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CONTENTS.

CHAPTER XI.—NATURAL HISTORY OF THE CRICKETS.

CHAPTER XII.—NATURAL HISTORY OF THE LOCUST, &c.

CHAPTER XIII.—NATURAL HISTORY OF THE CICADA.

CHAPTER XIV.—NATURAL HISTORY OF THE EPHEMERA OR MAYFLY.

CHAPTER XX.—THE NATURAL HISTORY OF THE FLEA.

CHAPTER XXI.—THE NATURAL HISTORY OF VARIOUS SPECIES OF CRABS AND OTHER CRUSTACEOUS ANIMALS.

CHAPTER XXII.—ON THE METAMORPHOSES OF INSECTS.

CHAPTER XXIII.—HINTS FOR STUDENTS.

INSECTS.

CHAPTER I.

ON THE NATURE OF THE METAMORPHOSES OF INSECTS, ILLUSTRATED IN THE TRANSFORMATIONS OF THE BUTTERFLY.

Introductory—Singularity of Transformations—Remarkable Caterpillar of the Swallow-tailed Butterfly—True nature of Chrysalides, and misstatement respecting them—Structure of Chrysalides—Errors of Gœdart—Golden Chrysalides—Inquiry how the Fluids of Chrysalides are converted into Solids—Experiments of Reaumur—Analogy of the inactive State of a Chrysalis with the chewing of the Cud in Animals—State of the Chrysalis when ready to disclose the Butterfly—Extrication of the Fly—Extension of the Antennæ and Tongue—Supposed Uses of the Antennæ—Expansion of the Wings—Scales of the Wings.

In the fifth and sixth chapters of our preceding volume, we have detailed the history and proceedings of various kinds of caterpillars; and in the concluding chapter, the seventeenth, we have shown the manœuvres by which the caterpillars of three kinds of butterflies, viz., the white, or cabbage butterfly (*Pontia Brassicæ*), the peacock butterfly (*Vanessa Io*), and the swallow-tailed butterfly (*Papilio Machaon*), effect their transformations to the inactive state of a chrysalis; the other larvæ which we have described in the two former chapters likewise belong, with the exception of the caddis worms, to various species of moths.

In pursuing the history of these transformations it remains for us to show the manner in which the chrysalis state is thrown off, after which the butterfly appears in all its beauty; but as the proceedings of the butterfly afford but a very insufficient idea of the various kinds of transformations undergone either by the moths or insects of other orders, we shall enter into the subject at further detail, feeling convinced that it is impossible for us to lay before our readers any subject connected with these little animals which so fully coincides with the title of our work—"The Natural History of Insects."

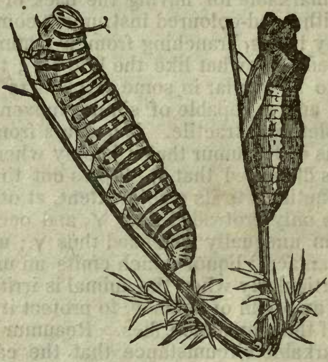
The manner in which Messrs. Kirby and Spence introduce this subject is so appropriate, that we cannot resist the temptation to quote it, as being admirably adapted to rouse the attention of the student to the metamorphoses of the insect world:—"Were a naturalist to announce to the world the discovery of an animal which for the first five years of its life existed in the form of a serpent, which then penetrating into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling more than any thing else an Egyptian mummy; and which, lastly, after remaining in this state, without food and without motion, for three years longer, should, at the end of that period, burst its silken cerements, struggle through its earthy covering, and start into day a winged bird—what think you would be the sensation excited by this strange piece of intelligence? After the first doubts of its truth were dispelled, what astonishment would succeed!—among the learned what surmises! what investigations!—among the vulgar what eager curiosity! what amazement!"

Swammerdam, indeed, justly observes—"This history is so amazing in all its circumstances, that it might very well pass for a romance were it not built upon the most firm foundations of truth;" and the illustrious Goethe, whose knowledge of mankind was only equalled by his love of nature, says of these changes, "I would call these transmutations wonderful, if the wonderful in nature were not that which occurs every moment."

We will now proceed more minutely to detail the manner in which these transformations are effected, especially the circumstances connected with the escape of the butterfly from the chrysalis, continuing to take as examples the three species of butterflies noticed above, and whose caterpillars we have figured in our former volume. There are several peculiarities, however, connected with the caterpillar of the swallow-tailed butterfly, which will be considered interesting.

Until recently this butterfly, which is by far the most remarkable of the British species, was of very rare occurrence in England; but it has within these few years been found plentifully in the fens of Cambridgeshire and Huntingdonshire. The caterpillar of this fine butterfly is of a green colour, with velvety black rings, which are alternately spotted with red; it feeds upon various umbelliferous plants, especially the fennel and carrot, preferring the flowers, and is remarkable for having the back of the neck armed with a red-coloured instrument composed of two fleshy horns, branching from a common stem, and shaped somewhat like the letter Y; this organ appears to be similar in some respects to the horns of snails, and is capable of similar movements, being completely retractile. It appears from the observations of Reaumur that it is only when the caterpillar is disturbed that it throws out this instrument, sometimes to its whole extent, at others with the horns only protruded thus Y, and occasionally with them unequally extended thus Y; and, as it secretes an acrid liquor which emits an unpleasant smell, particularly when the animal is irritated, it is probably an organ of defence, to protect it from the attacks of the ichneumon flies. Reaumur mentions the remarkable circumstance that the caterpillar, when spinning the silken cord by which it is to be supported on assuming the chrysalis state, invariably affixes it across its body at the junction of the fifth and sixth segments, where there is a cavity or gutter, in which it is easily kept from gliding backwards or forwards, and the cord is sometimes so completely immersed in this channel as to be almost hidden from sight.

Although, as we have already stated, the newly-formed chrysalis of a butterfly when opened is found to contain only a mass of pulp or soft substance, in which no trace of the parts of the future butterfly can be observed, yet we are able to perceive in the external covering of the chrysalis all the external organs of the fly, in a very short period before the skin of the chrysalis has been cast off. Indeed Swammerdam (whose inimitable dissections of various insects in their different states induced our celebrated philosopher Ray, in his "Wisdom of God in the Works of the Creation," to place him at the head of those observers who had, by their exquisite investigations, completely overturned the monstrous

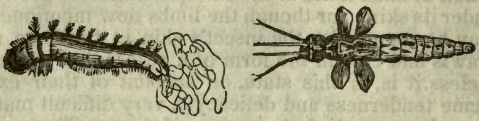


doctrine of equivocal generation) very plainly demonstrated, that even before the period when the caterpillar is ready to become a chrysalis, all the parts of a butterfly may be discovered within its body, thus satisfactorily proving that the chrysalis is no more than "a beautiful and orderly representation of such limbs of the caterpillar as have grown under its skin; for though the limbs now mentioned may be seen under the insect's skin at the time it crawls and eats in the form of a caterpillar, nevertheless it is, in this state, on account of their extreme tenderness and delicacy, a very difficult matter to have a satisfactory view of them. They are in a manner as fluid as water, and they lie folded up in many very tender membranes interwoven with pulmonary tubes. The best time to obtain an elegant view of them is when the caterpillar is just about throwing off its skin, and exhibiting to open view the miraculous operations of nature which it hitherto concealed."

In his remarkable history of "An Animal in an Animal," the same author gives practical directions as to the mode to be adopted to obtain a view of this interesting sight:—"one must choose a full-grown caterpillar, tie to its body a small thread, and then put it into boiling water, and take it out soon after; thus its external skin will separate, because the fluids between the two skins are by this means rarefied and dilated, and therefore they break and separate both the vessels and the fibres wherewith they were united together. By this means the external skin of the caterpillar, being spontaneously separated, may be easily drawn off from the butterfly, which is contained and folded up in it. This done, it is clearly and distinctly seen, that within this skin of the caterpillar a perfect and real butterfly was hidden."

These curious facts were illustrated by Swammerdam in the two following figures of the caterpillar of the tortoise-shell butterfly (*Vanessa urticæ*), in the second of which the outer skin has been drawn off, and the various limbs of the future butterfly are represented as extended.

These figures will be sufficient to refute, in the most satisfactory manner, the statement of a recent



author, that it is the tail of the larva which becomes the head of the butterfly.

The outer skin of a chrysalis is of a hard and rigid substance, although on its first exclusion from the skin of the caterpillar it is not enclosed in this hard covering. "At the moment of this change," observe Messrs. Kirby and Spence, founding their observations upon those of Reaumur, contained in the eighth memoir of his first volume upon chrysalides in general, "the envelope is nearly soft and membranous. But they are besides covered with a viscous fluid, which appears to ooze out chiefly from under the wings, and which, very soon drying, forms the exterior hard shell. At first the antennæ, wings, and legs can each be separated from the body; and it is only after these parts have been glued together by the fluid just mentioned, which takes place in less than twenty-four hours, that they

are immoveably attached to the body of the pupa, as we usually see them."

On examining a chrysalis we are enabled to discover, without difficulty, the eyes of the butterfly, as well as its wings, which are of a small size, and folded upon the sides; in addition to which, there are to be observed, arising from the head and lying upon the breast, several slender divisions, which, on being more minutely examined, are discovered to be the two filaments of the tongue or proboscis, the legs, and the antennæ, which are the outermost pair, shown in the figure, are distinctly articulated along their whole length, and are thickened towards the tip; the joints of the abdomen are all likewise plainly indicated by the various indentations of the abdomen. The hinder legs and wings are not discoverable, because they lie under the preceding pairs of those organs. The chrysalides of all butterflies are termed angular, from the various angular projections upon different parts of their bodies, while those of moths are termed conical, from not exhibiting any of those projecting tubercles.

Of these projections, the most remarkable in the common butterflies is one which is situated in the middle of the back, between the wings, of a triangular form, having on each side a smaller elevated black point, so that by giving a little stretch to the imagination, a person might easily consider these to represent the nose and eyes, as indeed some authors have done; "Nay," says Swammerdam, "they have given drawings of their idle conceits," evidently referring to the figures given by Gœdart in his work "De Insectis," published in 1685, from which we copy the first of the following figures of the chrysalis of the red admiral butterfly (*Vanessa atalanta*), which certainly resembles a lady in a plaited tippet, this portion of the dress being formed by the nerves of the wings of the chrysalis. The other and more accurate figure shows that this author mistook the projections on the back of the chrysalis for its face, and we are thus enabled to obtain a rational explanation of this strange statement, "that where the back of the caterpillar is placed,

there the belly and legs of the animal into which it is changed are situated; and on the contrary, where the belly and legs were, there the back of the animal, which by transformation was produced from the caterpillar, is discovered. And," adds he, "this wonderful transformation is effected in a short space of time, so as to be distinctly observed, because as soon as the skin is shed this transformation manifestly appears." Shortly after entering the pupa state the chrysalides of various kinds of butterflies assume, in a greater or less degree, a burnished golden appearance, whence they obtained the names of chrysalis and aurelia, which were subsequently applied to the whole of the lepidopterous pupæ. The alchymists, indeed, mistook this for real gold; and, as Messrs. Kirby and Spence observe, "referred to the case as an argument in favour of the transmutation of metals." But Reaumur found that this appearance is owing to the shining white membrane immediately below the outer skin, which, being of a transparent yellow, gives a golden tinge to the former, in the same way that tinfoil, when covered with a yellow varnish, assumes the metallic appearance which we see in gilt leather. He mentions too, "that for the production of this effect it is essential that the inner membrane be moist; whence may be explained the disappearance of the gilding as soon as the butterfly is ready to escape from the pupa. The shade of colour in these gilded chrysalides is various: some are of a rich yellow, like pure gold, others much paler, and some nearly as white as silver."

Respecting the gradual manner in which the various limbs of a butterfly are developed in the milky fluid with which the body of a newly-disclosed chrysalis is filled, and in which the rudiments of its future limbs and organs, themselves almost as fluid, swim, it does not appear that sufficiently precise experiments have hitherto been made. It was the opinion of Swammerdam, who dissected chrysalides at the end of two, six or eight, twelve or thirteen, and sixteen or seventeen days, after they had assumed that form, that it was by evaporation of the superfluous humidity, or by the help of an insensible perspiration, that the enclosed limbs of a butterfly acquire their full strength.

Reaumur, who investigated the subject with greater nicety than any other naturalist, observes, "a chrysalis remains many weeks, and often many months, without taking any sustenance, and during so long a fast, some evaporation must assuredly take place; but to what a shadow would its body be consequently reduced if the greatest part of the liquor which penetrates its different parts were to evaporate. It appears to me more probable, that this fluid unites or is incorporated with the more solid parts of the chrysalis, and that it becomes thicker when thus united, giving greater solidity to the different parts, in the same manner as the blood and lymph are employed to effect the same purpose in our own bodies; and the fluid which nourishes the limbs of a chrysalis surrounds, or, as it were, bathes them individually, so that the envelope of each of these parts being chiefly employed to prevent too much evaporation, may be regarded as performing an office analogous to that of the shell of the egg."

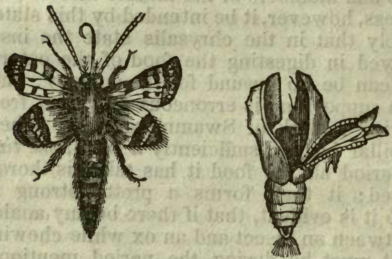
To put this supposition to the test of experiment, Reaumur accurately weighed two chrysalides immediately after their exclusion; one of these weighed nearly eighteen, and the other nearly nineteen grains; at the end of sixteen days, when they were ready to become butterflies, he found that the lightest weighed more than seventeen, and the heaviest more than eighteen grains: hence the fluid escaping by insensible perspiration must be very trifling in quantity. It consists of a kind of aqueous and very limpid liquor, as Reaumur discovered by an experiment recorded in his first volume, in which he placed chrysalides in glass tubes hermetically sealed, when it was found, at the end of several days, that small drops of a very clear liquid were attached to the inner surface of the tube, sufficient, when they had rolled to the bottom, to form a much larger drop. In his second volume Reaumur appears more decidedly to consider that it is by evaporation that the inspissation of the fluids is effected, having repeated the experiment, and discovered that the aqueous fluid collected in the bulb of the tube had, at the end of a few days, acquired a volume exceeding that of eight or ten large drops. Such are the views of Reaumur: and Messrs. Kirby and Spence observe, with respect to the subject, that "the end to be accomplished during the pupa's existence is the gradual *evaporation* of the watery parts of this fluid, and the development of the organs of the enclosed animal by the *absorption* and *assimilation* of the residuum." Now it will be seen that this observation perfectly corresponds with the views and the results of the experiments of M. Reaumur, notwithstanding a recent author has attempted to prove that Messrs. Kirby and Spence misunderstood and misapplied the observations of Reaumur.

It is also to be borne in mind, with reference to the solution of this question, that the chrysalis is furnished with the same number of breathing pores as the caterpillar, and, from the experiments of Reaumur and De Geer upon chrysalides, placed in water, oil, the receiver of an airpump, &c., there appears every reason to consider that the theory of Reaumur adopted by Kirby and Spence is correct.

A fanciful idea has recently been started, that the nearest analogy which exists among the other classes of animals with the inactive state of the chrysalis is that of an ox torpid, when reclining in a meadow to ruminate and digest the grass he had just been devouring, "for the pupa, though it does not chew the cud like the ox, assuredly rests for the purpose of digesting or (if the term be preferred) of assimilating the cruder fluids stored up by the caterpillar, and forming or perfecting therefrom the organs and members of the mature insect."

Unless, however, it be intended by this statement to imply that in the chrysalis state the insect is employed in digesting the food of the caterpillar, there can be no ground for the analogy; and that such a supposition is erroneous is evident from the following remark of Swammerdam:—"When the caterpillar has fed sufficiently *it rests some time;* in this period all the food it has taken is thoroughly digested; it then forms a pretty strong web." Hence it is evident, that if there be any analogy at all between an insect and an ox while chewing the cud, it must be during the period mentioned by Swammerdam, and not while in the chrysalis state.

When the insect has remained under the form of a chrysalis for a sufficient length of time to bring all the various organs to a proper state of consistence, the period of bursting through the walls of its prison may often be easily ascertained; the golden colour becomes indistinct, and, in those chrysalides whose skin is sufficiently thin, the form of the legs, antennæ, and tongue, and the colours of the wings of the enclosed butterfly, become visible through the skin which covers them, even without the assistance of the microscope. The extremities of the legs are now observed to move very distinctly, and the wings begin to enlarge, so that it is no longer possible for the brittle skin which covers the whole to withstand the struggles of the enclosed butterfly; it accordingly gives way by a longitudinal slit down the middle of the back, behind the head, where there is usually a suture for the purpose. The slit rapidly extends along the head down the breast on each side of the cases of the antennæ, so that the skin of the chrysalis is burst into four distinct and regular pieces, one of which enclosed the antennæ, legs, and tongue, another the abdomen, and the other two the two pairs of wings. From this slit the butterfly now emerges; but the insect has not



only to disengage itself from the hard outer skin: we have also seen that the different limbs are separately enclosed in sheaths, which become soldered together by an external glutinous secretion (forming when dried the outer skin); as, however, the skin which covers these various parts on the inside is extremely delicate and tender, from not being exposed to the air, it all breaks and flies off without any certain order; hence it arises that so many broken and ragged membranes, almost as thin as a cobweb, appear on the inner surface of the skin when thrown off.

But the insect, even when thus extricated from the walls of its chrysalis prison, has not yet attained its full perfection, being at first weak and feeble; and, as might easily be expected from an examination of the chrysalis, the wings are of a very small size, compared to that which they acquire when fully expanded, appearing at first like pieces of wet paper, soft, and full of wrinkles, cavities, and swellings, as represented in the following figure:—

They, however, expand so rapidly, that, as Swammerdam observes, "the naked eye cannot trace their unfolding, from reaching scarce half the length of the body, until they acquire, O miracle of miracles! in the short space of about half a quarter of an hour, their full extent and bigness," the various spots and markings increasing in equal proportion.

The proceedings of one of the insects which we have selected to illustrate this branch of the subject, namely, the swallow-tailed butterfly, when just disclosed, have been recorded by Messrs. Kirby and Spence from actual observation, and from their statement we extract the following passage:—"To observe how gradual, and yet how rapid, was the development of the parts and organs, and particularly of the wings, and the perfect coming forth of the colours and spots as the sun gave vigour to it, was a most interesting spectacle. At first it was unable to elevate or even move its wings; but in proportion as the aerial or other fluid was forced by the motions of its trunk into their nervures, their numerous corrugations and folds gradually yielded to the action till they had gained their greatest extent, and the film between all the nervures became tense. The ocelli, and spots and bars, which appeared at first as but germes and rudiments of what they were to be, grew with the growing wing, and shone forth upon its complete expansion in full magnitude and beauty."

Other changes also take place. The two filaments of the proboscis, which were stretched at full length along the breast, are now curled into a beautiful spiral tube under the head, and the antennæ, which were laid by the side of the legs beneath the body, are now stretched into the air, from the crown of the head upon which they are affixed; it requires, however, some little stretch of fancy to regard these latter organs in the light in which they were viewed by our poet Spenser:—

"Two *deadly weapons* first he bore,
Strongly outlanced towards either side,
Like two sharp spears, his enemies to gore;
Like as a warlike brigandine, applide
To fight, lays forth her threatful pikes afore,
The engines which in them sad death do hide;
So did this fly outstretch his fearful horns,
Yet so as him their terror more adorns."

SPENSER'S MUIOPOTMOS.

These appendages, which have generally been termed antennæ, horns, or feelers, are found in all insects, being of an endless variety of forms, and have been regarded by some naturalists as instruments of touch, by others as organs of smelling, while by others they have been considered as those of the sense of hearing.

Indeed, in the Alphabet of Insects, Mr. Rennie has not hesitated to give them the name of ears, observing, "As I have little doubt these organs will one day be proved to be ears, I think it will direct attention more decidedly to them by at once terming them ears, than by leaving them (their uses) open to all sorts of crude fancies, so easy to form, but so detrimental to correct inquiry." Until, however, it shall be proved, not only that the senses of insects are precisely similar to those of the higher animals (which, from the very great differences in their general organization, appears to many naturalists to be very doubtful), but also that the antennæ are the organs of hearing, it must be allowed that the employment of so decided a term as ears must be very improper, and really "detrimental to correct inquiry," by leading the student to suppose that the uses of these organs, upon which the most eminent naturalists are at variance, had been clearly ascertained. Hence, in the following pages, we shall continue to employ the term antennæ for these appendages, as being one unlikely to lead to erroneous suppositions.

The manner in which the surprising change in the size of the butterfly's wings is so suddenly effected, from its small corrugated form until it acquires its full development, is owing to the impulsion either of air or an aqueous fluid, or perhaps of both, into the tubular nervures of the wings; for although, on looking at these beautiful instruments of flight, we only perceive a covering of richly coloured down, yet on brushing this off and minutely examining the substance of the wing, it will be found to consist of two layers of very thin membrane, between which various veins, nervures, wing-bones, or ribs, as they have been termed, are found disposed in a longitudinal direction. Hence, when the insect impels into the minutest ramifications of these nervures of its moist and corrugated wings sufficient fluid to distend the tubes, it follows that the membrane between the tubes or nervures becomes at the same time extended to its proper size, when it very quickly dries by the action of the atmosphere. The experiments of Swammerdam and Reaumur sufficiently elucidate these facts, from which it would appear that an aeriform as well as an aqueous fluid is injected into the tubes, and hence it is that the insect, when newly disclosed, agitates its unfolded wings for the purpose of putting these fluids in motion. Indeed, according to Swammerdam, a violent agitation is produced in the fluids of the butterfly, so that they are driven from the internal vessels into the tubes of the wings, which are likewise supplied with air from the tracheæ. The manner in which the wings are wrinkled when closed is admirably adapted for the easy extension of the connecting membrane; for although the wing appears at first to be much thicker than it subsequently is, yet the appearance is not real, being only produced by the two layers of membranes not being applied to each other, so that there is a space between them, and also by the surface of each membrane being entirely covered with wrinkles, so very minute as to be almost invisible to the naked eye. Consequently it is to be observed, that these wings are not, as might be imagined, folded up like the wings of a beetle or an earwig, and hence it is that on the first extrication of the butterfly all the future markings of the wing are visible, but of a very diminished size.

It is a curious question, and one which we believe has not hitherto been noticed, in what manner the downy scales of the wings are at this time disposed, and whether they increase in size, since it is to be observed, that it is to these scales, which are so densely planted both upon the upper and the under surface of the wings, and not to the substance of the wing itself, that the butterfly owes all its gorgeous colours. According to De Geer these should be considered as feathers, from being affixed to the wings by minute quills; but Reaumur considers them rather as scales, from being composed of small membranous plates, having nothing in common with feathers. The number of these scales upon the wings of a single butterfly is really wonderful, Leeuwenhoeck having observed more than 400,000 upon the wings of the silkworm moth. Their forms are likewise extremely numerous in the different species. Indeed, a recent author has suggested, in the 11th number of the Magazine of Natural History, that they would afford very satisfactory marks to distinguish the various species of Lepidoptera. From examinations, however, which we have made for the purpose of verifying this remark, we are convinced that the adoption of such a character would be impracticable, not only from the difficulty attending its examination, for no one would be willing to spoil a fine specimen by rubbing the down off its wings, but also from the circumstance that, upon the different parts of the same wing of a butterfly, several forms of scales are to be found.

These scales are arranged upon the wing in transverse lines, the extremities of the scales of one row resting upon and lying flat on the base of the succeeding one, like the tiles upon the roof of a house. According to Messrs. Kirby and Spence, there appears to be a double layer of scales on both sides of the wings, the under layer generally consisting of white ones.

CHAPTER II.

FURTHER OBSERVATIONS ON THE METAMORPHOSES OF INSECTS, AS ILLUSTRATED IN THE BUTTERFLY.

Theory of Swammerdam—Theory of Herold—Observations thereon—Analogy of Insect Transformations with the Development of higher Animals and Man—No growth in Winged Insects—White Butterflies—Bloody rain—Peiresc's quaint Statement—Double-brooded Insects—Duration of the Life of Insects shortened by Warmth, and prolonged by Cold—Reaumur's Experiments—Irregular Period of Duration of Insects in the Chrysalis State—Periodical appearance of Butterflies.

In the preceding chapter we have seen that the general theory respecting the transformations of insects proposed by Swammerdam, and usually adopted, is, that the caterpillar, as soon as it has burst from the egg, contains within its body the various envelopes which present themselves on every moulting of the skin during the caterpillar and chrysalis state, as well as the butterfly itself. A celebrated German physiologist, Dr. Herold, who has studied the subject more closely than any naturalist since the days of Swammerdam, Reaumur, and Lyonnet, has, however, proposed an hypothesis which appears to differ considerably from the preceding. According to this author, as quoted by Kirby and Spence, "the successive skins of the caterpillar, the pupa-case, the future butterfly, and its parts and organs (except those of sex, which he discovered in the newly-excluded larva), do not pre-exist as germes, but are formed successively from the rete mucosum, or mucous network, which itself is formed anew upon every change of skin from what he denominates the blood or chyle," agreeing with other naturalists in the supposition that the epiploon or corps graisseux (a mass of thickish mucilage contained in floating membranes apparently analogous to the fat in the larger animals) is stored up in the larva, in order that, in the pupa state, it may serve for the development of the imago.

Now it appears to us, that although the first-mentioned theory seems at first sight to be completely at variance with the second, yet, on a more careful consideration, the differences will not be found to be very great.

It is to be observed in the first place, as giving much weight to the views of Herold, that in the dissections of Lyonnet and others who have studied the anatomy of caterpillars in their natural state, no traces of an enclosed animal or of any succession of skins have been observed, except the mucous network and fatty mucilage noticed above.

It is further to be observed, that in the works of Swammerdam, Reaumur, &c., who have by unnatural means succeeded in discovering in the body of the caterpillar the germe of the butterfly, no traces of the successive skins of the caterpillar or of the chrysalis have been observed. Indeed, as we have seen in the preceding chapter, the outer skin of the chrysalis is not formed until the insect has become a pupa, although it may be said that the gummy fluid which is employed by the pupa to form a coating, which upon exposure to the air immediately becomes hardened, must exist in its fluid state in the body of the caterpillar. And the same remark will apply to the other successive skins of the insect.

