dragon-flies or *Libellulites. Larva* with short *antennæ;* mandibles corneous, masticatory; *labium* very elongate, jointed and remarkable, being furnished with predatory, acute, mandibuliform *palpi;* aquatic, carnivorous. *Pupa* isomorphous. *Imago* with minute *antennæ* nearly concealed; mandibles strong, corneous, masticatory; *labium* of moderate proportions; wings of uniform development, beautifully reticulated, porrected laterally or meeting vertically above the back; *tarsi* three-jointed; flight rapid, well sustained; active, carnivorous. *Agrion, Libellula, Æschna,* represented at page 199, the central figure.

*Aberrant Orders.*—Ticklers or *Thripsites. Larva* resembles the perfect insect, but has a softer body, with the *meso-* and *metathorax* distinct; the mouth is almost similar to that of the *imago,* but the *antennæ* and legs are shorter; there are no simple eyes, and the compound are replaced by conglomerate eyes. *Pupa* resembles the perfect insect, but the articulation of the limbs is obscured by a film, and the wings are enclosed in short fixed sheaths: the *antennæ* are turned back on the head, and the insect, though it moves about, is much more sluggish than in the other states. *Imago* having the parts of the mouth united to form a short conical sucker, more fleshy than horny and not retractile; the *labium* has the usual parts, the *labium,* properly so called, being the longest; the *ligula* is sometimes prolonged between the labial feelers, equalling them in length, at others it does not reach beyond the base of these organs; the labial feelers are short and three-jointed; the *maxillæ* are somewhat triangular, with their *laciniæ* acute: the maxillary feelers are distinct and two- or three-jointed; the *galea* is obsolete; the mandibles are elongate and setiform, with their base flattened and dilated; the *antennæ* are somewhat moniliform and usually eight-jointed; the eyes are lateral and oval; the *ocelli* three, and situated in a triangle between the eyes; the *prothorax* is large and flat, the *meso-* and *metathorax* are so closely soldered together that the division is scarcely to be traced; the fore and hind wings are alike, long, narrow, delicate, generally nerveless and fringed with long *ciliæ;* the *tarsi* are two-jointed and without claws. Inhabits flowers, leaves, and the bark of trees. *Thrips.*

Bee-parasites or *Stylopites. Larva* apod, with a corneous head; inhabits the bodies of wasps and bees in the perfect state, the head of the *larva* projecting between the abdominal segments of the bee. *Pupa* changes in the same situations. *Imago* with elongate, linear mandibles, and minute *maxillæ*, but large maxillary feelers; the *antennæ* have but few joints, and these are of very irregular form: there are two tippet-like appendages very near the head, and two large membranaceous wings, by some supposed to be analogous to the wings of *Diptera* or the fore wings, by others to those of *Coleoptera* or the hind wings; the question is one of great interest, and its solution is reserved for more able insect-anatomists than have hitherto dissected this curious creature. The perfect insect flies in the sunshine, occasionally settling on twigs and leaves, on which it runs rapidly, vibrating its tippets and wings; the *tarsi* are two- three- or four-jointed. *Stylops, Elenchus, Halictophagus.*

Fleas or *Pulicites*. *Larva* long, slender, wormlike and without feet, composed of thirteen segments, the last having two hooks; inhabits the young of quadrupeds and birds, particularly of pigeons in a domesticated state, on the blood of which it probably feeds. *Pupa* quiescent, necromorphous, changes in a little silken cocoon, in which it remains from eleven to sixteen days. *Imago* with the *antennæ* many-jointed, usually concealed in cavities of the skull, but capable of being erected at the pleasure of the insect; the parts of the mouth are nearly as in *Diptera;* eyes simple; legs long; *tarsi* five-jointed. Inhabits all countries, sucking the blood of man and animals. *Pulex*.

# EXPLANATORY INDEX.

ABBREVIATIONS:—la. larva; pu. pupa; im. imago: where neither of these is used the figure is that of the imago.



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## PRINCIPAL GENERA FIGURED IN THE IMAGO STATE.



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WORKS ON

# ENTOMOLOGY AND BOTANY;


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