Herold's theory is formed in reference to the manner in which the development of the various organs becomes observable in a state of nature. It is not, however, to be supposed, that the period when these organs are first observable is necessarily that of their first existence, or that their gradual appearance is a sound argument against their pre-existence and co-existence as germes.

Now, as we have already seen in the preceding chapter, the experiments of Swammerdam and Reaumur clearly demonstrate that by a certain process the organs of the butterfly may be rendered visible in the caterpillar, the most decisive evidence of this fact being the circumstance recorded by Reaumur, that he discovered the eggs of a butterfly at least eight or ten days before its period of assuming the pupa state; and the same author likewise discovered that the rudimentary organs of a butterfly while in the caterpillar state are not arranged in the same position as in the chrysalis, the antennæ, instead of being laid flat along the breast, being curled like the horn of a ram, and the tongue, instead of being also laid along the breast as in the chrysalis,

or folded spirally and perpendicularly as in the butterfly, being laid flat, but in a spiral direction, beneath the head.

It would be interesting, observes Reaumur, to ascertain all the intimate communications ("communications") existing between the caterpillar and the enclosed butterfly, but the delicacy of the various parts must ever prevent our attaining this knowledge. In order, however, to discover as far as possible in what manner the organs of the butterfly are connected with those of the caterpillar, this author selected a caterpillar ready to change into chrysalis, the skin of which was already slit down the back, and cut off more than half of the three anterior scaly legs on one side; the chrysalis was subsequently discovered to have the corresponding legs shorter than those on the other side.

He does not, however, mention whether this was caused by the gradual shortening of all the joints of the legs, or by the want of the terminal ones; we should presume the latter.

In order to discover the limbs of the butterfly, Swammerdam and Reaumur had recourse to an unnatural mode of causing the visible development of the various organs. Herold, however, confines himself to nature, and his object is merely to trace the mode of the development and alteration of form which it must be admitted take place at every moulting of the skin; for instance, the inner skin of a caterpillar just preparing to moult is almost as tough as that of the outer skin of one which has recently moulted, but in the latter nothing is to be found, in a natural state, to represent its future skins or the enclosed chrysalis or butterfly, except mucous network or fatty pulp. It is true that, as in the outer skin of the pupa as noticed above, the rudiments of these skins may be contained in this network, and of the butterfly in this fatty pulp; but at the same time it must be admitted that the gradual development, or, as Herold misterms it, formation, of this skin, is constantly taking place, and this we imagine is precisely what Herold intends to illustrate when he states that the successive skins are successively formed, produced, or, as we ought rather to say, developed, from the rete mucosum. In like manner Herold expressly admits that the organs of sex of the butterfly are discoverable in the newly-excluded caterpillar, as well as that the future butterfly is produced from the fatty pulp which is stored up in the larva expressly for its development, and which constitutes the mucilaginous matter with which a newly-excluded chrysalis is filled. Herold has merely endeavoured to trace the manner in which the limbs of the butterfly are produced from this matter.

We have omitted to notice the improper use which appears to us to have been made by some authors respecting the statement of Herold, of the operation of a formative power supposed to be possessed by the rete mucosum in effecting the various developments of the insect, being convinced that Dr. Herold merely intended to refer to the continued action of the living and growing principle implanted by Providence in this mucous network, and not, as has been supposed, to a blind power possessed by it capable of acting without the superintendence of nature or the Creator, and forming itself into various envelopes or organs.

Hence, therefore, we do not consider the gradual development of these organs to be less indicative of the constant operation of the great Creator than the growth of the chick in the egg, or of a plant from seed; neither do we think, after what has been advanced, that the theory of Herold will be deemed, as it has hitherto been, a monstrous and untenable one. Indeed, by construing the statement of his theory (which we consider ourselves warranted in doing) in the following manner, "the successive skins of the caterpillar, the pupa-case, the future butterfly and its parts and organs (except those of sex), do not exist in the newborn caterpillar as visible germes, but are successively developed from the rete mucosum," the objections which have been made to it appear to vanish.

Various authors have endeavoured to trace an analogy between the growth of a butterfly through its various stages and the development of the higher animals from the fœtus until their arrival at full growth; but the result of these inquiries, as might naturally be expected from the great difference between the construction of the animals, has hitherto been contradictory. One class of naturalists viewing the extrication of the human fœtus from its external envelope (chorion), and its subsequent continuance in the liquor amnii, have thought that the exclusion of the insect from the egg represented the first of these events, that consequently while in the larva state they still continue a kind of fœtus, and that being in the pupa state enveloped in a fluid analogous to the liquor amnii, the true birth of the insect does not take place until it is excluded in the form of a butterfly. Reaumur, in his eighth memoir, has started an interesting idea, that not only does the chrysalis represent the egg of a bird, but that the caterpillar itself may be likewise regarded as an egg of an extraordinary kind, endowed with organs of motion and nutrition.

Other naturalists founding their observations upon the circumstances of the insect being capable of reproducing its species on becoming a butterfly or beetle, &c., and of its having now attained its full size, consider that this state is analogous to the full growth of the higher animals after their arrival at puberty.

This leads us to notice an error of very common occurrence among those who have paid but little attention to insects. We have been repeatedly asked, on showing our cabinet of insects to persons of this class, and pointing out insects of different sizes appearing at first sight very similar, what was the use of keeping such a number of specimens of the same species, many of which had evidently not yet arrived at their full size? We have given a double reason by way of answer, informing our querists, in the first place, that as soon as insects acquire perfect wings they cease to grow, and, in the second, we have pointed out the peculiar traits of the various distinct but closely allied species; thus, the white butterflies which sport over our gardens, and devour our cabbages while in the caterpillar state, have been constantly pointed out as instances of the growth of insects of the same species, some not being above an inch and a third across the wings, while others are nearly three inches in expanse;

but the fact is, that there are numerous distinct species among these white butterflies, varying in the time of their appearance and distinctive marks.

When we consider, moreover, that it is during the caterpillar state that the insect takes its chief nour-

ishment, and that in the butterfly state it sips only the nectar of flowers, it will be evident that no increase of size could be expected to take place in the latter portion of its life. It is true that by various circumstances (such, for instance, as depriving the caterpillar of its proper supply of food), a butterfly may be prevented from acquiring the full size of the species to which it belongs; but as soon as its wings are expanded it has acquired its full size, and would not grow a single hair's breadth wider or larger if it were to live as many months as its duration in the perfect state is confined to days.

Swammerdam, in his dissection of the chrysalis of a butterfly, discovered that the bladder, stomach, and some part of the gullet were filled with a deep purple moist substance, which, when laid upon paper, looked like real blood. When the butterfly has acquired its perfect form, it discharges this matter in the form of several large drops of a bloody-looking fluid, which has at different times become the object of superstitious terror, inasmuch as when the number of butterflies produced has been considerable, as when several broods have arrived at the winged state at the same time, the appearance of bloody showers has been produced. Thus, Hollinshed relates, that in the fifth century, "at Yorke, it rained bloud," and in 697, "corne, as it was gathered in the harveste-time, appeared bloudie;" and, "in the furthermost partes of Scotland, it rayned bloud." From Batman's "Doome," we find that in 1553 it was deemed among the forewarnings of the deaths of Charles and Philip, Dukes of Brunswick, that "there were drops of bloude upon herbs and trees;" but the most interesting account which has been published of an occurrence of this kind, is that related in the "Life of Peiresc," which, on account of its quaintness, we have preferred extracting entire from Gassendi's life, rather than copy Reaumur's version of it, as has been done by various writers.

"Nothing in the whole year 1608 did more please him than that he observed and philosophized about the *bloody rain*, which was commonly reported to have fallen about the beginning of July; great drops thereof were plainly to be seen both in the city itself, upon the walls of the great church, which is near the city wall, and upon the city walls themselves; also upon the walls of villages, hamlets, and towns for some miles round about; for in the first place he went himself to see those wherewith the stones were coloured, and did what he could to come to speak with those husbandmen, who, beyond Lambesk, were reported to have been so affrighted at the falling of the said rain, that they left their work, and ran as fast as their legs could carry them into the adjacent houses; whereupon he found that it was a fable which was reported touching those husbandmen."

Fanciful theories were, however, as much in vogue then as in the present day, for Gassendi proceeds:—"Nor was he pleased that the naturalists should refer this kind of rain to vapours drawn up out of red earth aloft into the air, which, congealing afterward into liquor, fall down in this form; because such vapours as are drawn aloft by heat ascend without colour, as we may know by the alone example of red roses, out of which the vapours that arise by heat are congealed into transparent water. He was less pleased with the common people and some divines, who judged that it was the work of the devils and witches who had killed innocent young children; for this he accounted a mere conjecture, possibly also injurious to the goodness and providence of God. In the meanwhile an accident happened out of which he conceived he had collected the true cause thereof;—for some months before he shut up in a box a certain palmer-worm which he had found, rare for its bigness and form, which, when he had forgotten, he heard a buzzing in the box, and when he opened it, found the palmer-worm, having cast its coat, to be turned into a very beautiful butterfly, which presently flew away, leaving on the bottom of the box a red drop as broad as an ordinary sous or shilling; and because this happened about the beginning of the same month, and about the same time an incredible multitude of butterflies were observed flying in the air, he was therefore of opinion that such kind of butterflies, resting upon the walls, had there shed such like drops, and of the same bigness: wherefore he went the second time, and found by experience that those drops were not found on the house-tops nor upon the round sides of the stones which stuck out, as it would have happened if blood had fallen from the sky, but rather where the stones were somewhat hollowed, and in holes where such small creatures might nestle and shroud themselves. Moreover, the walls which were so spotted were not in the middle of towns, but they were such as bordered upon the fields; nor were they on the highest parts, but only so moderately high as butterflies are commonly wont to fly."

The period in which an insect remains in the chrysalis state is not always of the same duration, although at the same period of the year it is similar; for instance, those caterpillars of the swallow-tailed butterfly which are changed into chrysalides about the middle of July, appear as butterflies at the end of thirteen days, while those which appear in the caterpillar state at the beginning of September remain during the winter in the chrysalis, and do not become butterflies until the spring. "Thus," says Reaumur, "here is one butterfly which only remains thirteen days in the chrysalis state, while another, precisely similar, requires nine months to bring it to perfection, just as though the inhabitants of cold regions were to live four or five centuries, while the life of those dwelling under the equator was only to be extended to its ordinary length: hence it is evident that it is by evaporation or combination of the fluid parts of a chrysalis, produced by the application of heat, that the insect is brought to its perfect state much quicker at one period of the year than at another."

Conceiving, therefore, that the butterfly is not in a state to burst from the chrysalis until by the action of heat and insensible perspiration a certain quantity of superabundant humidity has evaporated, and the other fluid parts of the body become assimilated, Reaumur came to a conclusion, that in proportion to the quickness with which the process of evaporation is effected by the increase of heat, the sooner the butterfly would be enabled to escape from the chrysalis. Acting upon this idea, this celebrated author tried various experiments with chrysalides, the result of which fully justifies the conclusion at which he had arrived, and thereby proved that he was enabled to prolong or shorten the life of an insect at pleasure. Thus, by placing various kinds of chrysalides, which would not naturally produce perfect insects until the spring or summer, in one of the hothouses of the Jardin des Plantes, in the month of January, 1734, he found that they very shortly produced butterflies and moths, those which would not have appeared until May escaping from the chrysalis at the end of ten or twelve days, others in three weeks, and others, which would not have become perfect insects until August, in five or six weeks. The insects thus produced differed in no single respect from those reared in a state of nature, and deposited their eggs even in the midst of winter. In the month of November following, being two months earlier than before, he placed other chrysalides in the hothouses, and these in like manner produced perfect insects in the beginning of December, which would not otherwise have appeared until May. Thus, by forcing the evolution of a butterfly in December, which ought not naturally to take place until June or July, we are enabled to convert a single-brooded species into one which produces two generations of caterpillars in the year, the first brood appearing in June, from eggs deposited in May, by butterflies recently disclosed; this brood of caterpillars being transformed into butterflies before the end of July, when they deposite eggs, which are hatched in August or September; and the second brood of caterpillars entering into the chrysalis state before the winter, from which they are excluded in the following May as butterflies.

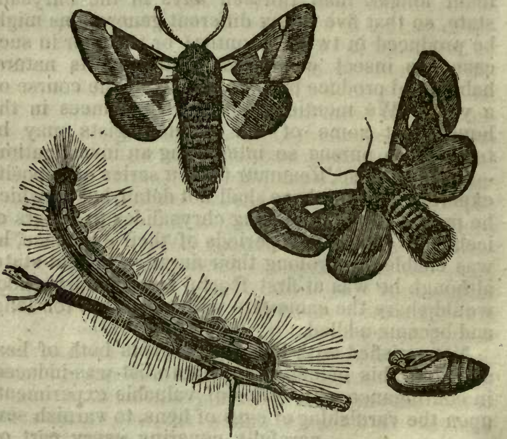
Reaumur had also recourse to a still more ingenious mode of causing the speedy disclosure of butterflies. In order to obtain a more regular supply of heat than could be obtained from a stove, he placed chrysalides in hollow balls of glass of the size of an egg under a sitting hen, which would as easily mistake them as round stones for her eggs; the results were similar to those in the former experiment, the butterfly appearing in the course of a few days. He omitted, however, to endeavour to discover by experiment, whether by increasing the temperature of the hothouse above summer heat he could not produce them in fewer than thirteen days, or whether a temperature beyond that of summer would not destroy them. He likewise did not endeavour to discover whether, by maintaining a constant summer heat, a succession of broods could not be obtained in the year, none of which should remain longer than thirteen days in the chrysalis state, so that five or six different generations might be produced in twelve months; or whether in such case the insect would not return to its natural habits, and produce but two broods in the course of a year. We mention these circumstances in the hopes that some of our entomologists may be tempted to pursue so interesting an investigation.

Besides these, Reaumur tried a series of opposite experiments, which we shall not detail, but by which he proved, that by placing chrysalides in cellars or icehouses at different periods of their existence, he was enabled to prolong their duration in that state, although he was at first fearful lest his chrysalides would share the same fate with eggs kept too long, and become addled.

Not satisfied with trying the effects both of heat and cold, this indefatigable naturalist was induced, in continuance of a series of valuable experiments upon the varnishing of eggs of hens, to varnish sev- carefully covering every part of the body except the respiratory spiracles, the result of which was, that although kept in the ordinary temperature, the exclusion of the perfect insects was delayed for some weeks.

But there are other circumstances connected with the irregular appearance of insects in their perfect state, which it is impossible to account for upon the same principles as those observed in the preceding experiments:—these are, first, the circumstance of some insects remaining for one or more years in the chrysalis state, while others of the same species, reared in a precisely similar manner, are evolved at the proper season; and, secondly, the irregular appearance of certain insects.

"The parental cares of nature," observes Mr. Haworth, in his account of the small eggar moth (*Eriogaster lanestris*), "are extended towards this poor insect in a very extraordinary and interesting



manner. Doomed to a regular appearance in the winged state at the termination of the cold and ungenial month of February, nature (that it may not fail and become extinct) reserves a small portion of it annually in the pupa state until the February following that of its pupation, and sometimes even until the third occurrence of that frigid month; denying their emancipation all the intermediate time, and thus effectually securing, by these unusual means, the safety and perpetuation of an animal, small, it is true, but whose animal existence in the winged state at that inclement season is probably of more consequence in the intricacy of its great Creator's plans than we are at present aware of, although he constantly exposes it to the dangerous vicissitudes of winter; for

> 'Each shell, each crawling insect, holds a rank
> Important in the plan of Him who framed
> This scale of beings; holds a rank, which lost,
> Would break the chain, and leave behind a gap
> Which nature's self would rue.'"

The cause of such exceeding care and solicitude for the welfare of this moth it is difficult for any one to explain or account for in any satisfactory manner, unless indeed in such a one as the divine Stillingfleet, author of the above admirable lines, has suggested therein.

It even appears that these insects are occasionally not disclosed until the fourth year. In like manner, the pivet hawk moth (*Sphinx ligustri*) has been known to remain three years in the chrysalis state; and the Rev. J. Burrell once bred a small emperor moth (*Saturnia pavonia minor*), which had existed two years in that condition. Mr. Marshall also records a similar circumstance respecting the spotted muslin moth (*Diaphora mendica*); but in this instance the regularity in the exclusion of the numbers of the moth was very remarkable, since out of thirty-six chrysalides twelve appeared at the proper season, twelve others appeared at the end of two years, and the remaining twelve at the end of three years. Heineken also relates that he kept several pupæ of the large emperor moth through the winter in a room heated daily by a stove, and several others in a cold chamber, and that some of each parcel appeared in March, while others had not appeared in July, although still in a healthy condition. In England this moth appears, in its natural state, in the months of April and May, and again in August. As, however, we do not find it recorded by Haworth or Stephens that this is one of the double-brooded moths, it appears to us probable that Heineken's remaining specimens would have appeared in the following August. But if this were the case with Heineken's specimens (and this supposition will enable us to account for the appearance of the British specimens in August), to what is it owing that a portion of the same brood should remain three or four months longer in the chrysalis than the remainder of the brood; the case being usually very different with those specimens which remain longer in the chrysalis, for these make their appearance at the same time of the year as their elder brethren? We may probably account for the circumstance mentioned by Heineken, that those placed in the heated room did not appear earlier than those kept in the cold, by supposing that the heat was not maintained during the night, and that even in the daytime it might not have greatly exceeded that temperature of the atmosphere.

Respecting the periodical appearance of insects, the *Cicada septemdecim*, subsequently noticed, which is said to make its appearance only once in seventeen years, affords one of the most striking examples; but there are several of the British butterflies which are not less remarkable. Among these, the painted lady butterfly (*Cynthia cardui*) is eminently conspicuous, occurring in the neighbourhood of the metropolis every third or fourth year. The fine white bordered butterfly (*Vanessa antiopa*) is another instance of this irregularity. Mr. Haworth remarks upon this insect, "There is something very extraordinary in the periodical but irregular appearance of these species—*Edusa* and *Cardui*. They are plentiful all over the kingdom in some years, after which *Antiopa* will not be seen by any one for eight or ten or more years, and then appear again as plentiful as before. To suppose they come from the Continent is an idle conjecture, because the English specimens are easily distinguished from all others by the superior whiteness of their borders. Perhaps their eggs in this climate, like the seeds of some vegetables, may occasionally lie dormant for several seasons, and not hatch until some extraordinary coincidences awake them into active life." And Mr. Stephens observes respecting the same butterfly, "Till about the middle of the last century few specimens had been observed; but about sixty years since it appeared in such prodigious numbers throughout the kingdom that the entomologists of that day gave it the appellation of the Grand Surprise." It also occurred again in plenty in 1789 and 1803, since which time it has been seldom met with. The same author elsewhere observes, "The cause of this interesting phenomenon appears inexplicable: its solution has baffled the inquiries of entomologists, and several speculative opinions have been advanced thereon. By some persons, their sudden increase has been attributed to the previous failures of their enemies, the ichneumons and the soft-billed birds; by others, to an increased temperature; others again suppose that their eggs lie dormant until called into life and vigour by some extraordinary latent coincidences. But all these opinions are mere conjecture, and they do not sufficiently clear up the difficulty, which is rendered more obscure from the fact that several of the insects, especially *Cynthia cardui*, appear constantly in some parts, and periodically in others." But the most extraordinary fact recorded of this kind is one related by this author, respecting the white W. hair-streak butterfly (*Thecla W. album* of Hubner, which was at first regarded by Mr. Stephens as the *Thecla pruni* of Linnæus). Previous to 1827 this butterfly had never been observed by him in the vicinity of Ripley, where he had for several seasons been in the habit of collecting, as we, who have had the pleasure of accompanying him in some of his excursions near that town, can testify. But in the month of July in that year, "the boundless profusion with which the hedges *for miles* were enlivened by the myriads that hovered over every flower and bramble blossom, exceeded any thing of the kind I have ever witnessed; some notion of the numbers may be formed when I mention that I captured, without moving from the spot, nearly two hundred specimens in less than half an hour, as they successively approached the bramble-bush where I had taken up my position." It will be observed that the insects were not confined to a single spot, but extended for miles; their numbers must consequently have been incalculable, and this is the more remarkable since Mr. Stephens adds, "that the hedges to the north and northwest of the village were perfectly free, although the brambles, &c., were in plenty."

CHAPTER III.

THE NATURAL HISTORY OF VARIOUS INSECTS WHICH FORM COCOONS.

Conical Chrysalides produce Moths, and are enclosed in Cocoons—Supposed Causes of the Difference between Butterflies and Moths in this respect—Distribution of Colours in Insects—Cocoons of pure Silk—Slender Silken Cocoons guarded by Leaves—Mode of Spinning Cocoons—Gum and Paste introduced into the Substance of Cocoons—Processionary Caterpillars form Cocoons in Company, in which Hairs are mixed with Silk—The Great Eggar Moth Cocoon—Assembling of Moths—Palisade Cocoon of Hair and Silk—Strength of Cocoons not indicative of the Duration of the Chrysalis State—Rough Cocoons formed of Earth and Silk—Elongate Tongue-case of Chrysalides—Polished Earthen Cocoon—Cocoons formed of Chips of Wood, and of Leaves, Twigs, and Moss—Extraction of the Moth from the Cocoon—Contrivance of the Larvæ to allow the more easy Extrication of the Moth—Regularity in the Time of Appearance of Insects—Extrication of the Chrysalis from the Cocoon—Extrication of Perfect Insects from the Caterpillar Case.

In a former chapter we have stated that, with very few exceptions, butterflies are produced from angulated chrysalides, while those of moths are of a conical shape. In addition to this, we may notice that the chrysalides of butterflies are, for the most part, naked and exposed, while those of moths are generally enclosed in a case or cocoon, formed by the larva previous to undergoing its change. The cause of this additional variation appears to us to result from the preceding, since it is evident that the projections and points which arm the chrysalis of a butterfly would very much annoy the inhabitant of a dwelling in which it can scarcely turn itself, while no form could be better adapted to the inhabitant of a cocoon than the conical, the base of the cone being rounded; and this appears to be still more satisfactorily illustrated by the circumstance that the slight motions of the pupa are entirely produced by the twisting about of the apex of the cone, which part encloses the segments of the abdomen of the insect.

We shall now proceed to notice the peculiarities observable in these conical chrysalides, and in the cocoons which are thus dependant upon the forms of their bodies.

Respecting the form of these chrysalides, but little need be said. They are of a cylindric shape, the head is rounded, and the tail produced into a conical point; the wings, legs, and antennæ, are disposed as in the pupæ of butterflies. It is the coverings constructed by the caterpillars, in which these chrysalides pass their inactive and almost lifeless state, which more particularly merit our attention. And here we may observe, that it appears to be a remarkable provision of nature, that while the chrysalis state of the delicate butterfly is undergone in a naked and exposed manner, the robust moths and sphinxes are buried in cocoons beneath the earth or in the midst of leaves. May not this circumstance be intended to represent the difference in the habits of the future insect; preparing it, as it were, for its coming mode of life? The butterfly passing its life in the sunbeams, we may suppose that in its exposed chrysalis state it is becoming fitted for the glare of light in which it is to live; while the moth, appearing only in the dusk, passes its inactive state within the darkened chamber of its cocoon.

This leads us to notice another beautiful provision of nature, in which, although we observe her everywhere lavishing her bounties with the utmost prodigality, we find them constantly applied where they will neither be lost nor misplaced. We allude to the illustration afforded by the various tribes of butterflies and moths of the distribution of colours in the works of the creation, from which we may perhaps obtain another reason why the chrysalides of the butterflies should be naked and exposed, and those of the moths incased in a dark cocoon.

The butterflies being day-fliers, and exposed to the sun, are far more splendidly adorned with colours than any other of the *Lepidoptera*, while the dusk and night-flying moths, especially the *Noctuæ*, which are eminently nocturnal, are almost invariably of dingy teints. Those *Noctuæ*, however, which depart from the character of the family by becoming partial day-fliers, such as *Noctua*, *Chrysites*, &c., have their wings clothed with splendid scales, whence some of them are known by the English names of the Burnished Brass Moth, the Gold Spangle, &c. This economy is however even carried to a more singular extent; since in those moths whose upper wings do not cover the lower, the latter are equally variegated with the former, while in those which rest with the upper wings meeting together and covering the lower, the latter are of a uniform dirty brown colour, without markings. In like manner, we find in the moths produced from the geometric or looper caterpillars, a greater variety of teints than are exhibited in the other tribes of moths; and we consequently find them sporting by day, and forming a portion of a section which Mr. Stephens has, from this circumstance, termed *Pomeridiana*, with the remark that they fly early in the afternoon, and in the evening or in the twilight, though some few may be found throughout the night. But the typical species fly in the full blaze of sunshine, and when they alight elevate their wings after the manner of the *Papilionidæ*.

The indefatigable French naturalist Reaumur, to whose remarks we and other authors have been so much indebted, has given two chapters upon the construction of cocoons—his twelfth memoir of the first volume, comprising such as are of a rounded form, composed of materials furnished by the caterpillar itself, being either entirely of silk, or of silk mingled with the hairs of the caterpillar; and his thirteenth memoir, comprising cocoons of an irregular form, in which other matters besides silk are employed. As these memoirs would occupy at least one hundred and fifty of our pages, we can give but an imperfect idea of the various objects treated upon. In the subsequent pages of this chapter we have, however, endeavoured to introduce an account of the chief peculiarities of structure, with some additional information and remarks.

Among those insects which form their cocoons of pure silk, the silkworm stands far pre-eminent; for, as Reaumur observes, if the luxury of silk were taken away, where could wool sufficient to supply its place be found? The poor, he adds, would be obliged to go unclad, unless, indeed, he should discover some method of employing the silken cocoons of other insects, which are sufficiently common, and equally prolific, and which seem to be well adapted for such an experiment: indeed, Reaumur endeavoured to rear a tubercled species of caterpillar, found in the pear, for that purpose, but he did not succeed, except in one instance, in which the cocoon weighed as much as three of those of the silkworm.

Some species of caterpillars being probably unprovided with a sufficient supply of silk, content themselves with spinning a cocoon of so flimsy a construction as to resemble network, allowing the chrysalis to be perceived without difficulty, and seeming formed merely as a support rather than as a defence to the enclosed animal. Of this description is one noticed by Messrs. Kirby and Spence, somewhat resembling an air balloon, the meshes of which are large and perfectly square. The pupa hangs in the centre, fixed by some few slight threads, which diverge from it to all parts of the cocoon, so that it looks as if suspended in the air, like Mahomet's coffin, without visible support.

Other species, among which the beautiful English scarlet tiger moth (*Hypercampa dominula*), may be mentioned, form their cocoons of a somewhat more compact texture, but still insufficient completely to hide the chrysalis. The majority of the species, however, of those which are but ill-concealed in their cocoons, endeavour to supply the deficiency by drawing the adjacent foliage close to-

gether with silken strings, in the middle of which they occasionally congregate and form their cocoons in company. But the majority of silken cocoons are of a more solid description. The manner in which these cocoons, including that of the silkworm, are spun, is remarkable for not having the thread disposed regularly like that of a ball of cotton, in which it is made to pass along the whole circumference of the ball. This we may easily imagine would be an easy task for the insect; but if a cotton-spinner were to be told that he must form his ball of cotton of equal thickness throughout, but that the thread must, at the same time, be arranged in an irregular and more or less zigzag course, he would give up his task in despair. This is, however, precisely what the silkworm and other caterpillars execute, as any one may observe in unwinding the silk from the cocoon of a silkworm.

In general, these cocoons of a firm consistence are composed of an outer loose covering of silk, in the middle of which the compact egg-shaped cocoon is observed; in some instances, however, the outer envelope is entirely omitted, and in others it is so closely spun as scarcely to differ from the cocoon itself.

Some caterpillars, in order to strengthen their cocoons, moisten them with a gummy matter diffused from the anus, after they have been completed; among these the emperor moth may be mentioned: In like manner the caterpillars of the lackey moth (*Clisiocampa neustria*), the white satin moth (*Leucoma salicis*, &c.), emit a yellow paste-like matter, which they apply by continued motions of the head to the under surface of the cocoon, and this, when dry, becomes a powder which renders it opaque. In some specimens which we have reared of the rare lappet moth (*Gastropacha quercifolia*), from caterpillars from the fens of Cambridgeshire, we found the inside of the cocoon and the body of the chrysalis thickly covered with a white powder of this description. We have also observed that the chrysalis of the large red-underwing moth (*Catocala nupta*), is covered with a powdery bloom of a bluish colour.

Cocoons formed entirely of silk are generally the work of smooth-bodied caterpillars, but many of these animals are in this state very hairy, whence they are termed in some parts of the country, woolly-bears. Some of these, on their changing to the chrysalis state, cast off their skin at once with the hair still attached to it, as may be seen from the exuviæ contained in the cocoon; but many, previous to becoming pupæ, strip themselves of their coat of hairs, which they incorporate with the silk of their cocoons. Among these, the processionary caterpillars, of which we have given an account in our previous volume, may be mentioned. This interesting insect (the *Cnethocampa processionea*), was introduced by Martin and Stewart, as a British species, on the authority of a specimen contained in the British collection at the British Museum, which has been regarded as belonging to it; but Mr. Stephens thinks that this is rather referable to another species, the *Cnethocampa pityocampa*, and, consequently, that the claim of the former insect to be considered as a British species is dubious.

In order to prepare for the last moulting which precedes the change to the pupa state, they arrange themselves on a branch in the manner represented in figure 1, page 54. In this position they remain many hours, at the expiration of which time they shed their skins. Immediately after this is accomplished, their hairs are of a white colour. In this state they remain for more than twenty-four hours longer without taking any sustenance. Having completed their growth, they undergo their change to the chrysalis; but this is effected in the nest, each caterpillar spinning for itself a cocoon, uniting their hairs with the silk; so that on opening a cocoon just before the caterpillar changes to a chrysalis, the former is scarcely recognisable, being completely smooth and divested of hairs. As in the larva, so in the chrysalis state, these insects are gregarious, fixing themselves as closely together as possible (fig. 2, p. 54); the cocoons being attached to and parallel with each other, and disposed in layers like a honeycomb, the thickness of the layer being equal to the length of the cocoon, and its extent

FIG. 1.

equal to the size of the nest; but it generally happens that the latter is not sufficiently large to allow all the cocoons to be arranged in a single tier, so

FIG. 2.

that sometimes they consist of two, and occasionally of three layers. After the whole of the moths have been produced (all of which make their appearance in the same day), these layers of cocoons very much resemble the combs of a bee or a wasp's nest, the head of each cocoon being stripped off by the moth on effecting its escape, and causing the whole to look like an assemblage of empty cells. These insects are remarkable for another quality, which renders it very unpleasant to approach their nests, or to handle the caterpillars. Reaumur had cause to speak very feelingly upon the subject, having suffered very severely from the intolerable irritation produced by their hairs. Reaumur likens these caterpillars to a species of bean which is brought from the American islands, the pods of which are covered with hairs so exceedingly sharp and fine, that, on touching or rubbing them with the hand, they run into the flesh: in like manner the hairs of these caterpillars, on being touched by the hand, cause it to swell: and Reaumur and some of his companions suffered for four or five days from the inflammation produced by them: his face, and especially one of his eyes, being very much affected in consequence of his having touched them with his fingers on which the hairs were sticking. Several ladies also, who were with Reaumur, but who did not handle the caterpillars, had their necks inflamed, and it was evident that this was produced by the very fine hairs which were floating in the atmosphere. This was especially the case after the insects were transformed into chrysalides and moths, being seldom observed while the insects remained in the caterpillar state. However, so powerful is their action, that Reaumur suggests that they might advantageously be used as *vesicatories*, and, indeed, no less than two enactments were made by the Roman senate against the medicinal exhibition of them, under severe penalties, in consequence of their virulence. The only remedy which Reaumur was able to discover to counteract the effects of these hairs, was to rub parsley-leaves smartly upon the affected parts for several minutes. This he found so efficacious, that, in the parts thus rubbed, the irritation immediately subsided.

The great eggar moth (*Lasiocampa quercus*), is another example in which the hairs of the caterpillar are introduced into the structure of the cocoon. The name of the genus has been given to this moth, in allusion to the hairiness of the caterpillars. In this insect it is observable that the size of the cocoon does not appear to be at all proportioned to that of the caterpillar; the former being so small that it is difficult to conceive how so large a caterpillar can shut itself up in a domicile as small and inconvenient as those dungeon cells built in the "olden time," in which the unfortunate captive could neither stand upright nor lay down. And this is the more remarkable, because the insects being at full liberty and not stinted of materials, there seems no sufficient reason why they should confine themselves within such narrow bounds. Some species, however, run into the opposite extreme; those, for instance, of the ghost moth (*Hepiolus humuli*), and the cream-spot tiger (*Arctia villica*), are several times larger than the chrysalis which each contains.

The great eggar moth is of very common occurrence in England, and its larva is almost one of the largest caterpillars which we have, being often nearly four inches long. It feeds upon various trees and shrubs; it is of an ochreous colour, with black rings and white spots, and is very hairy. It is full-fed about the end of June. The cocoon is of a cylindrical form, with the ends rounded, and the outer surface appears nearly smooth; hence in its appearance it so much resembles an egg, that the moths which are produced from this kind of cocoons are termed eggars. On touching it, however, it is found to be set with stiffish hairs. In order to form its cocoon of this figure, the caterpillar keeps its body continually bent in different positions while it is employed in its formation, each end of the body being constantly bent in the shape which is thus given to the two ends of the cocoon. Sometimes the head and tail are curled opposite to

each other, fig. A, while at others the body assumes the form of the letter S, fig. B. Hence the body of the insect becomes the model of its cocoon. The motions of the insect, in forming the different parts of the cocoon, are very gradual. The manner in which the layer of silk which serves for the groundwork of the cocoon is spun, does not materially differ from that of the caterpillars ; but when the network is somewhat advanced, it is observed to acquire an external covering of hair, which stands erect to a considerable height, as in fig. C. These hairs have been stripped from those parts of the body of the enclosed caterpillar which are placed against the sides of the cocoon, the caterpillar being observed at such time to fret itself against the inner surface of the network, whereby the hairs are protruded through the meshes of the net; the basal portion of these hairs still however remains within the cocoon, and as a prickly unevenness would be produced in the inner surface of the cocoon, which would irritate the soft chrysalis when newly disclosed if the hairs were to remain in that position, the insect, in order to remedy this inconvenience, forces the basal portions of the hairs closely against the inner surface of the cocoon, and fastens them in that position with silken threads; by this means the outer parts of the hairs are brought to lie flat upon the outer surface of the cocoon, which is then made stronger by further layers of silk, and when completed its consistence is very hard, the outer surface rendered smooth, and the inner lined with a coating of shining silken tapestry.

The perfect insects make their appearance about the end of July, and their singular mode of pairing has long attracted the attention of entomologists.

"It is a frequent practice with our London aurelians," observes Mr. Haworth, "when they breed a female of this and some other day-flying species, to take her while yet a virgin into the vicinity of woods, where, if the weather is favourable, she never fails to attract a numerous train of males, whose only business appears to be an incessant, rapid, and undulating flight in search after their unimpregnated females, one of which is no sooner perceived than they become so much enamoured of their fair and chaste relation as absolutely to lose all kind of fear for their own personal safety, which at other times is effectually secured by the reiterated evolutions of their strong and rapid wings. So fearless, indeed, have I beheld them become on these occasions, as to climb up and down the sides of the cage which contained the dear object of their eager pursuit, in exactly the same hurrying manner as honey-bees which have lost themselves climb up and down the glass of a window.

"While under this enervating fascination, if you even handle them, or suffer them to creep buzzing through your hands, they are not alarmed, as they would be at another time, but continue to urge their pursuit as before, endeavouring to gain admittance into the cage; of course any quantity of them may be readily secured. In about four hours after the aurelians have thought proper to admit a male of their liking into the cage to the poor drowsy object of all this anxiety, she will not fail to deposite a great quantity of large impregnated eggs, of an oval shape and whitish colour, blotched with darker marks, in miniature pretty much resembling those of a common sparrow.

"The aurelians call such a wedding as the above a *sembling* (assembling) *match*, and never succeed with any but a virgin female. By what unknown, and perhaps unnamed power, the males distinguish between a married female and one that has not been impregnated I know not, and should be glad to learn, but that they can and do make an unerring discrimination between the two is well known to most aurelians. They avoid the latter, and never approach her, while for the former they display all the solicitude and anxiety I have above so fully explained. There was once an instance of a male creeping into the pocket of an aurelian, which contained a virgin female in his pocket-box."

We have, however, heard of still more extraordinary exploits than this, performed by these inamoratoes. Jurine records two circumstances somewhat similar: one of his friends captured a female of the emperor moth, and stuck it with a pin upon his hat, and in the course of his walk no less than thirteen males were caught hovering about his head. The other circumstance was still more remarkable, and seems to prove that it is by scent that the males are attracted—a female of the fox moth (*Eriogaster rubi*) was killed immediately after her exclusion from the chrysalis, when she ejected some drops of a fluid similar to that which we have noticed above in the butterfly as the cause of the bloody rain. On the following day a male flew into the chamber, on the second day another male appeared, and in the evening a third, and from their motions it was evident that they were attracted to the spot by the scent of the fluid before mentioned. Jurine conjectures that the fine feathered antennæ of the male are the parts which serve to direct them in these flights, and the differences between these organs in the two sexes are easily perceived.

Reaumur has also narrated the proceedings of a small hairy caterpillar, which feeds upon lichens, and which appears to us to be that of the muslin moth (*Nudaria mundana*), which Schäffer has figured and described at great length under the name of the steinmoosraupe—the stone-moss caterpillar. These caterpillars form their cocoons about the 7th or 8th of July, and, at first sight, they may easily be mistaken for the caterpillars themselves; the cocoons are found upon walls or on flat bits of stone, and in forming them the caterpillar pulls off its hairs and plants them in an upright position round its body, side by side, like the pales of a palisade, in an oval ring, in the middle of which it is itself stationed; within this enclosure it spins a slender web, which scarcely conceals the chrysalis. This tissue supports the hairs, which are forced to bend over it at the top by silken threads, so as to form a kind of roof. The perfect insect appeared about the 25th of July.

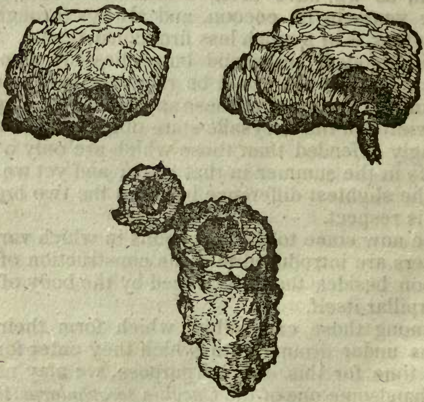
It has been considered by the author of the "Insect Transformations" (p. 180), to be one of the most striking instances of instinctive foresight, that the caterpillars which build cocoons of a substantial structure are destined to remain much longer in the chrysalis trance than those which spin merely a flimsy web of silk, the latter, for the most part, being stated to undergo their final transformation in a few weeks, while the former continue entranced the larger portion of the year, appearing in the perfect state the summer after their architectural labours have been completed. As we cannot but acknowledge that the view of nature exhibited by this theory is an interesting one, we regret that we are under the necessity of stating that it is unsupported by facts; for instance, there are many butterflies which pass the winter in the pupa state, and yet their cocoons are destitute of any covering at all. Again, some of the most robust cocoons are formed for the protection of insects which remain but a few weeks in the chrysalis state, while a cocoon of very flimsy construction often defends an insect throughout the winter; thus one of our largest and rarest moths, the Glory of Kent (*Endromis versicolora*), spins a slender, open, netlike cocoon, in which it remains enclosed not less than ten months, from June until April. The still rarer lobster caterpillar (*Stauropus fagi*) forms a cocoon of a delicate silky nature, in which it is enclosed from September till June. The cocoons of the ermine moth are equally slender, but they are still more exposed than the former, being placed at the root of trees, &c. There are, however, two moths already noticed in this and a preceding chapter, which most completely disprove the theory alluded to. The large eggar moth forms a very hard cocoon, in which it only remains four weeks, from the end of June to the end of July; the small eggar moth, which, as we have seen, sometimes remains as many years in its cocoon, and always throughout the winter, is of a much less firm consistence. The double-brooded moths and butterflies are also instances in which it would be requisite, for the support of this theory, that those specimens which pass the winter in the chrysalis state ought to be more strongly defended than those which are only a few weeks in the summer in that state; and yet we find not the slightest difference between the two broods in this respect.

We now come to those cocoons in which various matters are introduced into the construction of the cocoon besides those furnished by the body of the caterpillar itself.

Among those caterpillars which form their cocoons under ground, into which they enter for the first time for this express purpose, we may notice the handsome one of the *Cucullia scrophulariæ*, found upon the mullein and water betony, of a grayish pearl colour, with black spots which are surrounded by yellow rings. This caterpillar descends into the earth about the middle of July, where it forms an

egg-shaped cocoon of bits of earth fastened together by silken threads, from which the moth appears in the following April. One of these caterpillars afforded Reaumur a good opportunity of examining the proceedings of such caterpillars as form their retreats under ground, as well as the mode in which they procure materials for one or two additional inner linings of the cocoon, in the inside of which

C B



A

they constantly work. He dug up one of these cocoons when it was nearly completed, and broke off about one third of its extent at one end, as in fig. A, from which it will be perceived that the thickness of the structure is considerable. The insect immediately commenced the reparation of its cocoon, which it completely effected in the course of four hours, by means of bits of earth which had been placed within its reach. It commenced by protruding nearly the whole of its body out of the breach (fig. B) and seizing a piece of earth with its strong jaws, which it bore into its damaged cocoon; this employment it continued for some time, selecting with much care those bits of earth which were fittest for its use; during this time, therefore, it was employed only in collecting materials, since it was rarely that it affixed any of these grains to the walls of its cell unless it met with one which happened exactly to fit any part of the damaged breach. It now, however, commenced spinning a slight band of silken network round the aperture, and then attached bits of earth thereto by means of silken cords, which it spun for that purpose during its labour; thus by degrees the size of the damaged part became contracted. When the aperture had become nearly closed (fig. C), the caterpillar, in order to close it entirely, was observed to spin arched lines of silk from one side to the other of the aperture, crossing each other at different angles, like a coarse kind of network, into which it fastened grains of earth, so as to render its external surface similar to the sound part; it however did not content itself until it had also strengthened the inside with smaller grains of earth, so that when Reaumur opened the cocoon again with a penknife, the new part was found to be equally thick and compact with the other part which had not been damaged. The internal operations of these caterpillars are not observable, because they do not commence the silken tapestry with which they are lined until they have completely closed the outer walls.

The chrysalis of this insect is remarkable in having the tongue of the moth, not simply stretched along the breast as in most chrysalides; but as from its great length that organ would reach further than the extremity of the body if extended in a straight line, it is bent back when it has reached the last ring of the body, and is recurved to the length of several segments. The tongue-case of the chrysalis of the very rare English moth, *Noctua* (*Calophasia*) *linariæ* (whose cocoon is very similar in its construction to that of the spectacle moth subsequently mentioned), also turns upwards, and is prominent laterally beyond the sides of the body. There are other instances in which the tongue is even much longer than in these moths, and in which this organ is differently folded, as in the sphinxes, in which the tongue very far exceeds the length of the body; but in the chrysalis state it is folded up and incased in a short cylindrical proboscis, curved upon the breast.

There is another caterpillar, however, which exhibits much more ingenuity than that of the water betony moth above mentioned. Like the cocoons formed by the latter, the substance of its case is chiefly earth; but instead of the outside being rough

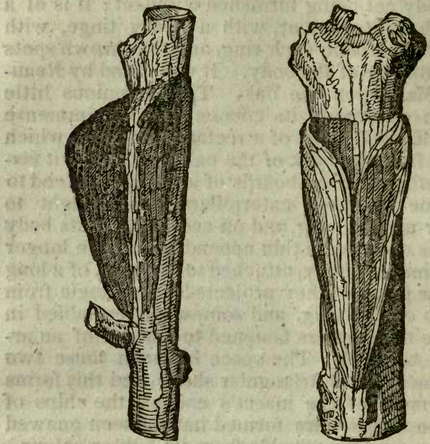
and uneven, it is smooth and finely polished, and, moreover, instead of being formed in the earth it is built upon leaves, so that the caterpillar is under the necessity of fetching its materials from a considerable distance.

Reaumur found these caterpillars upon the oak and apple, and some of them formed their cocoons during the night, without his having observed the process. He noticed, however, that the earthen walls of the cocoon were moistened, although the earth at the bottom of his breeding-cage was quite dry. It was evident, therefore, that the caterpillar had moistened the earth, but he could not imagine how a caterpillar, which, in constructing its cocoon, is for the most part enclosed within, could give to the exterior so smooth and polished a surface; and had he not been more of a naturalist than a gourmand, his curiosity in this respect would not have been satisfied; for, having observed one morning that his only remaining caterpillar was making preparations for forming its cocoon, by attaching a few silken threads as a base upon a leaf, he quitted his study at two o'clock to dine, and returning in less than an hour to watch its manœuvres, he found that it had, during his short absence, completed three quarters of its cocoon, the mode of construction of which was found to be somewhat similar to that employed by cottagers in building mud walls, the chopped straw which is employed to bind the mud together being replaced by the meshes of a loose silken web of an oval shape. When this web is nearly completed, the insect collects a quantity of earth within the net merely sufficient for its future purposes. It then shuts itself up in this net by entirely closing the aperture, and commences the building of its mud walls by moistening one of the bits of earth with a liquid which it emits from its mouth; when well moistened, it pushes the paste through the meshes of its net, when it immediately assumes a smooth appearance. Reaumur observed that it repeatedly pushed its head with considerable force against the inner surface of the cocoon, so as to force the more moistened earth to run through the meshes of its net. Hence it is evident that the silken net has both an external and an internal covering of mud. When the operation was completed, Reaumur opened the cocoon and took it away from the caterpillar, which, however, made a second during the night; it was, however, but slightly cased with mud, the insect not having sufficient fluid left to moisten the grains of earth with. The moths produced from some of the cocoons thus constructed, were found dead in the breeding-cages at the end of October. They were of an ashy gray colour, with two palish bands across the wings, and are considered by Ernst as the oak eggar moth (*Trichocera cratægi*). The cocoon which we have figured from Reaumur is similarly formed, but the caterpillar differed in its markings from those of the former caterpillars, and Reaumur did not succeed in rearing it to the perfect state.

The caterpillars of numerous other species of moths form their cocoons of chips of wood and bark, connected together with silk; but these are generally constructed without much regularity in the arrangement of the chips. Among these, that of the puss moth, subsequently noticed, is one of the hardest cocoons with which we are acquainted. It is composed of very minute gnawed bits of bark, strongly cemented together with a gummy secretion mixed with silk. There is, however, another species, whose proceedings have been detailed by Reaumur, which far exceeds the others in the neatness and ingenuity of its case; and it is consequently to be regretted that this author has not recorded the particular species, nor figured the moth produced from it. Messrs. Kirby and Spence, however, suppose that it may probably be the smallest black arch moth (*Pyralis* (*Nola*, Leach) *strigilata*). The caterpillar is of a small size, and of a flattened form, with fourteen legs, the fourth, fifth, and sixth segments of the body not being furnished with feet; it is of a yellowish white colour, with a fleshy tinge, with tufts of red hairs on each ring, and two brown spots near the middle of the body. It was found by Reaumur in May upon the oak. This ingenious little workman constructs its cocoon with an immense number of small chips of a rectangular form, which it gnaws from the bark of the oak, and which it fastens together like the boards of a room-floor, end to end. One of these caterpillars was brought to Reaumur upon a twig, and on each side of its body there was observed a thin appendage a little longer than the insect's body, attached to the twig, of a long triangular form. They projected at an angle from each side of the twig, and somewhat resembled in miniature the feathers fastened to the end of an arrow (fig. A, p. 68). The space between these two wings was also of a triangular shape, and this forms the basement of the insect's cocoon, the chips of which the wings were formed having been gnawed from it, as was perceivable from its lighter colour.

It does not seem requisite, as Reaumur observes, that nature should bestow any extraordinary degree of intelligence upon an insect for the purpose of constructing an oval or rounded cocoon, that being the shape in which it arranges its materials from the very commencement, and to which the various positions of its body while at work are sufficient to impart that form. But when we observe an insect commencing the construction of its cocoon (which when completed will resemble the longitudinal section of an inverted cone, with an elliptical protuberant base), by forming two flat and triangular walls, thus adopting a mode of procedure which certainly appears very unfitted for such a purpose, we must at least confess, if we find that this was the plan best adapted for the completion of its work, that the insect is as mechanical as ingenious.

A B



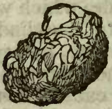
Reaumur wondered, at this stage of the building, what form the cocoon would ultimately exhibit, thinking that additional appendages would be affixed to these at different angles, so as to form a kind of perpendicular roof; but the insect's ideas of architecture were different from any which Reaumur had fancied, for the little workman destined these two wings alone to form a case perfectly closed, and these two were amply sufficient for its purpose.

The chief object of the insect was now perceived to be to bring the outer edges of these two wings together, just as we shut a pair of folding or cupboard doors, when they are opened and pushed backwards. Hence we may judge with what mechanical skill and precision the insect must form these two wings; for unless they are made of a proper size while apart, they could not possibly be brought together, nor could the edges be made to fit closely to each other, and yet the insect has neither compasses, rules, nor planes, without which a carpenter would make but a bungling job of his cupboard doors. When, therefore, these two walls or wings are of a proper size, the insect, which always keeps between them, attaches threads to the outer edge of one of them, at the lower part, which it then applies to the opposite outer edge of the other; these threads are then pulled until the edges are brought into contact, when it fastens them with shorter silken threads, and in this way proceeds upwards until the whole of the two edges are brought together, as represented in figure B, the insect being enclosed within them.

But another difficulty here arises; a concave, but not deep space, has been formed within these walls upon the bark of the twig; but the walls thus brought together are flat, and, like the closed doors of some oldfashioned cupboards, form an acute angle, not only in front, but at each side, which would necessarily be very inconvenient to a cylindrical chrysalis within; the insect, therefore, by repeatedly pushing against the walls when brought together, from within, with its head, causes them to assume a convex figure. The opening which is observed at the broadest part of the cone at the upper end of the figure is also subsequently closed in the same manner, and when the whole is thus completed, the seams are so nicely joined as to be imperceptible; the inside is then lined with a fine coating of silk, and the insect undergoes its transformation in security, being well protected by the great resemblance of the cocoon to the bark upon which it is affixed, and of which in fact it is composed.

Other caterpillars introduce the leaves of the plants upon which they feed into the structure of their cocoons, and these are arranged with more or less regularity in different species, in some of which they are very beautiful.

There is a caterpillar found upon the chickweed about the end of July, of a green colour, and of the middle size, with two black spots bordered with white upon the fourth ring, and with another spot of the same colour upon the eighth ring. Its mode of walking somewhat resembles that of the geometric caterpillars, although the moth, from Reaumur's account, evidently belongs to the *Noctuidæ*, the singular form of the larva indicating it to be one of the spectacle moths (*Abrostolæ*). It constructs its cocoon about the beginning of August, by attaching together without much precision the leaves and tender twigs of the chickweed which it has bitten off. In this way it forms an envelope, within which it is completely concealed, and, in order to keep the whole in place, it spins an inner slender web of white silk, from whence, in the following July, a moth of a brownish colour, with faint yellow spots, makes its appearance.




There is another caterpillar observed by Reaumur, which arranges the leaves with which it covers its cocoon with much more regularity than the preceding species. This is found in the month of October upon the cypress spurge, and it evidently belongs to one of the species of *Acronycta*, as may be seen by comparing Reaumur's figure of the caterpillar with those of Hübner and other lepidopterists. This caterpillar is black, with white longitudinal stripes, and with one lateral red line. It arranges the narrow leaves which it has detached from the plant with considerable skill, side by side, the rounded figure formed by their union being larger at one end than the other.

Other caterpillars, like the humblebees, give to their cocoons a covering of moss. One of these is

a small smooth larva, with sixteen legs, which feeds upon minute mosses or lichens, and which appears to be that of the marbled green moth (*Bryophila glandifera.*) This caterpillar forms a cocoon of a rounded form, surrounded with moss, of which small tufts are fastened together so as to form a hollow ball.

In general, the caterpillar enclosed in a cocoon becomes a chrysalis in a few days; but there are some instances in which the caterpillar remains unchanged for several months.

When one of these cocoon-forming insects has completed its state of inactivity in the chrysalis state, it bursts out of the pupa in the same manner as the butterflies. It has yet, however, another effort to make before it sees the light of day. It is born in a dark prison, the walls of which are often of the most surprising hardness, and the enclosed animal is weak, and apparently unprovided with jaws or other instruments to effect its escape. The manner in which this is managed has not been quite satisfactorily explained. Some authors have asserted that it is by the action of a powerful liquid which the moth emits from the mouth, that the threads of a cocoon are rendered moist and pliant, and the gum dissolved, so that the insect has then only to push against the end of the cocoon with its head, in order to make its way out; while others, including Reaumur, consider that no fluid is employed, but that the head becomes a battering-ram, to burst through the cocoon, breaking the threads in its passage; the facetted eyes being considered to act as fine files, assisting in making the aperture. Count Dandolo, in his work on the silkworm, however, observes that the end of the cocoon is wetted for an hour, and sometimes even several hours, before the moth makes its way out. "Perhaps," say Messrs. Kirby and Spence, "the two opinions may be reconciled by supposing the silkworm first to moisten, and then break the threads of the cocoon."

In other instances, in which more solid materials than silk have been employed, such as grains of earth, or chips of wood, the difficulty appears greatly increased—thus we have met with the cocoon of the puss moth (*Cerura vinula*), in its natural situation upon the bark of willow trees, and it has been with the greatest difficulty that we have been able to cut it open with a penknife; that this was, however, owing to the hardness of the gummy secretion with which the caterpillar (whose remarkable form we have subsequently noticed) had cemented the dust and chips of willow together, of which the cocoon is composed, is evident, for had it been formed only of silk and chips, it would have readily yielded to the knife; but the caterpillar, in a state of confinement, will moreover build its case with gnawed bits of paper, which, when dried, acquire an equal consistence with the chip-cocoons. Now the mouth of this moth is of a very rudimentary nature, and from the perfect and smooth appearance of the down upon the head of the newly-disclosed moth, it is evident that some other method than force must have been adopted to work a passage through so hard a wall. We must therefore refer the extrication to the effect of some liquid with which the insect is furnished, sufficient to dissolve the gummy matter of its cocoon. This liquid Reaumur ascertained by experiment was neither of an aqueous nor an inflammable nature, like spirits of wine. Messrs. Kirby and Spence consider that it must essentially be of an acid nature, so powerful as immediately to dissolve the gum, and yet so harmless to the moth as not to injure it by its action, a supposition which may be considered analogous to the action of the gastric juice. This caterpillar, notwithstanding its remarkable shape, and the singular fork at the extremity of its body, is unable to guard itself from the attacks of the ichneumon flies. One of these (*Ophion luteum*) attacks it, and deposites her eggs in its body, in which the grubs of the ichneumons feed in the manner stated in our former volume, a fact recorded by every naturalist since the days of Gœdart. We notice this circumstance, because it has been stated in a popular work (Insect Architecture, p. 95, 325) that the ichneumon fly contrives to deposite its eggs *in the case* of the puss moth; but no instance has ever yet been recorded of such a fact. When we consider how difficult a thing it must be even for this large moth to effect its escape through the walls of its cocoon, how much more so must it be for its delicately-formed parasites, which have not only to bore through it, but their own individual cocoons also which are enclosed within it. It is true that they are furnished with jaws, but may they not likewise be provided with some fluid analogous to that of the moth? It is remarkable that occasionally several of these parasites, of which four or five prey upon a single caterpillar, are found dead in their cocoons, while one or two only have contrived to escape. This we should consider a sufficient reason for doubting the supposition that these parasite grubs, knowing that it would require all the united efforts of their flies to effect an escape, had purposely arranged themselves with their heads all pointing to one end of the cocoon.

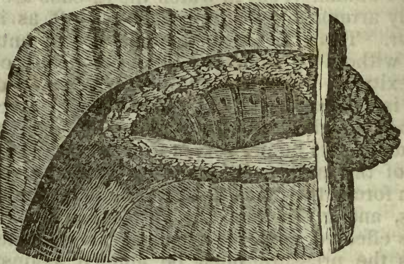
In the preceding instances the escape is effected by the perfect insect from a cocoon, the substance of which is of an equal consistence throughout; but there are numerous instances in which the caterpillar provides for the more easy extrication of the moth, by various peculiarities in the construction of the cocoon.

Of these we shall only notice the mode of escape of the emperor moth, of which Reaumur has given a complete account. On examining one of these cocoons from which the moth has escaped, and another which still contains the chrysalis, both appear perfectly alike, the place from which the moth has escaped not being observable. The cocoon is of an oval shape, with its upper end produced almost into a point, like a Florence flask; at this end the hairs of the cocoon are longitudinally gummed together, converging like so many bristles to a blunt point, in the middle of which is a circular aperture forming a kind of elastic funnel, through which the insect does not experience much difficulty in making its exit, but which immediately closes again when the insect has escaped. So easy a mode of

extrication would however afford an equally easy entrance to minute parasites or other voracious enemies; hence nature has instructed the caterpillar to form a second funnel within the former, formed similarly, but in which the threads are more closely arranged, no aperture being left as in the former. Thus, although the difficulty of entrance from without is increased in consequence of the convexity of the inner funnel, the escape of the moth is scarcely rendered more difficult. According to Meinecken, the pressure of the converging threads of this funnel serves to compress the abdomen of the moth as it emerges from the cocoon, which forces the fluids to enter the nervures of the wings, and gives them the full expansion. How this is effected, however, we can scarcely conceive; for as the pressure must be applied against the hind parts of the body while it is forcing itself through the passage, we should have considered that the fluids would have been forced into that part of the body which had not yet undergone that pressure, and not into the wings and legs which are at the front of the body, just as in pushing the finger through a tight ring, the blood is forced back into the hand, and not into the tip of the finger.

It is a remarkable circumstance that some insects are extremely regular in the hours of their appearance in the perfect state; some species, as the silkworm moth and the *Sphinx œnotheræ*, being produced at sunrise; others, as the true hawk moth, at noon; others, again, as the death's-head moth, in the afternoon; and lastly, others, as some of the May-flies, only in the evening.

Hitherto we have only stated instances in which the extrication from the cocoon has been effected by the insect after arriving at the perfect state. The chrysalis itself, in some insects, makes an aperture in the cocoon, through which it protrudes a considerable portion of its body, sufficient to allow the moth to disengage itself from the chrysalis without difficulty. The goat moth is an example of this mode of proceeding; the empty chrysalis cases of which may constantly be found sticking



half out of holes in rotten willow trees. This is effected by sharp points upon the head of the pupa, which are employed for the purpose of making the first breach in the cocoon, through which the body is subsequently further protruded by the assistance of a series of sharp hooks along its rings, by which it is enabled to keep itself in its advanced position when it makes a small further advance, and thus repeats the operation until a considerable portion is protruded into the open air.

In the fifteenth chapter of our former volume we have given the history of several caterpillars that construct cases in which they reside, and which they carry about with them. When these caterpillars have attained their full size, they fix the lower end of their cases, from which the head was previously protruded, to the adjacent objects, so that these cases also serve them as cocoons. Of these caterpillars, the species of the genus *Psyche* exhibit some extraordinary circumstances. One of these, which we have observed, is, that the male moths make their escape from the opposite end of the case, by first protruding the head of the chrysalis out of that end of the case which was originally occupied by the tail of the larva. There can be no doubt that this change of situation takes place before the change to the chrysalis occurs. The two remarkable cases described by Messrs. Kirby and Spence appear to us to be decidedly referrible to this group of moths, although those authors merely suspect them to belong to terrestrial animals.

Of these, one is described as being the production of an insect inhabitant of New-Holland, and as being six inches long, and about four fifths of an inch in diameter. It consists of a bag of thick cinereous silken web, to which are fastened in a sextuple series pieces of stick of about an inch long, the end of one mostly resting upon the base of another; between each series a space of about three tenths of an inch intervenes, but at the apex they all converge. This probably imitates the branch or stem of some tree or plant in which the leaves are linear, and diverge but little from the stem.

In a small periodical work on natural history, published in 1799, entitled "The Naturalist's Pocket Magazine," in which several productions of New-Holland were first published, we find a description of one of these cases and its caterpillar, under the name of porcupine caterpillar of New South Wales. It is described as a large grub, three inches long, the three first rings being of a fine yellow colour, beautifully marked with black or dusky oblong spots, each having a pair of claws ; the other rings are of a dirty pale yellow colour, except the extremity of the back, which is of the same spotted yellow colour as the head and three first rings. The case of the caterpillar resembled the finest fleecy hosiery, of a gray, ash, or mouse colour, having the silky softness of a moleskin, the exterior being fortified with small pieces of slight twigs of different lengths. It had two apertures, which the insect opened or closed at pleasure. It is stated, that whenever any accident has happened to the case, so as to lacerate or tear it in holes, the little animal repairs with incredible expedition whatever damage may have been received, so that in a few hours it fills up a large hole with the same silky substance, and this with an exactness so perfect that the nicest eye cannot discern what was the extent of the injury. It is likewise stated to experience the different changes to which the caterpillar tribe are subject: these changes are not however described; but the late Rev. Lansdown Guilding, to whom natural history is under many obligations, succeeded in tracing the transformations of two kindred species, inhabitants of the West Indies, and has published the result of his very singular observations in the "Linnæan Transactions." From these we learn that the insect produced from one of these cases proved to be a moth which nearly resembled our English wood-leopard (*Zeuzera æsculi*), that the female is very large and unwieldy, without wings, and that she never quits her case

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CHAPTER IV.

NATURAL HISTORY OF THE SILKWORM MOTH.

Description of the Egg—Caterpillar—Manner of changing its Skin—Sizes from the young to the full-grown Worm—Description of the latter—Silk-bags—Manner of forming its Cocoon—Length of the Silk—Description of the Chrysalis—the Moth—its Habits—number of Eggs.

THE silkworm, like all other insects of the same class, undergoes a variety of changes during the short period of its life; assuming, in each of its three successive transformations, a form wholly dissimilar to that with which it was previously invested.

We will proceed to trace the changes which it undergoes, commencing with the egg, which is about the size of a grain, and of a yellow colour when fresh; but after a few days, becomes rather dark, of a bluish cast. The period which the egg requires is dependant on the temperature of the climate; so much so, that some eggs may be preserved during the winter and spring; or they may be quickened by artificial means, when the natural food appears in sufficient quantity for their support.

When hatched, it appears as a black worm, about a quarter of an inch in length, gradually becomes larger and whiter, and in about eight days its head enlarges and it is attacked by illness, which lasts for three days; refusing food, and remaining in a state of lethargy. This illness is supposed to be on account of the smallness of the skin. The worm appears at the end of the third day much wasted, and throwing off a kind of humour, which has exuded between its body and the skin about to be cast off, at the same time emits from its body silken cords, so as to fasten the abandoned skin to a spot while the insect forsakes it, which it performs in the following manner. It first rubs its head among the leafy fibres, so as to disencumber itself of the scaly covering, and then breaks through that part of the skin nearest the head. This action causes the larva very great exertion. Soon afterward it disengages its fore feet, and then the body is quickly drawn from the skin, which remains stationary. This operation occupies two or three minutes. The insect then begins to feed with renewed vigour and health. The skin sometimes refuses to separate from the body; in which case the pressure occasions swelling and inflammations, and generally terminates in death.

Those worms which have recently shed their skin are easily known from the others, by the pale colour and wrinkled appearance of their new skin. The larva changes its skin five separate times; and, on each occasion, increases in size and weight, as may be seen in the following table:

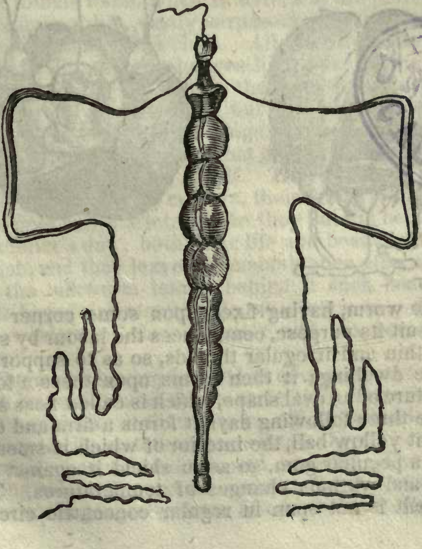
	Inches.	Take to an ounce.
When born	$\frac{1}{4}$	54,526
One moult	$\frac{1}{2}$	3,840
Two	$\frac{3}{4}$	610
Three	$1\frac{1}{2}$	144
Four	2	35
Five	$2\frac{1}{2}$ to 3	6

Thus, in the space of a few short weeks, the worm increases in weight more than nine thousand times.

The annexed figures represent the worm in its last stage, the chrysalis, and the cocoon.

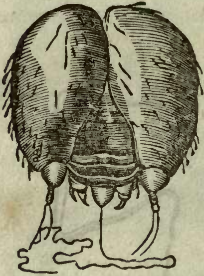
The caterpillar, having arrived at its last moult, devours its food most voraciously, and for ten days continues increasing in size; so that its structure can be better explained than in its former stages. It is now about three inches in length, and is composed of twelve membranous rings; the head is scaly, hard, and tapering; the mouth is horizontal; it has sixteen feet, six of which are placed in front, armed with claws, on the three rings nearest to the head; the other ten feet are placed behind, eight of which are on the sixth to the ninth, and two on the last ring. These feet may be termed holders. There is also a kind of tail on the upper part of the last ring but one.

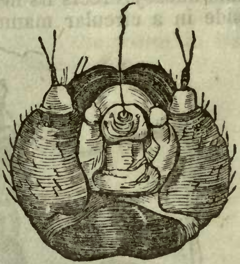
At the end of the period above stated the worm's desire for food begins to lessen, though it continues to nibble the leaves, which it scatters about; its colour is now of a light green; it is very restless and uneasy, erects its head, and moves from side to side in a circular manner, seeking a corner where



it can commence its labour of forming its cocoon, before which, however, the body becomes firmer, more glossy, and somewhat transparent towards its head; it also lessens in size.

It may not be out of place to mention here from whence the silk proceeds;—The silk is secreted in the form of a fine yellow gum, in two long slender vessels, one on each side of the body. This silky material, when drawn from the orifices beneath the mouth, appears to be one thread, but is, in fact, composed of two fibres, which are extracted from the orifices, and brought together by means of two hooks placed in the mouth.



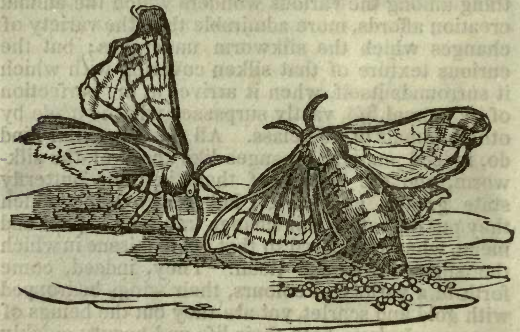


The worm, having fixed upon some corner that will suit its purpose, commences the labour by spinning thin and irregular threads, so as to support its future dwelling; it then forms upon these a loose structure of an oval shape, which is called floss silk; in the three following days it forms a firm and consistent yellow ball, the interior of which is smeared with a peculiar gum, so as to shield it against the rain and various changes of temperatures. The filament is not spun in regular concentric circles, but in stops, going backwards and forwards with a sort of waving motion, which the worm effects by means of its fore feet, while it remains in the interior.

Isnard, an old author, affirms, that the length of the silk of one cocoon, when drawn out, will measure six miles, that is, 10,565 yards; but Count Dandolo says, the probable length is 625 yards; other authors state it to be about 400 yards; while Pullein says the average length is 300 yards. The latter author thus writes:—"There is scarcely any thing among the various wonders which the animal creation affords, more admirable than the variety of changes which the silkworm undergoes; but the curious texture of that silken covering with which it surrounds itself, when it arrives at the perfection of its animal life, vastly surpasses what is made by other animals of this class. All the caterpillar kind do, indeed, undergo changes like those of the silkworm, and the beauty of them in their butterfly state greatly exceeds it; but the covering which they put on before this change into a fly is poor and mean, when compared to that golden tissue in which the silkworm wraps itself. They, indeed, come forth in a variety of colours, their wings bedropped with gold and scarlet, yet are they but the beings of a summer's day; both their life and beauty quickly vanish, and they leave no remembrance after them; but the silkworm leaves behind it such beautiful, such beneficial monuments, as at once record both the wisdom of their Creator and his bounty to man."

The worm, having finished its cocoon, rests a while from its labour, and at the same time decreases in size and bulk; it then throws off its last skin, and undergoes its metamorphosis into a chrysalis, which is of a chestnut colour, and smooth. The time during which the insect remains in this state of lethargy is generally from fifteen to thirty days, as it is influenced by the temperature of the climate in which this metamorphosis is about to take place, viz., in England it requires thirty days, in France twenty-one, in Spain and Italy eighteen to twenty, and in India only eleven days.

After the above stated periods the insect breaks through the upper end of the cocoon, by emitting a liquid from its mouth, which moistens the gum with which it has lined the interior of its chamber. After this operation it appears as the perfect insect, with four wings of a grayish white colour, with two trans-



verse undulated bands on the fore and hind wings. The stationary and sluggish habits of these moths are not entirely owing, as is generally supposed, to the insect being confined within certain limits during the period of several generations; as these habits are also common to others of the same family, which are only found in certain local districts; and this proves that this valuable insect partakes of the same mode of life in the domestic as in the wild or natural state. Their life continues for the short period of two or three days, in which time they are wholly occupied in securing the continuance of their kind. Various accounts are given as to the number of eggs which the female lays, some stating 250, while others mention 400 to 500 as the usual number.

CHAPTER V.

HISTORY OF SILK, &c.

History of its Fabrication—Several Kinds of Worms reared in India and America—The Silk Company—Culture of the Mulberry-tree—Laboratory—Air—Heat—Temperature—Light—Of the Kinds of Silkworm—Eggs—Hatching—Space—Food—Weight and Length of the full-grown Worm.

It is allowed by all, that the silkworm and the mulberry-tree are indigenous to China, where the former is termed Se. According to the Chinese historians, one of their emperors ordered his wife to endeavour to rear the silkworm, for the purpose of making its industry available to man. After many fruitless attempts, she at last completely succeeded, and was enabled to fabricate from the raw threads stuffs which she afterward embroidered with images of flowers and birds. This invention, which the Chinese state as taking place 2,698 years before the Christian era, raised the empress to the rank of a divinity, under the title of Spirit of the silkworm and of the mulberry-tree. From China the culture of the silkworm passed very slowly into Persia and India, and thence, though after the lapse of several centuries, into Europe. It is certain that prior to the time of Alexander the Great, silk was unknown in Greece; and it is probable that when that conqueror adopted the flowing robes of the Medes and Persians, he first became acquainted with silk. This commodity was unknown in the early times of the Roman republic; the victories of

Lucullus, and of Pompey the Great, first making the Romans acquainted with it. It is said that the Emperor Aurelian refused the request of his emperess, who desired a robe of silk, stating that he could not afford to purchase a vestment worth its weight in gold. Tiberius decreed that none should wear garments made of so costly a material. Heliogabalus was the first emperor who clothed himself in silk.

It does not appear that the origin of this precious material was known to the Romans for many centuries; for most of the classical authors suppose it to have been the produce of a tree, probably from finding the cocoons suspended by the worms to the branches of the mulberry. Aristotle, however, speaks of a large horned worm, which, after changing several times, spun a cocoon, which women disentangled, and the threads thus obtained were subsequently woven into stuff. This worm is stated by the same author to be a native of the Island of Cos, and Pliny makes it feed on the oak and the cypress-tree. It is probable, therefore, that this insect was not the silkworm, for in the same proportion as the silk obtained from the real insect was used among the Romans, so the importation from the Island of Cos was abandoned.

In the middle of the sixth century, under the reign of Justinian, two monks brought to Constantinople the eggs of the wonderful insect which produced silk, as also the tree on which it was nourished. Previously to this time immense sums of money went to Persia for the purchase of silk, a commodity then much used. Justinian thought it impolitic to enrich an enemy, when with little pains the silkworm might be cultivated at home. He therefore most amply rewarded the monks for instructing his people in the mode of rearing these insects. From Constantinople the culture of the silkworm spread over Greece, so that in less than five hundred years, that portion of this country hitherto called Peloponnesus, changed its denomination into that of Morea, from the immense plantations of the Morus alba, or white mulberry. Some authors, however, assert that the name was suggested by the resemblance of the Morea to the shape of the mulberry-leaf, a less plausible opinion than the former. Ancient authors asserted, that sericum or silk was obtained either from fleeces growing upon trees, or from the bark of trees or flowers; others, that it was procured from spiders or beetles; while some, however, who came nearer the truth, spoke of worms feeding on the mulberry-leaves, with cotton growing on the branches like flax.

When Roger, King of Sicily, conquered the Peloponnesus in 1130, he transported the silkworms and such as cultivated them to Palermo, and into Italy; and such was the success of the speculation in this last country, that it is doubtful whether even at the present moment Calabria, where the silk-cultivators were early encouraged, does not produce more silk than the whole of the rest of Italy.

In the wars of Charles the Eighth, in 1499, in Italy, some gentlemen seeing the advantages of the commerce of silk, introduced the mulberry into France, and large plantations were soon raised in Provence. The first tree which was ever planted in France by Guy-Pape St. Auban, Seigneur d'Allan, still existed in 1802, near Montelimart. Faujas Saint-Fond, who saw it, gives the following description:—"Its large branches are withered, and its stem is divided into three parts; but, in spite of the number of winters it has braved, it is still covered in spring with leaves and fruit. Its descendants are now spread over the soil of France, and yield a large revenue to the state."

In spite of the encouragement given by Charles the Eighth to the culture of the silkworm, still little progress was made; for the silks of Spain, into which country the Moors had introduced the silkworm, were used in France. Henry the Second issued an edict in 1554, commanding large plantations to be made in France; and he is reported to have been the first French king who wore silk stockings; while in 1668, the women's hats were turned into hoods made of French silk, whereby every maidservant became a standing revenue to the French king of one half of her wages. A simple gardener of Nismes established a nursery of mulberries under the reign of Charles the Ninth, which in a few years supplied the plains of Languedoc, Provence, and Dauphiné with the finest plants. Henry the Fourth, contrary to the advice of Sully, encouraged the native production of silk; he issued an edict in 1599, prohibiting the importation of stuffs of that material; and by letters patent invited, as much as possible, the further plantation of the mulberry-tree. He ordered Olivier de Serres to bring the tree to Paris, and twenty thousand were transported to that city, where the king had built a large house near the Tuileries for the cultivation of the silkworm.

This branch of commerce was neglected in France under Louis XIII., but in the following reign, under the auspices of the sage Colbert, it once again revived. He established royal nurseries in Berri, Angoumois, Orlêannois, Poitou, Burgundy, and Franche Comté, and distributed and planted the tree gratuitously. Nevertheless, as these beneficial measures were forced upon the people, it happened that, instead of thriving, the young plants were found to perish rapidly. The government then promised to pay twenty-four sous for every mulberry-tree which should have been planted three years. This judicious measure at once succeeded, and the above-named provinces soon became covered with this precious wood. Not content with this first step, Colbert invited Le Sieur Benais, from Bologna, to superintend the unravelling of the cocoons; and this the Italian did so well, that in a short time the raw thread of France was quite as beautiful as that of Italy. As a recompense for his skill, Benais received letters of nobility and considerable pecuniary gratifications at the hands of Louis XIV.

During the turbulent times of the Revolution, a vast number of the finest mulberry plantations were ruined: since the Restoration nearly a million of fresh trees have been planted, and the cultivation of the silkworm has thriven proportionably. Notwithstanding this advance, however, France does not produce a sufficient quantity of raw silk for the purposes of its manufacturers.

Such being the history of the silkworm in France, the profits derived from it make it a matter worth inquiring into, whether there is any thing in the climate of England which is unfavourable to the cultivation of the silkworm.

It is stated, that at the celebration of the marriage between Margaret daughter of Henry III., and Alexander III. of Scotland, in the year 1251, a most extravagant display of magnificence was made by one thousand English knights appearing in cointises of silk. It appears also that in the reign of Henry VI., there were a company of silk-women as early as the year 1455; but these, it is probable, were employed rather in embroidering and making small haberdasheries, than in the broad manufacture of that article. Italy continued to supply England and most other countries with silk.

In the year 1554, in the reign of Mary, an act of parliament was made to restrain the growing vanity of the lower classes of the people. This statute enacts, "That whoever shall wear silk in or upon his or her hat, bonnet, or girdle, scabbard, hose, or spur leather, shall be imprisoned during three months, and forfeit ten pounds." This absurd statute was however repealed in the first year of the reign of James I., who, remarking the effect of the great encouragement given by Henry IV. to the plantation of the mulberry, recommended the same measures most earnestly more than once from the throne, unhappily however without effect. It is recorded of him, that while King of Scotland, being anxious to impress the ambassador sent from the English court with due reverence, he wrote to his friend the Earl of Mar to borrow a pair of silk stockings, an article of extreme rarity in those days; concluding his epistle with the following appeal to the feelings of his subject—"For ye would not, sure, that your king should appear like a scrub before strangers." It is said also of Elizabeth, that being presented by her silk-woman, Mrs. Montague, with a pair of silk stockings, she was so much pleased with the gift as never to wear any of a different material during the rest of her life. The magnificent and expensive prince Henry VIII. was not able to indulge his vanity, on gala days, as successfully as his daughter, except when by great chance he could procure a pair of silk stockings from Spain. Sir Thomas Gresham presented Edward VI. with a pair of long Spanish silk stockings, and from their rarity this offering was deemed worthy of much notice.

The broad silk manufacture was introduced into England in the year 1620, and in nine years after it was become so considerable, that the silk throwsters were incorporated by charter. In 1661, forty thousand persons were employed by this company. The revocation of the edict of Nantes contributed to promote the manufacture of silk in England most largely; and the invention of the silk-throwing machine at Derby, in 1719, added so much to the reputation of English manufactures, that, according to Keyster, the English silks were higher in the market than even the Italian.

It appears from the statements which have been made, that there exist several kinds of this valuable worm: the one which is reared in Europe has been termed an annual; while the one procured direct from China is a monthly worm, therefore capable of producing twelve crops of silk in the year, superior in quality to many other sorts: and the same observer mentions, that it actually would be a mine to whoever can undertake its cultivation. The worm which produces the fine nankeen silk is considered the best in the world.

Various persons have tried to rear the silkworm in the East Indies, especially in Bengal and Coromandel, and as the climate is more congenial to it, we have every reason to suppose that they will ultimately succeed. The East India company has granted to, and has also exerted its influence with the native princes, in obtaining for the experimenters portions of lands in various parts for the propagation of the mulberry-trees. The princes themselves consider it no mean occupation to rear this useful worm, for the purpose of obtaining silk to make state dresses for their camels and elephants.

In North America, especially in Pennsylvania, they have succeeded in cultivating the silkworm, the silk of which is stated to be finer in texture than the Italian silk, and produces a larger return from the same number of cocoons. Should the production of silk increase as rapidly in America as cotton has done in that country for the last thirty years, it will become an article, in a commercial point of view, of the greatest importance. As the white mulberry and silkworm are said to succeed in almost all the states of the Union, it has attracted the attention of the American government.

In spite of the encouragement held out at various times for the culture of the silkworm in England, it has never been attempted on a large scale in this country, and yet it appears not improbable, that it would not only succeed, but be attended with advantages here which are wanting in climates more apparently favoured than ours.

In Italy the chrysalides come too early to life: it is therefore necessary to destroy them, lest by eating their way out of the cocoons the silk should be injured. In order to effect this, they are collected and placed in heated ovens, where the silk, without singular precautions, is very apt to be injured. In our climate the progression of the insect tribe is slower, and in the case of the silkworm sufficient time is afforded to wind off the silk without killing the chrysalides. But besides the damage which may be done to the silk in Italy, from subjecting the cocoons to the heat of ovens, it is necessary, in order to obtain eggs, to allow the most vigorous moths to eat their way out of the largest cones: hence the silk of all such cones is as certainly lost in Italy as it would be preserved in England. In the south of France the frosts are often so intense after the mulberry-leaves are out as to nip them. This is seldom the case in South Britain. A further advantage in our favour arises from the comparative absence of those sultry heats and those thunder-storms so injurious to the life of the silkworm.

In the year 1825, a company was formed for the produce of silk in the British dominions, under the title of "The British, Irish, and Colonial Silk Company," and was supported by individuals of the highest rank and respectability, many of whom were induced to give their countenance to the project, by a patriotic desire to ameliorate the condition of the Irish peasantry, by adding to them a profitable source of industry. A royal charter was obtained, and active measures were taken to promote the success of the design. A spot of ground, of about eighty acres, was selected on the estate of the Earl of Kingston, near Michelstown, in the county of Cork, and in this place nearly 400,000 trees of the white mulberry were transplanted. The whole proved unusually successful; very few trees having died, and many having in the first year of their transplantation put forth shoots twenty inches in length. A small but complete building for rearing silkworms was adopted on the plan of Count Dandolo, and every thing seemed to promise that success which should attend judicious plans and well-directed energy. The experiment was also repeated on a more limited scale in England. Between 70,000 and 80,000 mulberry-trees were planted on nineteen acres of fine rich soil, situated near Slough. The trees flourished here as well as in Ireland; but the attempt to rear silkworms in the United Kingdom has been ultimately abandoned by the company. Its managers now turn the whole of their attention to an establishment in the Island of Malta, where the growth of the trees is said to be more rapid by at least one third than in Italy.

The great desideratum with us is plantations of mulberry. This tree accommodates itself to almost any soil, although it is finer and more vigorous in some than in others. If planted in elevated spots, and exposed to dry, light winds, the leaves yield a food very favourable to the production of an abundant supply of the best silk. If, on the other hand, the soil be too dry, and the exposure too warm, the mulberry-tree speedily languishes, producing a small yellow leaf, an improper and inadequate food for the supply of the worm. According to the best judges, the gentle slope of a calcareous hill, on which there is a sufficiency of earth, and where the clefts of the rock permit the roots to insinuate themselves so as to be protected from humidity, while they are kept fresh, affords the best soil for the mulberry-tree. A deeper or moister soil, though very favourable to the growth of the plant, causes the production of a watery leaf, which, it is found from experiments, tends to make the silk less abundant and less fine. Within these twenty years the Russian government have encouraged mulberry plantations in various parts of their dominions. Marshal Bieberstein has introduced the silkworm in the Ukraine, where, in 49° N. latitude, the admirable incitements to the cultivation of silk by honorary and substantial rewards from the Emperor of the Russias, are about to be repaid to that government by the abundance of the silk produced.

The testimony of Evelyn as to the feasibility of producing silk in England is unequivocal, and will perhaps appear conclusive when compared with what has been already stated.

"We have already mentioned some of the uses of this excellent tree, especially of the white, because the fruit is of a paler colour, which is also of a more luscious taste, and less than the black. The rind also is whiter, and the leaves of a mealy, clear green colour, far tenderer and sooner produced by at least a fortnight, which is a marvellous advantage to the newly-disclosed silkworm; also they arrive sooner at their maturity, and the food produces a finer web. Nor is this tree less beautiful to the eye than the fairest elm, very proper for walks and avenues. The timber, among other properties, will last in the water as well as the most solid oak, and the bark makes good and tough boat-ropes. It suffers no kind of vermin to breed on it, whether standing or felled, nor dare any caterpillars attack it, save the silkworm only. The loppings are excellent fuel, but that for which this tree is in the greatest and most worthy esteem is for the leaves, which, besides the silkworm, nourish cows, sheep, and other cattle, especially young porkers, being boiled with a little bran. The fruit is excellent to feed poultry. It seems whatever eats of them will with difficulty be reduced to endure any thing else, as long as they can come by them. To say nothing of their other sovereign qualities, I have read that in Syria they make bread of them, but that the eating makes men bold.

"To proceed with the leaf, for which the mulberry is chiefly cherished, the benefits of it are so great, that they are frequently let to farmers for vast sums, so that one sole tree has yielded the proprietor a rent of twenty shillings per annum for the leaves only, and six or seven pounds of silk, worth as many pounds sterling, in five or six weeks, for those who kept the worms. We know that till after Italy had made silk above a thousand years, they received it not in France, it being hardly yet a hundred since they betook themselves to this manufacture in Provence, Languedoc, Dauphiné, and Lyonnais, and not in the Orleannois till the time of Henri IV.; but it is incredible what a revenue that amounts to in that kingdom. About the same time it was, or a little after, that King James did, with extraordinary care, recommend it to this nation by a book of directions, acts of council, and all other princely assistance. But this did not take, no more than that of Henry the Fourth's proposal about the environs of Paris, who filled the highways, gardens, and parks of France with the trees, beginning with his own garden for encouragement.

"Yet I say this could not be brought into example till this present great monarch, Louis XIV., by the indefatigable diligence of Monsieur Colbert, so successfully revived it, that it is prodigious to consider what a happy progress they have made in it;—to our shame be it spoken, who have no other discouragements from any insuperable difficulty but our sloth and want of industry, since wherever these trees will grow and prosper, the silkworm will do so also.

"It is demonstrable that mulberries, in four or five years, may be spread all over this land; and when the indigent and young daughters in proud families are as willing to gain three or four shillings a day for gathering silk, and busying themselves in this sweet and easy employment, as some do to get fourpence a day for hard work at hemp, flax, and wool, the reputation of mulberries will spread in England and other plantations.

"The leaves of the mulberry should be gathered from trees of seven or eight years old—if of such as are very young, it impairs their growth, neither are they so healthful for the worms, making them hydropsical, and apt to burst—as do also the leaves of such trees as are planted in a too waterish or over rich soil, and where no sun comes—and all sick and yellow leaves are hurtful. It is better to clip and let the leaves fall on a subtended sheet or blanket, than to gather them by hand, or strip them, which mars and hurts the branches, and bruises the leaves, that should hardly be touched. Some there are that lop off the boughs, and make it their pruning; and it is a tolerable way so it be discreetly done, in the over thick parts of the tree; but these leaves, gathered from a separate branch, will die and wither much sooner than those which are taken from the tree immediately, unless you set the stem in water. Leaves gathered from boughs cut off will shrink in three hours, whereas those you take from the living tree will last as many days, and being thus awhile kept are better than over fresh ones. It is a rule never to gather in a rainy season, nor to cut any branch while the wet is on it, and therefore against such suspected times you are to provide beforehand, and to reserve them in some fresh and dry place. The same caution you must observe for the dew, though it do not rain, for wet food kills the worms. But if this cannot be altogether prevented, put the leaves between a pair of sheets, well dried by the fire, and shake them up and down, till the moisture be drunk up in the linen, and then spread them to the air a little, on another dry cloth, you may feed with them boldly. The top leaves and oldest should be gathered last, as being most proper to repast the worms with towards the last change. The gatherer must be neat, have his hands clean, and his breath sweet, and not poisoned with onions or tobacco, and be careful not to press the leaves, by crowding them into bags or baskets. Lastly, that they gather only, unless in case of necessity, leaves from the present, not from the former year's sprigs or old wood, which are not only rude and harsh, but are annexed to stubbed stalks, which injure the worms and spoil the denudated branches. One note more let me add, that in first hatching the eggs sometimes disclose earlier than there is provision for them on the trees, in which case the tender leaves of lettuce, dandelion, and endive may supply the defect, so they feed not on them too long or over much, which gives them the lask.

"I have no more to add but for this our encouragement, and to encounter the objections which may be suggested about the coldness and moisture of our country—that the spring is in Provence no less inconstant than is ours in England, that the colds at Paris are altogether as sharp, and that in May, when it had continued raining for nine-and-twenty days successively, M. Jenard assures us he proceeded in his work without the least disaster; and in the year 1664 he presented the French king, his master, with a considerable quantity of better silks than Messina or Bononia could produce, which he sold raw at Lyons for a pistole the pound, when that of Avignon, Provence, and Dauphiné produced little above half that price. There is a mulberry-tree brought from Virginia not to be contemned, upon which they find silkworms, which would exceed the silk of Paris itself, if the planters of nauseous tobacco did not hinder the culture.

"Sir J. Berkley, who was many years governor of that ample colony, told me he presented King Charles the Second with as much silk as made his majesty a complete suit of apparel.

"Lastly, let it not seem altogether impertinent if

I add one premonition to those less experienced gardeners who frequently expose their orange and light tender furniture trees of the greenhouse too early—that the first leaves putting forth of this wise tree (*sapientissima*, as Pliny calls it), is a more infallible note when those delicate plants may be safely brought out to the air than any other prognostic or indication."

The rearing of the silkworm requires not only great caution, but great art. The laboratory destined to preserve these useful insects, from the time of hatching to the period of maturity, should not be built in the vicinity of any damp spot, or near large rivers or masses of stagnant waters.

It has been remarked, that a free circulation of dry air is the most favourable to the health of the silkworm; hence, the silkworms in laboratories which are situated on gentle elevations yield a more abundant and a finer harvest of silk than those which are reared on the plains. The laboratory should be placed north and south, in such a way that the largest side should look eastward. A due temperature, proper ventilation, and light, are so absolutely essential to the health of the worm, and therefore to the quality and quantity of silk, that no other apology than the importance of the subject will be needed for enlarging on each of these three heads.

Heat.—It is clear that the hatching of the worm should be adapted to the budding of the leaf on which it is to be fed, otherwise the animal would be produced only to die. Temperature is the mean by which the insect may be retarded or advanced in its development, so as to time its birth precisely to the period of the production of the mulberry leaf. If it be considered that the foliation of trees varies sometimes during many days in the same season of different years, the importance of ascertaining the precise degree of heat necessary to hatch the silkworm will be very apparent. When eggs have been kept in a certain degree of warmth, it requires less stove-heat to develop the silkworm; this is so true, and so worthy of notice, that we find, if in winter the eggs have been kept in an atmosphere of 55° or 59°, or heaped together, they come forth, without the aid of the stove, spontaneously when the room is but slightly warmed, and before the mulberry-tree has given any signs of vegetation; in this case these worms must be thrown away.

The eggs of different proprietors, placed in the same room, under the same circumstances, are found not to be hatched at the same time. Those which during the winter have been kept at a higher and more even temperature, come forth four or five days earlier than others.

The following extract from Dandolo exhibits the power and the utility of temperature in the art of rearing the silkworm.

"A prudent proprietor has done all in his power when, on observing the season favourable, and the bud of the mulberry-shoots in a proper degree of forwardness, he has put the eggs into the stove-room. Should the weather suddenly change, as it did in 1814, it is then of great use to have the power of backing the hatching of the eggs without injuring the worm, as I have before stated, and to prolong their two first stages by a few days. To obtain this, the only method is, after the worms have been removed into the laboratory about five hours, to lower the temperature to 73° from 75°, four hours after further to lower it to 71°, and the following day to 68°, if necessary.

"This cooling of the air diminishes the hunger of the young silkworm by degrees, and without danger; and by these means the modifications are prevented, which, at 75°, would have brought on the casting or moulting much more speedily.

"At 75° the first moulting is effected the fifth day; while at 71° it requires six or seven days. The second moulting, which at 75° is wrought in four days, at 69° and 71° takes six days for its accomplishment. Thus, by foresight and prudence, the proprietor will be enabled to gain seven or eight days, which prevents any ill effect from the unfavourableness of the season; and this time gained, it is evident, may be of the utmost consequence, for in the year 1813 the silkworms were reared in thirty-one days, and it required thirty-eight days to raise them in 1814, to allow time for the growth of the mulberry leaf; and I do not comprise in these seven days which I gained, three days which I delayed in the hatching of the silkworms, having perceived that the whole season was bad. Those who are not careful thus to meet the accidental untowardness of seasons, and by art to prevent their injuries, would be obliged either to throw away the early hatched eggs, or to strip the mulberry-tree too soon, and injure the leaves which are to feed the sllkworm in its adult stages hereafter. These considerations must strongly impress the necessity of delaying the hatching of the eggs by some days, rather than hurry their coming forth; particularly as there is no fear, when worms are reared in this secure manner, of their being injured; should there occur two or three hot days, these would only accelerate the moulting a few days sooner. It is also certain that the later silkworms, in their last stage of progress, make choice of the leaves suitable to their age, and particularly those leaves which are quite ripened, which, for the proprietor's interest, is the most important period, as it is at that last period the greatest consumption of the leaves occurs."

That a great degree of heat will be borne is proved by the following facts :—

"It cannot be said that silkworms are injured by any degree of heat in these climates, however considerable it may be. Native of Asia, it must be accustomed to heat more intense than it can experience in Europe; but the sudden change from moderate heat to violent heat it cannot bear. Rapid changes in general from heat to cold and cold to heat, are highly injurious. In its native climate it is not exposed to these vicissitudes, and therefore thrives well without requiring all the care we are obliged to bestow on it. With us, on the contrary, the temperature of the atmosphere is so variable, that without artificial means we could not fix it in our laboratories for rearing silkworms. A series of experiments has proved, that in France, 68° is the most suitable to the silkworm. Some cultivators have raised it as high as 73° and even 77° with good success. We must not lose sight of this fact, that it is not heat that affects the silkworm, but sudden transitions from one temperature to another, such as making it pass from 68° to 77° in one day, I am convinced would greatly annoy it, and injure its health. If it happen to be necessary to hasten the worms in consequence of the advanced state of the mulberry leaf, which cannot be retarded, it should be done gradually, so that they perceive not the alteration. The silkworm suffers as much from difficulty of breathing in bad air, as from sudden changes of temperature. M. Boissier de Sauvagues will show us, by his experiments, to what degree the heat may be raised in rearing silkworms, without fear of injuring them. One year, when hurried by the early growth of the mulberry leaves, which were developed towards the latter end of April, I gave the silkworms 100° of heat during the two first days after hatching, and about 95° during the remainder of the first and second age. There elapsed only nine days from the hatching until the second moulting or casting, inclusively. Those who saw the process could not imagine that silkworms would be able to stand so intensely hot and overcoming an atmosphere. The walls, wicker hurdles, were so heated, they could scarcely be touched. All thought they must be burnt—must perish; however, all went on perfectly well, and, to their great surprise, I had a most abundant crop. I afterward tried giving the silkworms, in their first age, from 93° to 95°; 89° to 91° in the second age; and it is remarkable, that the duration of these two ages was nearly similar to that of the preceding experiment, in which they had experienced some degrees more of heat. Perhaps there may be a degree of heat beyond which we cannot affect the progress of the silkworm. It is to be added, they had an equal proportion of food in both experiments to that which is given in the common manner of rearing silkworms. It is singular that these worms, thus hastened in their two first stages, consume only five days in moulting the third and fourth time, although with only a temperature of 82°; while those worms that have not been hastened, take seven or eight days for each of the two last moultings, in an exactly similar degree of temperature. It appears sufficient to have given the constitution of the insects an impetus to regulate the quick succession of its changes.

"This impetus, which we have been describing as operating such rapid growth, also gives the insects vigour and activity, which they preserve through their after ages, and prevents diseases; thus the hastened and forced cultivation presents a double advantage. It also shortens the care and attendance necessary for silkworms, and sooner ends the anxiety of the cultivator, who must necessarily feel anxiety until the cocoon is gathered.

"To follow this method, it is requisite well to observe the advancement of the season; the shooting of the mulberry leaf; whether it is checked by cold; if, again, the growth of the leaf is delayed, and heat should soon after set in, and ripen it more quickly than was expected, as often occurs, it would be advantageous then to hasten the worms by heat; for if they are allowed to delay from want of heat, their first age is prolonged, and the mulberry leaf will grow and harden, and become unfit for them; the essential point is, that their progress should follow that of the mulberry leaf. If cultivators adopt this method, they must put the eggs to hatch ten days later than they would require to be laid to hatch in the ordinary way, and they must calculate the duration of the different ages of the worm, and so manage that the completion of the rearing, or fourth age, should fall into the time in which the leaf has attained its full growth."

Air.—The exhalations produced from a laboratory spacious enough to contain worms proceeding from an ounce of eggs, are quite astonishing.

If one ounce of the dung taken from the wicker trays be put into a bottle capable of holding one pound and a half of liquid, and hermetically sealed, in six or eight hours after, according to the temperature, the atmospherical air in the bottle will be found vitiated, and totally poisonous. To determine this, a bird may be put into the bottle when it is first opened; it will faint and die if left in it many moments; or, if a lighted candle be introduced into it, the candle will go out directly. These phenomena would not of course occur if the bottle contained atmospherical air alone.

From this it is evident that in the fifth age, the laboratory before mentioned containing 1,200 pounds of excrement, that quantity may corrupt, about every eight hours, a volume of air equal to 16,800 *Paris* pints, or bottles, that are capable of holding two pounds of liquid; and in one day this quantity of excrement would corrupt a volume of air equal to 50,400 Paris pints.

Having thus stated the quantity of corrupt air produced by the excrement in the laboratory, it must appear evident how necessary it is to get rid of it as soon as it disengages itself, and continually and gently to renovate the atmosphere.

Light.—Many think that light is injurious to silkworms. It is certain that in their native climate it does not injure them, although they are exposed to it by various circumstances; however, there is here no question of exposing them to the sun, but only of rendering their habitations as light as our own.

It is always observed, that on the sides on which the light shines directly on the hurdles, the silkworms are more numerous and stronger than in those places where the edges of the wicker hurdles intercept the light, and form a shade, which is also a reason for having very low edges to the wicker trays. Even the sun shining full on the worms seems not to annoy them. If the rays are too hot, and shine too long on them, they may suffer; but this cannot occur, nor does it affect the question, as it is not proposed to expose the silkworms to the sun, but only desired to show that the air is more vitiated, and that there is more damp in a dark laboratory than in a light one.

The effect of this, perhaps the most powerful agent on life in general, should be particularly attended to in the rearing of the silkworm.

In order, therefore, to cultivate the silkworm with advantage, and to put this precious insect in nearly the same circumstances as if it were in its native climate, it is necessary that ventilators should be so placed that the mass of noxious vapours should never be allowed to stagnate to the prejudice of the silkworm; that stoves should be so situated as to maintain an equable and a fit temperature, and that the windows should be sufficient to admit a due degree of light.

The size of the laboratory will vary according to the number of worms to be reared; but in all cases the space should be ample, as nothing is more prejudicial to the health of the insect than being crowded in one spot. Count Dandolo's laboratory, calculated to hold twenty ounces of eggs of silkworms, which would ultimately yield about twenty hundred weight of cocoons, was thirty feet wide, seventy-seven feet long, and twelve feet high.

The time from the hatching of an egg to the caterpillar spinning, is nearly five weeks. This period is subdivided by cultivators into five others, marked by the events of the worm moulting. Count Dandolo mentions three species of silkworm; the first the common one, 39,168 eggs of which weigh an ounce, and which casts its skin four times, hence termed the common silkworm of four casts. Second, the small silkworm of three casts, 42,620 eggs of which weigh an ounce; the worms and the cocoons of this sort are three fifths smaller than the preceding. They eat as much as the four-cast worm. Their cocoon is better constructed, the thread finer, and, from an equal weight of cocoons, a greater quantity of silk is yielded by the three-cast silkworm than by the common or four-cast one: besides this advantage, these three-cast silkworms require four days' less care, by which the accidents and expenses of that period are saved. The mulberry-tree, too, being stripped sooner for these, shoots faster, and is therefore better prepared to resist the approaching cold. For these reasons, Count Dandolo strongly urges the cultivation of this species in preference to that of the four-cast or common worm. There is also a large species of four-cast silkworm. The eggs of these are only one fiftieth more in weight, although the worm is, when at its full size, twice and a half as heavy as the mature common four-cast worm. The only advantage these offer is that $18\frac{3}{4}$ lbs. of mulberry leaves will produce $1\frac{1}{2}$ lb. of cocoons, while it requires $20\frac{3}{4}$ lbs. to produce the same quantity of silk from the common silkworm. The disadvantages of the cultivation of this large species are manifest: the silk is coarser; their life being four or five days longer, the labourers must be kept longer; the expense and the risks are therefore greater; and the accidents attending the mulberry-tree will also be thereby multiplied.

It has been stated, that 39,168 eggs of the common silkworm weigh an ounce. If each egg produced a worm, and each worm came to maturity, an ounce of eggs should yield 162 lbs. of cocoon. This is in conformity with Count Dandolo's experience, under his improved mode of rearing the silkworm. Latreille, however, gives a very different result. Formerly, he says, an ounce of eggs produced 80 or 100 lbs. of cocoon, ten or at most twelve pounds of cocoon yielding a pound of silk. But for some time the ounce of eggs has scarcely yielded thirty or forty pounds of cocoon, and fifteen or sixteen pounds of cocoon yields but a pound of silk. This difference he attributes to the injudicious selection of eggs.

A perfect egg or grain, as it is termed, should be of a dark slate-colour. There are different modes adopted to hatch them. In the south of France they are enclosed in cotton, and carried by the women between their petticoat and chemise during the day, and at night placed in the same bed with them.

The spontaneous hatching of eggs by means of the natural heat of the atmosphere, is of course out of the question in climates as variable as those of Europe. During the hatching of the eggs, the temperature of the stove-room in which the worms are to be developed should be at least 64°, and this should be gradually increased up to 75°, in which degree of warmth the young worm is to be kept until the first cast or moulting. The heat during the second cast should be between 73° and 75°, between 71° and 73° till the third, and lastly, between 68° and 71° till the fourth.

The extent of space which should be occupied by the silkworms in their different ages is no less essential than the due regulation of temperature to their development; an ounce of eggs should have a space,

In the first age, of 7 feet 4 inches square;
In the second age, of 14 feet 8 inches square;
In the third age, of 34 feet 6 inches square;
In the fourth age, of 82 feet 6 inches square;
In the fifth age, of 183 feet 4 inches square.

The food which they consume should be no less accurately determined; and great care must be taken in picking and sorting the leaves for the feeding of the worms of the first ages, such as picking off all the twigs, the stalks of the leaves, spots, &c., and to clear them as much as possible from all useless parts. This operation is most essential in the two first ages, when the leaves are to be chopped very small. In the third age, the sorting and picking the leaves is not of much consequence, and still less so in the fourth and fifth ages.

The sorting and picking is of importance, inasmuch as it enables you to put fifteen or twenty per cent. less substance upon the wickers than would otherwise be done, and which the worms would not eat. This substance increases the litter and the moisture, without necessity or motive. In climates where they are in the open air, it would, of course, be unnecessary to sort the leaves.

In the fifth, and even in the fourth age, when the season is favourable, leaves, mixed with a quantity of mulberries, boughs and stalks, may be put on the hurdles, although it is known that the worms do not eat them, because at that period it would be too troublesome to sort so large a quantity perfectly, nor is there the same motive to do so. These substances being by this time grown large, hard, and woody, are less liable to fermentation, although they may accumulate as litter. If the laboratories are kept constantly dry and well aired, these substances will do no mischief, but keep the litter light, and allow the air to circulate more freely through it.

When the silkworms find any leaves that they do not like, they leave them. There are some of a dark hazel colour, which have fermented slightly; these the worms will eat, if they are not quite spoiled, nor are they the worse for it; from which fact it would appear that the fermentation has not affected the saccharine or resinous part of the leaf.

The quantity of leaves, according to Dandolo, taken from the tree, and employed for each ounce of eggs, amounts to 1609 lbs. 8 oz., divided in the following manner:

	lbs.	oz.
First age, sorted leaves,	6	0
Second age, ,,	18	0
Third age, ,,	60	0
Fourth age, ,,	180	0
Fifth age, ,,	1098	0
	1362	0

But this leaf has lost by sorting much of its weight, in the following proportion:—

Refuse picked from the leaves:—

	lbs.	oz.
First age,	1	8
Second age,	3	0
Third age,	9	0
Fourth age,	27	0
Fifth age,	102	0
	142	8

	lbs.	oz
Sorted leaves,	1362	0
Refuse picking,	142	8
	1504	8

During the whole period of rearing the silkworms, the 1609 lbs. 8 oz. of the leaves taken from the tree, have lost

	lbs.	oz.
Brought forward . . .	1504	8
by evaporation and other causes, besides sorting and picking, as above stated, ...	105	0
Total,	1609	8

With these precautions, it is found that in thirty-nine days the worm becomes 9500 times heavier, while in twenty-eight days it is increased forty times in length. In the last twenty-eight days of its existence, viz., from the period of its greatest development as a caterpillar until its death as a moth, it gradually diminishes in length a fifth, and in weight about thirty times.

CHAPTER VI.

NATURAL HISTORY OF INDIAN MOTHS AND OTHERS REARED FOR THEIR SILK.

Tusseh Silkworm, its Metamorphoses, its Flight, Manner of winding the Silk—Jarroo Silkworm, their Habits—Arrindy or Arundi Silkworm, Manner of Rearing, its Metamorphoses, its Silk, Manner of Spinning—The Manner of Manufacturing the Silk of Tinea punctata—Account of the Silk of an indigenous American Moth—History of preparing Silk from Spiders, Kinds of, Manner of Spinning, Number of Spiders, Eggs, Quantity of Silk, Weight of the Bags.

Dr. Roxburgh informs us that the East Indians possess three or four species of moths, from the cocoons of which they have been in the habit of spinning coarse kinds of silk.

The first is termed the Tusseh silkworm, or Bughy, of the natives of the Burbhoom Hills (*Phalæna paphia*), which seems to have been employed from time immemorial, and is found in such abundance over many parts of Bengal and the adjoining provinces, as to have afforded to the natives a plentiful supply of a most durable, coarse, dark-coloured silk, which is woven into a kind of cloth called Tusseh doothies, much worn by the Brahmins and other classes of Hindoos.

This silkworm cannot be reared as the common one; the natives therefore go out in quest of them into the jungles, and find the young worms on the branches of the asseen and byers trees, which the natives cut off, and convey near their habitations, distributing the worms on the asseen in proportion to the size of the trees, but they place more on the byers, and employ the Pariahs to guard them day and night, to preserve them from birds and bats.

The eggs of this species are white, and are hatched according to the temperature of the air; in two or three weeks, however, the worms have nearly acquired their full size, which is above four inches in length and three in circumference; their colours are light green, with a light yellowish-coloured stripe on each side; the sixth and seventh rings are marked with an oblong gold spot; the back is also marked with a few round darker col-

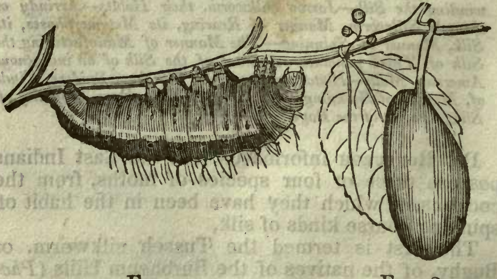


FIG. FIG. 2.

oured spots, and from these issue a few long, coarse, distinct hairs, with others of a smaller size scattered over the body. These worms, when they approach near their full size, suspend themselves by their feet, as they are too heavy to crawl in search of their food with their back upwards, as is usual with most caterpillars.

When these worms are ready to spin their cocoons, in which they are to pass the torpid state of their existence, each of them connects, by means of the recent glutinous filaments of which the cocoon is made, two or three leaves into an exterior envelope, which serve as a basis to spin the complete cocoon in; besides which it is suspended, as in fig. 2, from a branch of the tree in a wonderful manner, by a thick solid cord, spun of the same materials as the cocoon, which is of an oval form, and very firm in texture. After the space of nine months the chrysalis discharges from its mouth a quantity of liquor, with which the upper end of the cocoon is softened, so as to enable the perfect insect to work its way out in a very short space of time.

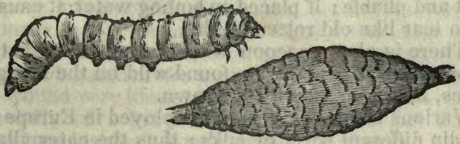
The perfect insect is very large, and measures from the tip of one wing of the male to that of the other, five or six, and the female from six to eight inches. The wings are of a uniform yellowish brown, with one round transparent spot in each of the fore wings. In this state, it is said, they all take flight, females as well as males; and the accounts given by the natives of the distance which the male insects fly are truly astonishing, for it is no uncommon practice among them to catch some of the male moths, and put a mark on their wings previous to letting them fly, the marks of different districts being known, and it has been stated that these insects have been caught at a distance of a hundred miles and upwards. Their life, which continues from six to twelve days, is wholly taken up in providing for a continuation of the species.

The female deposites her eggs on the branches of the tree on which she may happen to rest, and they adhere firmly by means of the gluten which covers them when newly laid.

The natives, when about to wind off these cocoons, place them in a ley made of plantain ashes and water, for about two hours, and then set them in an earthen pot; those which are properly softened are first applied to the reel, and so on, till the whole are wound off, which is performed in the following manner: the cocoons are laid in a smooth earthen dish without water, the reel is turned by the right hand, while the thread of four or five cocoons passes over the left thigh of the spinner, and he gives the threads a twist with his left hand upon his thigh. The thread is exceedingly apt to come off double and treble for several yards together, which is not regarded by the natives, as breaking off double threads would diminish the produce, and moreover would occasion loss of time; a very even thread, however, may with care be reeled from either the Bughy or Jarroo cocoons.

The species just mentioned is so called from being produced in the coldest month of the year, say January, the former being about a month before them. The history of the Jarroo is very similar to the one just described; but the principal difference between these two species is, that the natives dress out plots of asseen-trees on purpose for these worms, and retain a part of the cocoons, which they hang out on the asseen-trees when the proper season arrives for the moths to come to their perfect state. The male insects of this species are said invariably, soon after birth, to fly away and leave the females on the trees; but, in the space of ten or twelve hours, or perhaps one, two, or three days, a flight of strange males arrives, settles on the branches with the females which have been neglected, and after a short time the female lays her eggs and then expires. The hill people calculate good or ill fortune in proportion to the speedy or tardy arrival of the males. The cocoon is of darker colour than the bughy, and like that the worms are also guarded. The other species is peculiar to the interior of Bengal, and is named Arrindy or Arundi, on account of the worms feeding on the arrindi, ricinus, or palma christi, from which tree the castor-oil is extracted.

This species is capable of being reared in the same manner as the common silkworms. The eggs of this insect are ovate, of a pure white colour, and are hatched in about ten or fifteen days. In about a month the worms arrive to their full size, in which period they cast their skins three or four times; the size of this worm is from two and a half to three inches in length, composed of ten rings; across the centre of each are several small, soft, conic, pointed tubercles; the prevailing colour is pale green; in this state they are voracious, devouring daily many



times their own weight of food. The cocoons are white or yellowish, of a very soft delicate texture; in general, about two or three inches in length, and three in circumference, pointed at both ends. In this case the chrysalis remains ten to twenty days, then issues forth from one end, and in the perfect state exists from four to eight days, during which period it is wholly employed in the great work of nature, remaining perfectly contented in its chamber, and seldom attempting to fly away. The wings expand from four to five inches, and are of a grayish-brown colour, with bands across and a diaphanous spot in the centre.

The silk is so exceedingly delicate as to render it impracticable to wind it off; it is therefore spun like cotton. The yarn thus manufactured is woven into a coarse kind of white cloth, of a seemingly loose texture, but of incredible durability, the life of one person being seldom sufficient to wear out a garment made of it, so that the same piece descends from mother to daughter.

The manner of spinning the cocoon of this species is stated to be in the following way, viz.: four or five are fastened to a stick, stuck in the ground, or on an apparatus held in the hand; their threads are united into one, by means of being made fast to a piece of wood, with a heavy weight to make it spin round, while suspended by the thread; but they are always spun wet, by being placed in cold water. The cloth is woven in small pieces in a loom; it is coarse and open. On being however well washed and beaten in cold water, it is made soft and pliable; if placed in boiling water, it causes it to tear like old rotten cloth.

There is also a cocoon which is mixed with the above species in spinning, found wild on the mango-trees, but otherwise little known.

Various means have been employed in Europe to obtain different sorts of silks; thus the caterpillars of a minute moth (*Tinea punctata*) have been used by M. Habenstreet in the following manner:—A great number of these worms are placed on a model (which is suspended from the ceiling of a room), of the form of the robe or shawl, &c., that is required to be made, and the motions of the insects are directed by oiling the part of the model not to be covered by them. The cloth thus obtained exceeds in fineness the lightest gauze, and has been worn as a robe, over her court dress, by the Queen of Bavaria.

In America Mr. Bartram has experimented on an indigenous species of moth, which he found much more easily raised than the common silkworms: he did not lose any by sickness; neither lightning nor thunder disturbs them; nor are they subject to be hurt by the frost, as is the case with the common kind. And as they lie so long in their chrysalis state, the cocoons may be unwound at leisure hours during the winter evening. One of their cocoons will weigh more than four of the common silkworms, and, it may be presumed, will yield a proportionably greater quantity of silk.

Means also have been employed by M. Bon, in the year 1710, for procuring and preparing silk from the webs of spiders, from which we have extracted the following:—

"M. Bon reduces the spiders under two heads, those with long legs and those with short, which furnish the finest raw silk. The filaments of the spiders are of two kinds; the first is weak, and is commonly termed the web, it only serves for the purpose of catching flies; the second is much stronger, and is formed into bags to contain the eggs, which, by this means, are sheltered from the cold, and guarded from the ichneumon: the bags are wound very loose round the eggs; the latter are generally of a gray colour when fresh, but they soon turn blackish when exposed to the air."

M. Bon collected about twelve or thirteen ounces of the bags of the short-legged kind, as they were the most common to be met with; and caused them to be well beaten for some time with the hand and a stick, to get out all the dust; he then washed them in lukewarm water, till they left the water very clean; after this operation, he laid them to steep, in a large vessel, with soap, saltpetre, and gumarabic. The whole was left to boil over a gentle fire for three hours, then taken out, and washed in warm water to get out the soap; and after all, laid to dry some days, to fit them for carding, which was done by the common silk-carders, but with cards much finer than ordinary. He thus obtained a silk of an ash colour, which was easily spun; the thread thus procured was both stronger and finer than that of common silk; which shows, that all sorts of works may be made of it; nor is there any reason to fear but that it will stand any trials of the loom, after having passed that of the stocking-weavers. M. Bon had stockings and gloves made of this material, which he presented to the French Academy and to the Royal Society.

Some difficulties having been advanced as to the practicability of procuring a sufficient quantity of spider-bags for any large work, M. Bon observes that there would be no difficulty at all, had we but the art of breeding them, as we do silkworms; for they multiply much more, every spider laying from six to seven hundred eggs, which are hatched of themselves, without any care, in the months of August and September. M. Bon ordered all the short-legged spiders that could be found in the above months to be brought to him, and placed them in boxes made of paper, which he pricked full of pin-holes to give them air, and fed them with flies: some time afterward, he found that the greatest part of them had formed their egg-bags; and he considered that the spiders yielded more silk in proportion than the common silkworm; for example, he said that it really required two ounces of spider-silk to make a pair of stockings, whereas it takes seven or eight of common silk.

But M. Reaumur was of an opinion that the natural fierceness of the spiders renders them unfit to be bred in the manner of silkworms, or to be kept together in cells, fifty or more in each, for the large and strong spiders destroy and eat their weak companions, until there is hardly one or two left in each cell. He also affirms that the spider-bag is inferior, both in lustre and strength, to that of the common silkworm; and he mentions that the thread of the spider-bags only bears the weight of thirty-six grains, while that of the common silkworm is capable of bearing two drachms and a half, although the former is about eighteen times thicker; and that they furnish much less silk than the silkworms, as the weight of the spider-bag is about a grain, and when clean for use it loses two thirds, while that of the silkworm weighs four grains. Therefore it requires 2,304 of the latter to produce a pound of silk, while it takes at least 27,648 spiders to produce the same weight; the work of twelve spiders only equals that of one silkworm; nor can the thread be wound off as easily as that of the silkworm, but must, of necessity, be carded; by which means, being torn in pieces, its evenness, which contributes much to its lustre, is destroyed.

CHAPTER VII.

ON LUMINOUS WINGED INSECTS.

History of the Glow-worm—Description of the Egg—The Larva—Its Cleanliness—The Pupa—The perfect Insect—Difference between the Sexes—The Light—Whether extinguished at pleasure—The luminous Matter—Darwin's Opinion—The Effects when placed in Gases—In Acid—Carus's Opinion—Whether it contain Heat—Murray's Opinion—History of the Lantern of Paussus sphærocerus—Of the Firefly—Of the Lanternfly—Of the Candlefly—Object of the Light.

We propose in this chapter to give an account of those insects which are remarkable for their luminous property. Most of our readers may have observed a phenomenon, which is thus described by the poet Thomson,

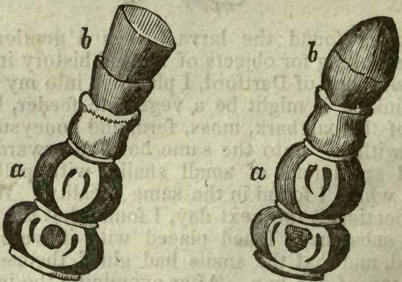
> "Among the choked lanes, on every hedge
> The glow-worm lights his gems; and through the dark
> A moving radiance twinkles."

We well remember, even this day, the idea we received in our childhood by the first impression on viewing one of these insects; we could scarcely overcome the species of terror and distrust with which we saw moving insects on fire, and yet not consumed; but a short time corrected our errors, and admiration succeeded the more painful feeling. No time has since been able to diminish the delight with which we first contemplated these "stars of the earth."

The glow-worm (*Lampyris noctiluca*) is very common, but is either local in its habits, being only found in certain places, and has been supposed to disappear occasionally for some time, and then re appear with its usual splendour. It is more generally found to inhabit the borders of paths and the outer margins of woods or coppices, especially in low situations, where it is observable after the heat of the day is over, and when the dew is falling. The females, which are more numerous than the males, deposite their eggs in the month of June or July, on grass, moss, &c. They are of a yellow colour, and are stated to be luminous, but it is doubtful whether the luminous matter so observed is any thing but an excretion of the insect, appearing under the form of a congeries of minute brilliant points. The larvæ, after remaining quiescent for about five or six weeks, break their shells and make their appearance; when first emerged from the eggs they are very small and of a white colour, but they rapidly increase in size, and become much darker, passing from a dark brown to almost black. The three stages of these insects, viz., larva, pupa, and imago, or perfect insects, are very similar to one another The larva is composed of eleven segments; it has six feet; two rows of reddish spots down the back; and is capable of emitting a phosphoric light from the last rings of the abdomen. The light appears like two brilliant spots, when attentively examined, during the fine nights in autumn, when they are creeping about in search of their food, which consists of small snails, &c. A curious account has been given of the cleanliness of the larvæ, after having partaken of their food, from which we will make the following extract:—

"Having found the larva," says a gentleman, "when looking for objects of natural history in the neighbourhood of Dartford, I placed it into my box, and thinking it might be a vegetable feeder, I put some of the oak bark, moss, fern, and honeysuckle along with it. Into the same box I afterward put several specimens of small snails, with pellucid shells, which I found in the same locality. When on inspecting it the next day, I found that the vegetable substances I had placed with it were not touched, and that the snails had glued themselves to the top of the box. After examining the insect for some time, I noticed that it made some very singular movements with its tail, in the manner of the common earwig and the devil's coach-horse, by bending up its tail over its back. There appeared to be something so uncommon in its movements, that my curiosity was excited to observe them more minutely; and, as the creature was not at all

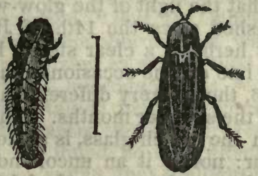
timid, I could easily observe it through a glass of some power. The caudal instrument, I discovered by this means, consists of a double row of white cartilaginous rays, (*b*) disposed in a circle, one row



With the rays open, With the rays shut.

within the other, and what was most singular, these were retractile in a curious manner, to the horns of the snail. The rays were united by a soft, moist, gelatinous membrane, but so as to be individually extensile; one or two being frequently stretched beyond the line of the others. It was not long before I convinced myself that this singular instrument was employed by the insect for cleaning itself, and it would have been difficult to devise any thing more effectual for the purpose, though its actions were different from all others of this kind with which I was acquainted, inasmuch as it operated by suction, and not as a comb, a brush, or a wiper. It was moreover furnished in the interior with a sort of pocket of a funnel shape, formed by the converging rays, into which was collected the dirt, &c., from off the back of the insect." The accuracy of these facts we must leave for further investigation.

After the space of one year and nine months the larvæ are changed, having however frequently cast off their skins, into the second or pupa state, in which they remain nearly quiescent for two or three weeks, when they change their last skins and become perfect insects. In this state the two sexes are easily distinguished, as the male appears like a perfect beetle, having wings and wing-cases;



while the female, on the contrary, seems to have undergone hardly any change in appearance from that of the larva, except that she is much larger, and of a lighter colour. It is the female which is principally luminous in the perfect state. The male was generally considered incapable of exhibiting any light, until John Ray, the father of English naturalists, first pointed out that the latter sex was also in possession of this luminous property, but in a less degree; the light in it is only distinguishable when the wings are expanded, or when the insects are flying, as the luminous matter is hidden and much smaller in this sex.

The females of the glow-worm can occasionally conceal or eclipse their light. The author of the excellent "Natural History of Selborne" supposed that they regularly extinguished the torch between the hours of eleven and twelve; which has called forth the idea that it may be to secure themselves from becoming the prey of the nightingale or some other nocturnal bird: while the author of the "Journal of a Naturalist" considers that the summer light of the glow-worm is displayed as a signal taper, or, as Mr. Moore has more poetically said—

"The glow-worm's lamp is gleaming, love."

The appearance of the autumnal light can have no such object, unless it serves as a point of union in the supposed migrations, like the leading call in migratory birds.* The last mentioned observer informs us "that the light of the glow-worm has sensibly diminished since the 14th of July. Though deep in the herbage, a clear steady light has been observed as late on one occasion as the 28th of September, 1826, though very different in its sparkling from that of the summer months. The light of one, if placed on the watch-glass, is sufficient to ascertain the hour: nor is it an uncommon occurrence for anglers, &c., to place several of these insects on their hats, when they have been out in the evening, to cheer them after their day's sport.

We are informed by Mr. Macartney that the light-yielding matter reposes under the transparent portion of the skin, through which it is seen; and he

* The common people of Italy believe that these insects inhabit the graves of the departed.

infers that the luminous matter in the glow-worm is absorbed, being replaced by the interstitial matter, when the season for emitting light is gone by. He also observed two minute elliptical sacs, formed of an elastic fibre, wound spirally, and similar to that of the tracheæ of insects, which contained a yellow substance, soft in consistency, and closer in texture than that lining the adjoining region, and affording a more brilliant and permanent light. This light he concluded to be less under the control of the insect than the luminous substance in its vicinity, which he infers it has the property voluntarily to extinguish, referable to some inscrutable power dependant on volition, and not, as was advocated by Carradori, by retracting it under a membrane: when he extracted the latter from living glow-worms it afforded no light, while the two sacs, in like circumstances, shone uninterruptedly for several hours.

It was supposed by Dr. Darwin that the luminous appearance was owing to a secretion of some phosphoric matter, and a slow combustion arising from this phosphorus entering into combination with the oxygen inspired; Mr. Murray, however, has experimentally ascertained, "that the luminous matter does not contain phosphorus." It was, however, regarded by Spallanzani as a compound of hydrogen and phosphoretted hydrogen: this gentleman and Foster also ascertained that the luminous matter shone more brilliantly in oxygen: yet several experimenters have found no such effect take place. It has also been stated, that the light of the glow-worm is extinguished by the application of hydrogen and carbonic acid gas; while, on the other hand, these effects have also been contradicted; but it is added, that the insect appears not to suffer materially in the former; and though the insect expired in carbonic acid gas, the light suffered no eclipse by its death, but continued for some time.

It has also been stated, that the light was increased by heat and oxygen, and extinguished by cold, also by hydrogen and carbonic acid gas. Mr. Murray has ascertained, by experiments, "that the light is not sensibly increased by the purest oxygen, and is not extinguished in hydrogen and carbonic acid gas;" and he found that the luminous matter continued to shine, without alteration, in oxygen, nitrous oxyde, hydrogen, carbonic acid gas, cyanogen, olefiant gas, and nitrous gas; and the light is not extinguishable by being placed in water, oil, or even in different kinds of acids, such as muriatic, nitric, and sulphuric, but continued for some seconds. In a solution of pure caustic potassa it became of a bluish teint, and appeared to undulate; and in tincture of iodine the light continued for a minute. In alcohol it lasted nearly two, and in ammonia it continued for a minute.

It has lately been discovered by Dr. Carus, of Dresden, that there is a connexion between the circulation of the blood in the *Lampyris Italica*, or Italian glow-worm, and the luminous matter which occupies a great part of the under side of the abdomen, and that the varying intensity of the light is thus produced; the greater intensity corresponding precisely with each pulsation of that fluid: being from forty-four to fifty-four times in a minute, when the insect is not disturbed, but more rapid and irregular when alarmed.

Some authors are of opinion that there exists a sensible degree of heat in the luminous matter, for it has been stated that the thermometer was affected by nearly a degree when the insect was allowed to pass over its bulb; while others have asserted that *no* heat is perceptible.

Mr. Murray is of opinion that the luminous substance remains *permanently luminous*, and the eclipse seems entirely occasioned by the spherulæ, in which the luminous principle resides, being withdrawn by a contractile movement into the darker recesses of the body of the insects, or being imbosomed in the interstitial substance. The light, when placed in elevated temperatures, is destroyed, perhaps by decomposition, which low temperature only temporarily suspends.

We think it proper to add, that the glow-worm is not the only insect which is capable of emitting a light, but that there are several species in different orders which possess this property in common. The light is, however, displayed from various parts of their bodies. Thus, in a rare insect (*Paussus sphærocerus*) from Africa, the globes of the antennæ, as we are informed by Mr. Afzelius, were, to his astonishment, on opening a box, wherein he had placed one for security, able to spread a phosphoric light, like, to use his expression, two lanterns. This so excited his curiosity that he was induced to examine this singular phenomenon several times during the evening. But on looking at it the following morning, he found the insect dead, and that the light had disappeared.

The next insect, an inhabitant of South America, is termed the firefly (*Elater noctiluca*). It is about an inch long, and one third of an inch broad, of a dark brownish-black colour, except a yellow eyelike tubercle, placed at each posterior angle of the thorax. There are also two patches on the abdomen, concealed by the wing-cases, which are luminous. When the insect is flying, it appears adorned with four brilliant gems of the most beautiful golden-blue lustre: in fact, the whole body of this remarkable insect is stated to be full of luminous matter, which shines forth between the abdominal rings when stretched. This fact probably suggested the following lines of Darwin:—

"You bid in air the tropic beetle burn,
And fill with golden flame his winged urn."

The light which proceeds from the two spots on the thorax is said to be sufficient for a person to read the smallest print, by moving one of them, when placed between the fingers with the light down wards, along the line; and, when several are put together in a glass or transparent tube, the light will be found sufficiently great to admit of writing by it. These singular creatures have doubtless lent a friendly light to many a tropical wanderer. No doubt the brilliancy of the spectacle alone is sufficient to raise the despondent spirit of a person who has lost his track in one of the deep American forests. Their splendour has been mentioned in the following words:—"I could not but admire the thousands and tens of thousands of fireflies that spangled the gulf below, a tiny galaxy; they did not twinkle promiscuously, but seemed to emit their small green light by signals, beginning at the head of the ravine, and glaring all the way down in a wavy, continuous, lambent flash; every fly, as it were, taking the time from its neighbour ahead; then, for a moment, all would be dark, until the stream of sparkles flowed down once more from the head of the valley, and again disappeared astern of us." We are informed that these insects were formerly used by the Indians as lamps, so that they were enabled to perform their evening household works, to spin, weave, paint, dance, &c., by their light, as well as for the purpose of lighting them on their nocturnal hunting and fishing expeditions; when employed for the latter, one of them was tied to each of their feet.

They are also used by the Indians, by whom these insects are denominated *cucuji*, for the purpose of destroying the gnats or moschetoes in their abodes, which would become otherwise excessively troublesome. When required for this occupation, it becomes necessary for the Indians to place themselves on some eminence, with a lighted firebrand in their hands, which they wave about in the air;

these insects, as well as others, are attracted by the light, and, at the same time, we are told, the Indians often call out *cucuie, cucuie;* and after having secured a sufficient number, they return and let them loose in their residences, where the insect seeks the moschetoes about the beds, and the faces of those asleep. The same person also relates, that many wanton wild fellows rub their faces with the luminous matter of these insects, for the purpose of meeting their neighbours with a flaming countenance.

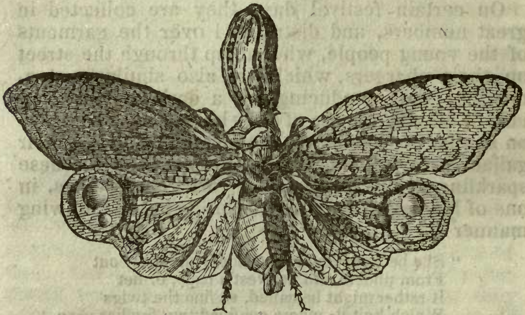
On certain festival days they are collected in great numbers, and distributed over the garments of the young people, who gallop through the street on their chargers, which are also similarly ornamented; thus producing, on a dark evening, the idea of moving figures of fiery horsemen. And also on similar occasions, the young men display their gallantry by decking their mistresses with these sparkling living "diamonds." Mr. Southey has, in one of his poems, mentioned this fly in the following manner:—

> "She beckoned and descended, and drew out
> From underneath her vest a cage, or net
> It rather might be called, so fine the twigs
> Which knit it, where confined two fireflies gave
> Their lustre. By that light did Madoc first
> Behold the features of his lovely bride."

It is related by Mouffet, that, on one occasion, this insect caused in the West Indies the failure of some troops; for in the evening of the day on which they had landed, they saw an infinite number of moving lights in the woods, which they supposed were the torches of the Spaniards advancing upon them, and immediately betook themselves to their ships.

Having mentioned three species of coleopterous or hard-winged insects, we will now proceed to speak of two of the hemipterous order, which are stated to possess the power of discharging a light from the projection in front of their heads; but as to the accuracy of this statement, we think it best to quote the words of the European who first promulgated this extraordinary phenomenon. Madame Merian, in her work on the Insects of Surinam, gives the following curious account of the manner in which she was frightened by this insect:—

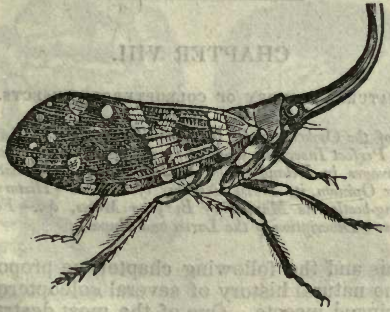
"The Indians once brought me," says the lady, "before I knew that they shone by night, a number



of these lanternflies (*Fulgora lanternaria*), which I shut up in a large wooden box. In the night they made such a noise that I awoke in a fright, and ordered a light to be brought, not knowing from whence the noise proceeded. As soon as we found that it came from the box, we opened it, but were still more alarmed, and let it fall to the ground in a fright, at seeing a flame of fire come out of it; and as many animals as came out so many flames of fire appeared. When we found this to be the case, we recovered from our fright, and again collected the insects, highly admiring their splendid appearance."

She also states, that the light proceeding from one of these insects was sufficient to read a common newspaper. Parts of the lanternfly are formed into armlets and necklaces, attached together by means of fine metallic thread, and worn by the higher ranks of the Brazilian ladies, by whom their splendour is considered exquisite and brilliant. Such gems are these ornaments held by the ladies, that the sum of ten to fourteen pounds is said to be given for them. It has also been stated by a traveller, that he journeyed many miles by the light of these insects through the woods and district of the Brazils.

The second species, which is designated the candlefly (*Fulgora candelaria*), is an inhabitant of China, from whence dry specimens are sent in great profusion. The light is said to proceed from the projection in front of the head, as in the former, though some authors have doubted the accuracy of this idea. Mr. Donovan, in his book on the Insects of China, has represented one seated on a flower, emitting a powerful light, which light is stated to



be of a faint purplish colour. This is supposed to be the insect collected by the tenawhat (which may prove to be a species of Ploceus or Weaver-bird), to decorate its nest, to which they are attached by means of clay or some other adhesive substance, whether for the purpose of food or of light remains to be proved, or "perhaps to scare some nocturnal spoiler;" one author states it may be "to see company."

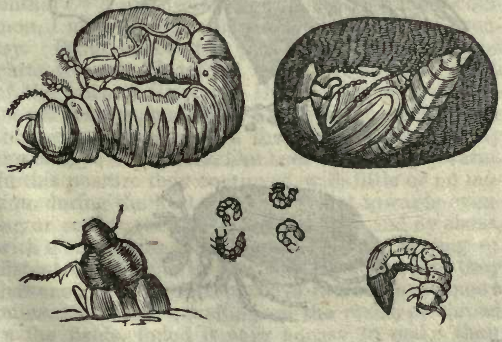
The real object of this light is not thoroughly understood by entomologists; but Messrs. Kirby and Spence "consider that it may act the part that their name imports, enabling them to discover their prey, and to steer themselves safely in the night," which probably is the case, as most of the herbivorous sucking insects are nocturnal. When this luminous projection is cut down the centre and laid open, it will be found perfectly hollow, without any appearance of having contained any luminous matter, which, perhaps, is situated between the outer skin and the interior lining of the rostrum or beak of the insect.

CHAPTER VIII.

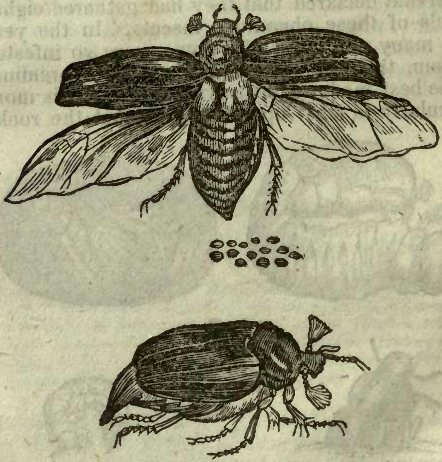
NATURAL HISTORY OF COLEOPTEROUS INSECTS.

History of the Cockchafer, its Ravages—Description of the Larva, Pupa, Perfect Insect, its mode of appearing, Habits—Account of its Ravages in Ireland—The history of the Death-watch, the Vulgar Opinion, its Noise, Number of Strokes—History of the Burying-beetle, its Manner of Burying Moles, &c.—For what Purpose—Description of the Larva and Pupa.

In this and the following chapter we propose to give the natural history of several coleopterous or hard-winged insects. One of the most destructive is commonly known by the name of Cockchafer (*Melolontha vulgaris*). The larva, which is vulgarly called the whiteworm, commits great ravages during four years which nature has allotted for the duration of their existence, on the roots of plants, grasses, and on any vegetable substances that may fall in their way while burrowing beneath the surface of the earth. In autumn they begin to bury themselves deep in the earth, to protect them from the inclemency of the winter, lying in a torpid state. On the approach of spring they recommence their work of destruction, by undermining acres of the richest meadows, so that the turf can be rolled up as if it had been cut with a turf-spade. A poor farmer, near Norwich, suffered so much from the grubs, that the court of that city, out of compassion, allowed him twenty-five pounds; the man and his servant declared that they had gathered eighty bushels of these obnoxious insects. In the year 1785, many provinces of France were so infested by them, that the government offered a premium for the best mode of destroying them. It is more particularly to feast upon this grub that the rooks



follow the plough. When the larva has arrived to its full growth they cease to eat, and then bury themselves in the earth to the depth of a foot and a half or two feet. It constructs itself a very even sort of cocoon, smooth within, and lines it with its excrements, and with some silken thread. Their bodies become shorter and inflated. They quit their skin and change into a chrysalis, through the covering of which all the parts of the perfect insect are easily distinguished. In the month of February the cockchafer tears its envelope, and issues forth under its final form. But the insect is at first yellowish, and rather soft, and still remains for some time under ground, to get rid of its superfluous humidity. It approaches by little and little to the surface of the earth, from which it does not issue forth entirely until it is attracted by a mild heat.



The contact with the air completely fortifies it, and gives its external parts their proper colour.

Having now arrived at its perfect state, it begins to congregate in great numbers on the borders of forests or woods, remaining motionless in the daytime, but on the setting of the sun it issues forth to devour the leaves of the various trees, and is not particular whether it be elm or lime. They remain in this state eight or nine days, having performed all the functions intended by nature on their arriving at this their last stage. The female, when about to lay her eggs, digs a hole in the earth, with the assistance of her fore-feet, about half a foot in depth, and deposites her eggs, one by the side of the other; having finished this operation, the insect returns to the trees, and perishes, after having languished one or two days.

It appears, from a paper printed in the Philosophical Transactions for 1697, that these insects committed great ravages in particular districts in Ireland. "These insects," says Mr. Molineux, "were first noticed in this kingdom in 1688. They appeared on the southeast coast of Galway, brought thither by a southwest wind, one of the most common, I might almost say, tradewinds of this country. From hence they penetrated into the inland parts towards Headford, about twelve miles north of the town of Galway. Here and there in the adjacent country, multitudes of them appeared among the trees and hedges in the daytime, hanging by the boughs in clusters, like bees when they swarm. In this posture they continued, with little or no motion, during the heat of the sun; but towards evening or sunset they would all disperse and fly about, with a strange humming noise, like the beating of distant drums, and in such vast numbers, that they darkened the air for the space of two or three square miles. Persons travelling on the roads, or abroad in the fields, found it very uneasy to make their way through them, they would so beat and knock themselves against their faces in their flight, and with such a force as to make the place smart, and leave a mark behind them. In a short time after their coming they had so entirely eaten up and destroyed all the leaves of the trees for some miles round, that the whole country, though in the middle of summer, was left as bare as in the depth of winter; and the noise they made, in gnawing the leaves, made a sound much resembling the sawing of timber. They also came into the gardens, and destroyed the buds, blossoms, and leaves of all the fruit-trees, so that they were left perfectly naked; nay, many that were more delicate than the rest, lost their sap as well as leaves, and quite withered away, so that they never recovered again. Their multitudes spread so exceedingly, that they infested houses, and became extremely offensive and troublesome. Their numerous young, hatched from the eggs which they had lodged under ground, near the surface of the earth, did still more harm in that close retirement than all the flying swarms of their parents had done abroad; for this destructive brood, lying under ground, ate up the roots of corn and grass, and thus consumed the support both of man and beast. This plague was happily checked several ways. High winds and wet mizzling weather destroyed many millions of them in a day; and when this constitution of the air prevailed, they were so enfeebled that they would let go their hold, and drop to the ground from the branches; and so little a fall as this was quite sufficient to disable, and sometimes perfectly to kill them: nay, it was observable that even when they were most vigorous, a slight blow would for some time stun them, if not deprive them of life. During these unfavourable seasons of the weather, the swine and poultry of the country would watch under the trees for their falling, and feed and fatten on them; and even the poorer sort of the country people, when the country laboured under a scarcity of provisions, had a way of dressing them, and living upon them as food. In a little time, it was found that smoke was another thing very offensive to them; and by burning heath, fern, &c., the gardens were secured, or if the insects had already entered, they were thus driven out again. Towards the latter end of summer they retired of themselves, and so totally disappeared, that in a few days you could not see one left. A year or two ago, all along the southwest coast of the county of Galway, for some miles together, there were found dead on the shore such infinite multitudes of them, and in such vast heaps, that, by a moderate estimate, it was computed that there could not be less than forty or fifty horse-loads in all; which was a new colony, or a supernumerary swarm, from the same place whence the first stock came, in 1688, driven by the wind from their native land, which I conclude to be Normandy or Brittany, in France; it being a country much infested by this insect, and from whence England has, therefore, been pestered in a similar manner with swarms of this vermin; but these meeting with a contrary wind before they could land, were stopped and tired with the voyage, and were all driven into the sea; which, by the motions of its waves and tides, cast their floating bodies in heaps to the shore. It is observed, that they seldom keep above a year together in a place, and their usual stages or marches are computed to be about six miles in a year. Hitherto their progress has been westerly, following the course of that wind which blows most commonly in this country."

"In the year 1574," says Mouffet, "so great a number of cockchafers were driven into the river Severn, that they altogether hindered the mills from working, and were with difficulty destroyed by the united efforts of the people, and the different kinds of hawks, ducks, and other birds, which devoured them with eagerness."

Various methods have been proposed for destroying the insect, both in the larva and imago; when in the larva state, it is proposed to cause the plough to be followed by children, to gather up in baskets such of these animals as the share might upturn, and then burn them. The method proposed for destroying the perfect insects is to burn flambeaux made of sulphur, surrounded with pitch, rosin, and a slight external layer of yellow wax: while the insects remain in a state of repose on the leaves and hedges, the flambeaux being paraded under, the insects are suffocated by the smoke and the odour of the sulphur, rosin, &c., so that they are easily shaken off and burnt.

The rook, jay, and several other omnivorous birds, are thought, instead of being reckoned a nuisance to man, amply to deserve his protection, for the great benefit they confer on the farmer; for nearly three months of the spring they do little else than walk about the fields for the purpose of seeking for and feeding on the grub of this destructive insect. From the following curious calculation, an idea may be formed as to the just value of these much-injured birds:—"Suppose a nest of five young jays, each, while yet young, consumed," says a cautious observer, "at least fifteen of these full-sized grubs in a day, and averaging their sizes, it may be said they each consumed twenty; this, for five, makes one hundred; and if we suppose the two parents to devour between them the same number, it appears that this family consumed about two hundred. This, in three months, amounts to 20,000: but as the grub continues in the same state four years, this single family, without reckoning their descendants after the first year, would destroy as many as 80,000 grubs. Now, supposing that 40,000 of these insects would have been in due time females, and that each female lays, as is really the case, two hundred eggs, it will appear that no less than 8,000,000 of grubs have been destroyed, or at least prevented from being hatched, by this single family of jays."

That remarkable insect commonly known by the name of the death-watch, under which, however, several insects are confounded, has been the cause of more terror to mankind than any thing in nature of equal bulk: its size does not exceed a quarter of an inch, and the colour is very similar to decayed wood, in which the animal lives.

It has been considered a portentive of death to some one of the family in the house where it is heard, though the philosopher and naturalist may smile at this absurd idea: "Yet," says Sir Thomas Brown, "the person who could eradicate this error from the minds of the people, would save many a cold sweat from the meticulous head of nurses and grandmothers." This vulgar error no doubt gave rise to the following lines of Swift:—

> "A woodworm
> That lies in old wood, like a hare in her form,
> With teeth or with claw, it will bite or will scratch;
> And chamber-maids christen this worm a death-watch—
> Because, like a watch, it always cries click:
> Then wo be to those in the house who are sick—
> For, sure as a gun, they would give up the ghost
> If the maggot cries click, when it scratches the post:
> But, a kettle of scalding hot water injected,
> Infallibly cures the timber affected:
> The omen is broken, the danger is over,
> The maggot will die, and the sick will recover."

In old houses, where these ominous insects abound, they may be heard during the day, as the spring advances, to call to one another; which call, if no answer be returned, the insect repeats in a different place. This sharp ticking, which by its distinctness quickly fixes the attention, is performed by raising itself upon its hind-legs, and then, with its body a little inclined, it strikes its head with great force and agility on the plane of position, and its

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strokes are sometimes so powerful as to make considerable impression, especially if they fall on any substance softer than wood. Mr. Derham tells us, that he had two of these insects in a little box for about three weeks, and he could make one of them beat whenever he pleased, by imitating the insect, which can be done by tapping with a nail upon the table; it having become so familiarized as to answer readily. The prevailing number of distinct strokes which this insect of ill omen beats, is from seven to nine or eleven times in quick succession; which very circumstance may, perhaps, still add, in some degree, to the ominous character it bears among the vulgar. The silence of night gives such full value to the love-calls of these insects, that it has caused vulgar and superstitious minds to suppose that the death-tick is only heard at midnight.—

> "The wether's bell
> Before the drooping flock tolled forth the knell,
> The solemn death-watch clicked the hour she died!"

A more curious instance of laborious industry is furnished by the burying beetle. It was first re-

marked by M. Gleditsch, that dead moles and other small animals, if laid on loose ground, quickly disappeared. In order to ascertain the cause of such a curious circumstance, he placed one in his garden, and found that on the third morning it was removed from the surface and buried three inches beneath the soil. It was strange that the dark and peaceful life of a mole should have merited at some friendly hand the honours of the sepulchre: observing nothing, however, but four beetles under the carcass, he buried the creature again, and found that in six days it swarmed with maggots. It then struck M. Gleditsch that these were the progeny of the beetles he had seen, and that these had performed the rites of sepulture for the purpose of safely committing their young to a mass which, if not concealed, would have been destroyed by the first carrion crow.* Accordingly he placed four of these beetles under a glass cover, and gave them two dead frogs. In twelve hours, two of the insects had buried one of the frogs; the other two ran about the whole day, apparently busied in measuring the dimensions of their work; and, on the third day, the second frog was also buried. M. Gleditsch then gave them a dead linnet: a pair of beetles immediately prepared to inter the bird. They pushed out the earth from under the body, and tugged at the feathers, and made all the efforts suitable to their end. The male, however, chose to drive away the female, and for five hours to labour alone. He lifted up and turned the bird, gave it a more convenient arrangement, and from time to time mounted on the carcass to tread it down. At length, wearied with its labour, it leaned its head upon the earth, beside the bird, and for a full hour remained as motionless as the corpse by its side. After this it proceeded with renewed vigour. And by dint of pulling from below and treading it down from above, the dead linnet was buried on the third day. The result of these experiments was, that in fifty days, our four beetles

* Could one have imagined, says M. G., that a small beetle, without the aid or assistance of any other stronger creature, could bury under the earth, in so short a space of time, a mole, which surpassed it at least thirty times in bulk and in weight?

had interred twelve carcasses, viz.: four frogs, three small birds, two fishes, one mole, two grasshoppers, besides the entrails of a fish, and two morsels of the lungs of an ox.

These laborious operations generally take place when the weather becomes steadily warm, say from the middle of April to the end of October; and it is the smaller carcasses only which are thus buried, to form a proper nidus for the eggs, and to nourish the young family which spring from them; thus nature has ordained the procreation of this species should go on under ground, because foxes, ravens, and other carnivorous creatures, devouring the bodies above ground, would swallow the larvæ of this beetle along with their food, which might possibly extirpate these singular but useful insects. The eggs deposited by the parent insect are white; from these the larvæ proceed, which are, when full grown, more than an inch in length, and of a yellowish white colour, with a scaly orange-coloured shield across the middle of each division of the body. Each larvæ forms for itself an oval cell in the ground, in which it changes to a yellowish chrysalis, out of which, in the space of about eighteen days, proceeds the perfect insect, as represented in the figure.

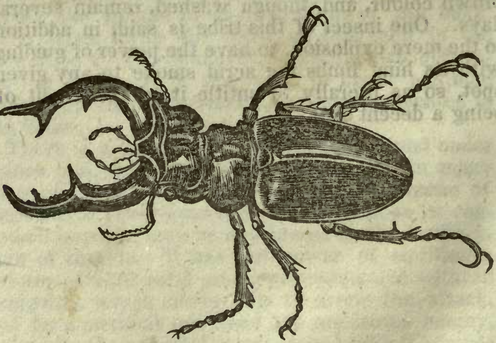
There is a small beetle occasionally found under stones and under heaps of rotten plants, in many parts of Great Britain, and known by the name of Bombardier (*Brachinus crepitans*), which, as its cognomen imports, may be considered as the artilleryman of insects. It has the power of emitting a volume of blue acrid smoke, accompanied with an explosion, which never fails to arrest the attack, and for a moment confound the audacious enemy, especially the splendid carnivorous beetle (*Calosoma sycophanta*). When its assailant has recovered the effect of its surprise, the pursuit is renewed, a second discharge again stops its career, and during the interval it takes the opportunity of escaping. In this way the artillerymen can keep up a running fire, so as to let off twenty good discharges successively. On lifting up a large stone in gravelly situations, an explosion will be heard, and a streak of smoke occasionally seen issuing from the ground; —no sooner is the alarm thus given, than twenty or thirty other subterranean volcanoes vomit forth their little smoke, evidencing the terror and the remedy for it of a colony of Bombardier beetles. There is also another species, rather smaller than the former, which is capable of exploding in the same manner about ten or twelve good discharges; but they afterward emit a yellow or brown fluid. The smell of the smoke is strong and pungent, and has some similarity with that exhaled by nitric acid; the fluid is caustic, and turns paper red, and produces on the skin, when handled, the sensation of burning and forming red spots, which pass into a brown colour, and, though washed, remain several days. One insect of this tribe is said, in addition to the mere explosion, to have the power of guiding with its hind limbs the acrid smoke to any given spot, so as literally to entitle it to the credit of being a decent shot.

CHAPTER IX.

FURTHER HISTORY OF THE COLEOPTEROUS INSECTS.

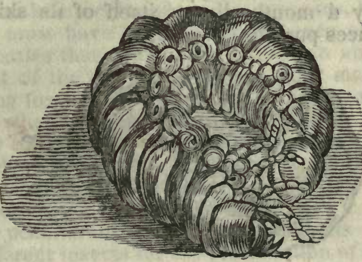
History of the Stag-beetle, its Habits—Description of the Larva, Pupa, and Cocoon—a Marvellous Story—History of the Pellet-beetle, the Manner of forming its Pellet, &c., its Strength, an Emblem of the Egyptians, its Symbolical Meaning—History of the Water-beetle—Description of the Nidus, Larva, its peculiarly formed Jaws, the Utility of the Fringe of the Tail, its Ravages, considered a Shrimp, Pupa, perfect Insect—History of the Tortoise-beetle—Description of the Larva, its Habits, Pupa, perfect Insect.

One of the largest of our indigenous insects is the stag-beetle (*Lucanus cervus*). It is chiefly found in

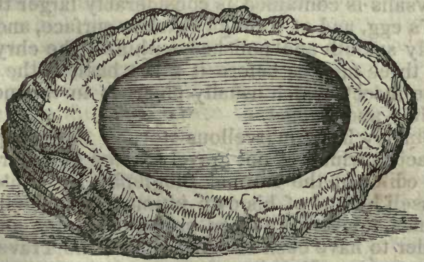


narrow shady lanes, generally on an oak or elm tree. The perfect insect attacks the roots and leaves of those trees. It lies concealed in their stumps during the day, and feeds only during the evening.

Linnæus, however, states, that its food is the juice which exudes from decayed oaks. Their young burrow in the bark and hollows of trees, and there undergo the usual metamorphoses.



Its larva, which perfectly resembles that of the other true beetles, is also found in the hollow of oak trees, residing in the fine vegetable mould usually seen in such cavities, and feeding on the softer parts of the decayed wood. It is of a very considerable size, of a pale yellowish or whitish brown



colour, and when stretched out at full length measures nearly four inches. When arrived at its full size, which, according to some, is hardly sooner than the fifth or sixth year, it forms, by frequently turning itself, and moistening it with its glutinous saliva, a smooth oval hollow in the earth, in which it lies, and afterward remaining perfectly still for the space of nearly a month, divests itself of its skin, and commences pupa or chrysalis.

It is now much shorter than before, of a rather deeper colour, and exhibits, in a striking manner, the rudiments of the large extended jaws and broad head, so conspicuous in the perfect insect: the legs are also proportionably larger and longer than in the larva state. The ball of earth in which this chrysalis is contained is considerably larger than a hen's egg, and of a rough exterior surface, and perfectly smooth and polished within. The chrysalis lies three months before it gives birth to the complete insect, which usually emerges in the months of July and August.

Bingley has a marvellous story of their supposed rapacity, which, if not gravely stated by the reverend editor of the Animal Biography, as related to himself by one of his own intimate and intelligent friends, might have been supposed by the general reader to have been borrowed from the Travels of the veracious Munchausen.

"An intimate and intelligent friend of the editor informed him that he had often found several heads of these insects together, all perfectly alive, while the trunks and abdomens were nowhere to be found; sometimes only the abdomens were gone, and the heads and trunks were left together. How this circumstance took place he never could discover with any certainty. He supposes, however, that it must have been in consequence of the severe battles that sometimes take place among the fiercest of the insect tribes; but their mouths not seeming formed for animal food, he is at a loss to guess what becomes of their abdomen. They do not fly till most of the birds have retired to rest, and indeed, if we were to suppose that any of them devoured them, it would be difficult to say why the heads or trunks should be rejected."

The peculiar instinct which nature has ordained the different insects for the preservation of the kind, is well exemplified in the tribe of the Pellet-beetles, natives of both continents. Though the casual observer may be apt to raise associations rather unfavourable to the cleanliness of these insects, yet their indefatigable industry cannot but cause him to be struck with the wisdom of the Creator. Between the months of April and September, several of these insects may be seen rolling globular pellets of moist dung, which, according to Catesby, "they discover by the excellence of their noses." Their industry is surprising, as well as the mutual assistance which they render to one another in rolling these globular balls from the place where they made them to the place of their interment, which is usually several feet. This operation is performed by fastening their four fore-legs firmly, raising their hind parts, and forcing the ball with the hind-legs. Several of them are sometimes engaged in trundling one ball, which, on meeting with impediments from the unevenness of the ground, they sometimes desert; when, however, it is attempted by others with success, unless it happen to roll into some deep hollow, where they are constrained to leave off; but they continue to work by rolling the next ball that comes in their way. None of them appear to know their own ball, but an equal care for the whole appears to affect the community. They form these pellets while the dung remains moist, and leave them to harden in the sun before they attempt to roll them; in their removing them from place to place, the balls may be seen tumbling about over the little eminences that are in their way; they are not, however, easily discouraged, and repeated attempts usually surmount the difficulties. This object is effected, because in the middle of each of these pellets is buried an egg, the larva of which, when awakened into life, finds its food already prepared for its use: after having devoured the parent's supply, it seeks the surface, and after the usual time, it forms its pellet of moist dung, coated outside with clay, which gives them the appearance of round stones. Their roundness has caused much surprise to entomologists, as regards the manner in which it is formed; some supposing that, having proceeded so far as to allow of its entering, the larva lays in a supply of clay and dung, then fixes itself, and plasters first the outward coat, and then the inward, with the dung. It silently changes into a chrysalis, and after a short time it appears in the perfect insect, when it is of a deep shining black colour, about three quarters of an inch in length.

The strength of these insects is very great, which is often shown by the planters in America placing one under each candlestick, where they will remain quiet until the table is struck; the insect being thus disturbed, will begin to move the candlesticks about of its own accord, though in an awkward manner, to the great delight of the visiters.

Several of this tribe were emblems of the Egyptians, and accordingly are to be met with abundantly in their hieroglyphics, symbolical of the world, the sun, and of a courageous warrior: of the sun, from its head being surrounded with radiated projections, the number of the joints of the feet equalling the thirty days of the month: of courage, from an idea entertained that the insect was born of a male: and of the world, because it rolled dung into little orbs.

Among those insects which reside in stagnant water during their metamorphoses, we select the water-beetle (*Dytiscus marginalis*), to show its peculiar transformation. The larvæ proceed from eggs left in a singularly formed nidus of a silky substance, which is allowed by the parent to float on the surface of the water: the part above is long and tapering, as if to serve as a mark of some distinction. After the period of ten or twelve days,

they put on the form shown in the upper figure. They are of a yellowish brown colour, measuring two inches and a half in length, and rather transparent; the body is covered with strong shields; the end of the abdomen is furnished with two long appendages, fringed on their sides with fine hairs. When the larva wishes suddenly to change its position in the water, or dart from the approach of some larger insect or animal, which might devour it, the insect gives a prompt vermicular movement to its body, striking the water with its tail, the fringe of which then becomes very useful to the animal, since the tail is thereby rendered more fit to resist the water, and to cause the insect to advance. The head is rather flat, armed in front with a pair of very strong, long, and curved jaws, which, when magnified, appear to have at their apex an aperture or an oblong hole, through which the insect sucks, by little and little, all the solid parts of its prey, which generally consist of other larvæ.

They are even bold enough to attack water-newts and tadpoles, and have been known to seize a young tench of three inches in length, and to kill it in the space of a minute: they are, therefore, considered as one of the most mischievous animals that can infest a fish-pond. The singular form of the larva caused it to be considered by ancient authors as analogous with the shrimp tribe, and it has actually been referred to that series of crustaceous insects under the denomination of *Squilla aquatica*. When arrived at its full growth, the larva forms itself an oval hollow cocoon, made of soft earth or clay, collected from the banks of the water it inhabits; in a few days it changes into a chrysalis, which is of a white colour. After the space of three weeks it undergoes the last metamorphosis, as represented in the right-hand figure.

The perfect insect is rather more than an inch long, of a blackish olive colour, with the outer margins of the neck and wings bordered with yellow. The two sexes of this insect are easily distinguished from each other. The male is known not only by the smoothness of the wing-cases, but also by the breadth of the fore-feet, which are abbreviated and dilated, convex beneath, and serve as a sucker; while all the feet of the female are similar to one another, and the wing-cases are deeply impressed with a series of longitudinal furrows.

On mint, and other verticillated plants, w sometimes find a very singularly formed larva of the tortoise beetle, *Cassida viridis*, which is yellowish brown in colour, and of an oval shape, and has the sides of the body edged with a fringe of projecting fibres; the two terminal ones are longer than the rest, and generally carried over the body towards the head, while the animal is in motion. On these

filaments, it is said, the animal collects its own excrement, and thus forms itself a canopy of it over its back, probably for the purpose of defending itself from the attacks of its enemies. When it arrives at maturity, it fastens itself to a leaf, casts its skin, and commences the pupa state, which is also

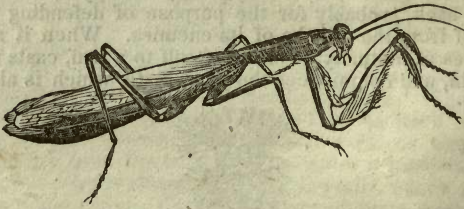
of a very remarkable shape, and is peculiar for the breadth or dilatation of the forepart; from the chrysalis, in the space of three weeks, proceeds the insect in its complete state, when its length is nearly a quarter of an inch; its body is of an oval shape, and its colour bright green above, with the under part black.

CHAPTER X.

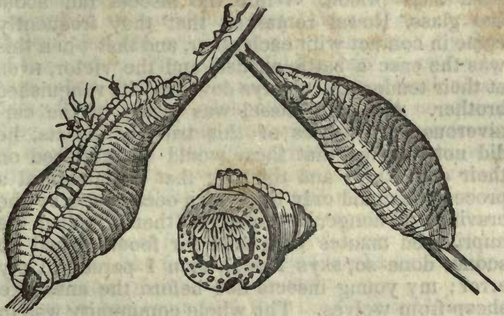
NATURAL HISTORY OF THE MANTES, ETC.

Why called Fortune-tellers—Description of the Nidus—Larva—Rœsel's Observations—Destroyed by Ants—Combat between Two Mantes—Manner of entrapping its Prey—Superstitious Idea of the Hottentots—Natural History of the Walking Leaf—The Supposition of the Indians—Its Similarity to a Leaf—Walking Stick Its Habits—Their Eggs—Natural History of the Cockroach—Whence brought—Their Ravages—Manner of laying their Eggs—Natural History of the Eearwig—The Care of the Parent for her Young—Its voracious Habits—Wings of the perfect Insect—Natural History of the Field Bug—Its Young, &c.

This singular insect has, from its peculiar attitudes, given rise to some superstitious ideas. Mouffet tells us, that "they are called mantes, that is,



fortune-tellers; either because by their coming they do show the spring to be at hand, so Anacreon, the poet, sang; or else they foretel death or famine, as Cælius, the scholiast of Theocritus, writes; or, lastly, because it always holds up its forefeet like hands, praying, as it were, after the manner of their diviners, who, in that gesture, did pour out their supplications to their gods. So divine a creature is this esteemed, that if a childe aske the way to such a place, she will stretch out one of her feet, and show him the right way, and seldom or never misse. As she resembleth these diviners in the elevation of her hands, so, also, in likeness of motion, for they do not sport themselves as others do, nor leap, nor play, but walking softly, she returns her modestly, and showes forth a kind of mature gravity." Such are the marvellous stories told by old authors of the praying mantes.



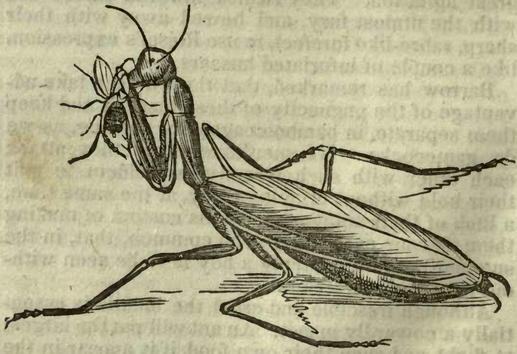
This tribe of insects, which is scientifically termed *Mantides*, is peculiar for the eggs being imbedded by the female in a case of matter of the consistence of fine parchment, of an orange colour, nearly two inches in length, and about three fourths of an inch in its greatest diameter. This mass is usually fixed to the stalk of some plant. The eggs themselves are arranged in two rows in the coriaceous mass. One of these masses being sent to Rœsel, he observed that a double row of egg-like bodies sprouted up in close contact with each other in a furrow, which divided the mass longitudinally; these little eminences soon became animated, for out of them Rœsel perceived the young mantes struggling to come forth. As soon as one had succeeded in freeing itself from the egg, it ran off with the agility of an ant; the colour, general form, and size of which, it had a no less strict resemblance to, than to its nimbleness.

Rœsel, determining to study their habits, enclosed the young mantes in a glass vessel, but this confinement appeared to be excessively irksome; the insects, accordingly, made every attempt to escape from their prison. While the insects ran about the glass, Rœsel remarked that they frequently came in contact with each other, and that when this was the case a battle ensued, and the victor, even at their tender age, always devoured its vanquished brother. Although Rœsel was aware of the carniverous propensities of this tribe of insects, he did not imagine that these would be exercised on their own kind; and thinking that so unnatural a proceeding could only have been occasioned by the cravings of hunger, the observer then supplied the imprisoned mantes with ants for food. I had no sooner done so, says Rœsel, than I perceived my error; my young insects fled before the ants like sheep from wolves. The whole community was in great commotion, and I soon saw the ants, which I had intended to be eaten, falling on, killing, and eating the mantes. It was a matter of wonder to me, to remark how quickly the mantes, which had only seen their own kind, know their natural enemies. I afterward learned that ants fall on these insects, even when they are full grown, and speedily kill them. I removed my young mantes, therefore, as soon as possible out of the way of their enemies, and put a dozen into a glass case by themselves, and fed them with flies and plant-lice; the size of the former frightened them at this stage of their existence; the latter, however, appeared to be a dainty food for them. Nevertheless, although they had an abundant supply of nourishment, they never ceased to attack, kill, and eat each other when they met; so that I speedily lost almost the whole of my original stock; and thinking to preserve the remainder by permitting the insects to stray among the flowers of my garden, I found that these, too, were lost to me, having fallen a prey to their enemies, the ants.

The same observer having put a full-grown male and female mantis into a glass case, and taken the precaution of satisfying their hunger, saw nevertheless that the cruelty was not surpassed by that of the spider. No sooner did the two insects espy each other, than both remained stiff and motionless, fixing their eyes on each other. In this condition they continued a long time, when the whole frame of each became violently agitated; the neck was stretched out, the wings expanded and fluttered, while the rest of the body and tail were moved with great agitation. They rushed towards each other with the utmost fury, and hewed away with their sharp, sabre-like forefeet, to use Rœsel's expression, like a couple of infuriated hussars.

Barrow has remarked, that the Chinese take advantage of the pugnacity of these insects, and keep them separate, in bamboo cages, for fighting, as we do gamecocks. He mentioned that they attack each other with such ferocity, as seldom to quit their hold without bringing away, at the same time, a limb of their antagonist. This custom of making them devour each other is so common, that, in the summer months, scarcely a boy is to be seen without his cage of warriors.

Although irascible and cruel, the mantis is essentially a cowardly insect. An ant will put the largest to flight, and even their own food, if it appear in the shape of a blue-bottle fly, will terrify them. When, however, the fly is not too large, it is curious to remark how cunningly it endeavours to entrap its prey. For this purpose it raises its body, and lifting up and joining its two forefeet, it remains for hours motionless, in the attitude of one praying. When the mantis espies a fly, even at a distance, it never takes off its bright green eye from its destined booty. The slightest variation in the movement of the fly is met by a correspondent one of the eye, without moving the head of the mantis. If the fly should not approach sufficiently near, or if, on the contrary, it should betray any signs of removing altogether, the mantis drags its body so cautiously towards its prey as to be almost imperceptible to the observer; it then stretches itself as near as possible to the fly, without absolutely shifting its place; and when it has approached sufficiently near, the long claws, hitherto raised and folded up, are thrown upon the victim with the rapidity of lightning. Rœsel asserts, that the mantis will hook up a fly at the distance of four inches.



The insect thus caught is held carefully by the mantis, until it mangles and devours its prey, limb by limb. Having finished its repast, the mantis cleans its claw, feelers, and head, with the greatest apparent care, and then sets forth in quest of fresh booty. Rœsel says that a male mantis will eat four, and a female six flies, daily.

The Hottentots consider the species which is found in South Africa an insect of good omen; especially if one should, by chance, alight upon them.

The insect which is here represented belongs to a tribe very analogous to the last, but whose habits and manners are totally different, so much so that

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our readers may not consider them unworthy of notice. On looking at the figure very attentively, one is struck by the great similarity it bears to a leaf. This opinion is also entertained by the Indians, who believe that these insects grow on the trees like leaves; and that, when they have arrived at maturity, thev loosen themselves and fly away. It has also caused Messrs. Kirby and Spence to observe, "To such perfection, indeed, has nature in them carried her mimetic arts, that you would declare, upon beholding some insects, that they had robbed the trees of their leaves to form for themselves artificial wings, so exactly do they resemble them in their form, substance, and vascular structure; some representing green leaves, and others those that are dry and withered; nay, sometimes this mimicry is so exquisite, that you would mistake the whole insect for a portion of the branching spray of a tree."

There are also some other species, which are wingless, and therefore called walking-sticks. Throughout their metamorphoses these are stated to be more especially found only in the colder latitudes, while the winged species inhabit only the warmer parts of the world. They also bear great likeness to branches of trees, which induced one of the former mentioned authors to say, "I have one from Brazil, eight inches long, that, unless it was seen to move, could scarcely be conceived to be any thing else than a small branch with its spray; the legs, as well as the head, having their little snags and knobs, so that no imitation can be more perfect."

Their habits have been stated to differ from those of the former tribe. These insects live on the trees, on the leaves of which they feed by night; they are very unsocial in their mode of life, being rarely found more than two in company; during the day they are found lying close under the surface of the leaves of plants, with their forelegs stretched out before, parallel with their antennæ, or feelers, as if to protect them from enemies. One extraordinary circumstance has been mentioned with respect to these insects, that is, if by any violence they should lose a limb, the same is reproduced, when they undergo their change of skin, as occurs among crustacea and spiders.

They do not lay their eggs in a conglomerated mass, but indiscriminately scatter them in various places. They, as well as the more perfect insects, are so like portions of vegetables, that if one was unacquainted with the circumstance of their dissimilarity, he would be induced to pronounce them seedvessels of some species of umbelliferous plants.

Of the cockroach, or, as it is more generally termed, black beetle, which so infests houses, but more especially the bakers', in this metropolis, there are many species; some of them are nearly three inches long. They principally inhabit the warmer parts of the world, though now more scattered, by means of shipping. The one most common in this country is from Asia; there is also another, which came with raw sugar from the West Indies. This pestiferous race of beings, says an observer, are equally noisome and mischievous to natives or strangers, but particularly to collectors. These nasty and voracious insects fly out in the evenings, and commit monstrous depredations. They plunder and erode all kinds of victuals, dressed and undressed, and damage all sorts of clothing, especially those which are touched with powder, pomatum, and similar substances, every thing made of leather, books, paper, and various other articles; which, if they do not destroy, at least they soil, as they frequently deposite a drop of their excrement when they settle, and some way or other, by that means, damage what they cannot devour. They fly into the flame of candles, and sometimes into the dishes; are very fond of ink and of oil, into which they are apt to fall and perish. In this case they soon turn most offensively putrid, so that a man might as well sit over the cadaverous body of a large animal as write with the ink in which they have died. They often fly into persons' faces and bosoms; and their legs being armed with sharp spines, the pricking excites a sudden horror not easily described. In old houses they swarm by myriads, making every part filthy beyond description wherever they harbour, which in the daytime is in dark corners, behind all sorts of clothes, in trunks, boxes, and, in short, every place where they can lie concealed. In old timber and deal houses, when the family is retired at night to sleep, this insect, among other disagreeable properties, has the power of making a noise which very much resembles a pretty smart knocking with the knuckle upon the wainscoting. The gigantic cockroach which is found in South America, is frequently known by the name of the drummer. Three or four of these noisy creatures will sometimes be impelled to answer one another, and cause such a drumming noise, that none but those who are very good sleepers can rest for them. What is most disagreeable, those who have not gauze curtains are sometimes attacked by them in their sleep. The sick and dying have their extremities attacked, and the ends of the toes and fingers of the dead are frequently stripped both of the skin and flesh.

Mouffet relates, that "I have heard from persons of good credit that one of these cockroaches was found and taken in the top of the roof of the church at Peterborough, which was six times larger than the common species, and which not only pierced the skin of those who endeavoured to seize it, but bit so deep as to draw blood in great quantity. It was a thumb's length and breadth in size, and being confined in a cavity of the wall, after two or three days made its escape, no one knew how." It appears, from this description, to have probably been the one which we have just mentioned as from South America.

The female of the common cockroach lays one or two singularly-formed capsules, of a long square shape, half the size of the abdomen, with one side rounded, and shelving down with the margin straight and saw-shaped on the other. It is, when fresh, white and soft, but, after being exposed to the air, becomes hard and brown. The capsule contains sixteen or eighteen eggs placed in two rows; the young make their escape through a cleft on the straight side. Their metamorphoses are very similar to other insects of the orthopterous order. It is not uncommon to find the cast skin of these insects lying about the houses which they inhabit in innumerable quantities.

The idea of the earwig introducing itself into the human ear, and causing madness and death, may be ranked among vulgar errors. If it infested human ears, it is more than probable that it would be often found in the ears of other animals, and yet such is not the fact. The cerumen or waxen secretion in the ear is in itself a sufficient guard against the entrance of an insect, whose natural food is decayed fruit and vegetables. Some years ago, several regiments were encamped in the neighbourhood of Winchester, in fields swarming with these insects; nevertheless, during the whole season, one single instance only occurred of the earwig getting into the human ear. The insect fell into the ear of a soldier who was sleeping. The accident caused no inconvenience, and it was speedily killed by pouring oil into the ear, and extracted by syringing the cavity with warm water.

In most other insects the parent is solicitous only to place the eggs in circumstances most favourable to their protection, after which she seems to forget even the spot to which her offspring have been committed. But, among earwigs, on the contrary, the eggs are hatched and the young ones fostered by the parent. M. Degeer relates, that at the beginning of the month of June, he found under a stone a female earwig, surrounded by a number of young offspring, which were evidently her own. He put them all into a box of fresh earth; they did not enter the earth, but placed themselves under their mother and between her legs, she remaining quite quiet, and suffering them to continue there sometimes for an hour or two together. For their nourishment he placed in the box a piece of very ripe apple, which the old one instantly seized on and began to eat with avidity; the young ones, too, seemed to eat a little, but with much less relish. On the eighth of June he observed that the young earwigs had changed their skins; and though this moulting had effected no material difference in their appearance, yet by it they were evidently brought nearer to the state of a perfect insect.

At another time, about the beginning of April, says the same observer, I found a female earwig under some stones, placed over a heap of eggs, of which she took all the care imaginable, without ever quitting them. Degeer took both the insect and the eggs, and put them into a box filled with earth. As he had scattered the eggs about, the parent insect set about gathering them together. She seized them one by one in her jaws, removed them carefully to the surface of the box, and in a few days formed a little heap, on which he found her sitting and brooding like a hen over her chickens. The young burst their shells in the middle of May. Their colour was at first white. Degeer fed them with apple for some time, and saw them change their skins more than once. The mother at last died, when her young nearly devoured her carcass, impelled, as Degeer supposes, to so unnatural a deed by hunger and the want of proper food. One only survived on the 23d of July. In their larva state they differ very little from the perfect insect in outward appearance, with the exception of wanting wings and wing-cases. The wings are folded up with wonderful neatness in the wing-cases, though the former are nine or ten times larger than the envelope which contains them. The wings are first drawn together lengthwise like a fan, and then refolded across in two different places, one about the middle of the membrane, the other from the centre where the first fold proceeded.

A species of field-bug (*Pentatoma grisea*) also shows a very great affection for her young offspring; though the family consist of about thirty or forty, yet the parent pays as much attention as a hen does to her brood. She never leaves them, and, as soon as she begins to move, all the little progeny closely follow, and whenever she stops they assemble in clusters round her. Degeer remarks, that if disturbed, the mother shows every symptom of excessive uneasiness. In other circumstances such an alarm would have caused her immediate flight; but now she never stirred from her family, but kept beating her wings incessantly with a rapid motion, evidently for the purpose of protecting them from the apprehended danger.

CHAPTER XI.

NATURAL HISTORY OF THE CRICKETS.

History of the House Cricket, its Habits, popular Prejudices, its Noise—History of the Field Cricket, difficult to catch, its Habits, its Sound—A singular Species—History of the Mole Cricket, its Fore legs, its Chamber for its Eggs, its Metamorphoses, Mode of attacking its Enemies, its Noise, Manner of Flight, supposed to be Luminous.

THE crickets and mole crickets resemble each other so closely, that we shall take the opportunity of bringing their respective histories into one chapter.

Tender insects, says White, that live abroad, either enjoy only the short period of one summer, or else doze away the cold, uncomfortable months in profound slumbers; but the house crickets, re-

siding, as it were, in a torrid zone, are always alert and merry; a good Christmas fire is to them what the heat of the dog-days is to others.

> "Around, in sympathetic mirth,
> Its tricks the kitten tries;
> The cricket chirrups in the hearth;
> The crackling fagot flies."

As one would suppose by their living near fires, they are a thirsty race, and show a great propensity for liquids, being frequently found drowned in pans of water, milk, broth, or the like: whatever is moist they affect, and therefore they often gnaw holes in wet woollen stockings and aprons that are hung to the fire. These animals are not only very thirsty, but very voracious, for they will eat the scummings of pots, yest, and crumbs of bread, and kitchen offal or sweepings of almost every description.

In the summer they have been observed to fly, when it became dusk, out of the windows and over the neighbouring roofs. This feat of activity accounts for the sudden manner in which they often leave their haunts, as it does also for the means by which they come into houses where they were not known before, especially new-built houses, being pleased with the moisture of the walls; and, besides, the softness of the mortar enables them to burrow and mine between the joints of the bricks or stones, and to open communications from one room to another. It is remarkable that many sorts of insects seem never to use their wings but when they wish to shift their quarters and settle new colonies. When in the air, they move in waves or curves, like woodpeckers, opening and shutting their wings at every stroke, and thus are always rising and sinking. When their numbers increase to a great degree, they become pests, flying into the candles, and dashing into people's faces. In families at such times they are like Pharaoh's plague of frogs, in their bedchambers, and in their beds, and in their ovens, and in their kneading-troughs.

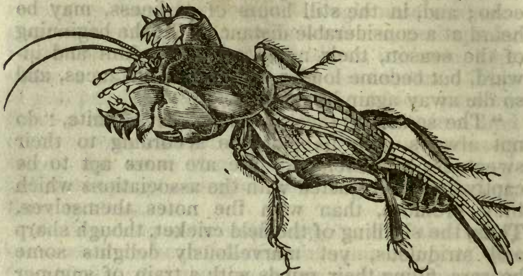
Popular prejudice frequently prevents any attempt being made to rid the house of this noisy animal. Many persons imagine that their presence is attended with good fortune to the inmates, and that to drive them away or to kill them will bring some misfortune on the family. The noise of the cricket, according to Degeer, is produced by the male elevating its horny wing-cases, and rubbing them briskly together. The sound, no doubt, suggested the name, for it is exactly imitated by the syllables, cree-cree. It is in the dusk of the evening, when friendly faces are assembled round the blazing hearth, that the warmth raises the cricket's cry of love. It is the single tale, the one chant of its life and, however loud the conversation or the laugh, its shrill note is heard through all. This shrilling was once so troublesome to a lady as to cause her to resort to every means to dislodge the insect from its roost; but all in vain. It so happened that a wedding was celebrated in her house with all kinds of music. The trumpet and the drum were rather more than the cricket could cry down; and whether it was fright, or whether it was anger at being vanquished, which drove these insects off, is not quite certain; but certain it is, they never after troubled the house or the lady. There are few, however, who object to the cry; for over the hearts of most men the merry chirp of the house cricket has power, calling up those days when its single note was mingled with many a voice, which will not, perhaps, be heard again. The learned Scaliger, it is said, kept some in a box, to cheer him in his labours. This is also practised in Spain; and in Africa, persons make a trade of crickets; they feed them in a kind of iron oven, and sell them to the natives, among whom the noise they make is thought pleasing and these people imagine that it assists in lulling them to sleep.

While taking our evening rambles over the heath, we sometimes hear the cheerful summer cry of the field cricket; but they are so sly and cautious, says White, that it is difficult to obtain sight of one of these sonorous animals; for, feeling a person's footsteps as he advances, they stop short in the midst of their song, and retire backward nimbly into their burrows, until all suspicion of danger is over. There is one way, however, by which an observer may obtain his wish: it is by a pliant stalk of grass being gently insinuated into their burrows, which will probe their windings to the bottom, and quickly bring out the animal, as it lays hold of the grass with its paws. When the males meet, they fight fiercely, as White found by some which he put into the crevices of a dry stone wall, where he would have been glad to have made them settle. The first that got possession of the chinks would seize on any that were obtruded upon them, with their strong jaws, toothed like the shears of a lobster's claw; with them they perforate and round their curious cells. They feed on such herbs as grow before the mouths of their burrows, and rarely stir more than two or three inches from home. Sitting in the entrance of their caverns, they chirp all night as well as day, from the middle of the month of May to the middle of July. In hot weather, when they are most vigorous, they make the hill echo; and, in the still hours of darkness, may be heard at a considerable distance. In the beginning of the season, their notes are more faint and inward, but become louder as summer advances, and so die away again by degrees.

"The sounds of these animals," says White, "do not always give us pleasure according to their sweetness and melody. We are more apt to be captivated or disgusted with the associations which they promote, than with the notes themselves. Thus, the shrilling of the field cricket, though sharp and stridulous, yet marvellously delights some hearers, filling their minds with a train of summer ideas, of every thing that is rural, verdurous, and joyous." They afford some persons much amusement when placed in a paper cage and set in the sun, and supplied with plants moistened with water, on which they will live some time, and become so merry and loud as to be irksome, when in a room where a person is sitting.

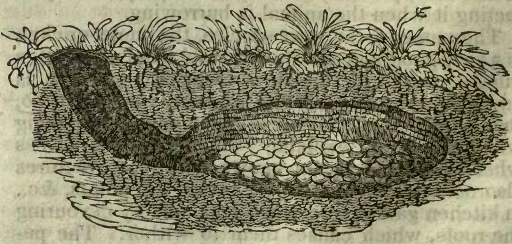
There is one species which is singularly furnished with an apparatus, like an umbrella, over the front of the face, probably useful for the purpose of protecting it when the animal is burrowing.

The name of the next species, the mole cricket, is a very good index to its form and habits. It often infests gardens by the sides of canals, where it is an unwelcome guest to the gardener; so much so, that a German author of an old book of gardening was induced to exclaim, "Happy are the places where this pest is not known." These creatures also occasion great damage among the plants, &c., in kitchen gardens, by burrowing, and by devouring the roots, which causes them to wither. The peculiar shape of their fore-arms is well adapted for the purposes of burrowing, both by their great strength and breadth. They are turned outwards, like their namesake's, the mole, to whose habits



they are very analogous, and enable the insects when sought for to burrow with very great rapidity, leaving a ridge in the surface as they work; but they do not form hillocks as the mole. These animals prefer for their haunts moist meadows, also the sides of quiet and running water, and swampy wet soil.

Their habitations are surrounded with many winding passages, which generally lead to a kind



of chamber or nursery, marvellously formed by the parent for the preservation of her offspring. This chamber is about the size of a small egg, though not quite so oval, neatly smoothed and rounded, and within are deposited more than a hundred eggs of a dirty yellow colour. In a month, these give birth to the young, which resemble the parent in every thing but the wings, except that at first they are white, soft, and very small. The careful parent, it is said, not only protects her eggs by forming the oval chamber for them, but surrounds it with a regular defence of ditches and ramparts, about which she herself keeps anxious watch. A black ground-beetle is the enemy from which she has most to dread, but for which the maternal instinct is often more than a match; for, as it endeavours to creep into the chamber, the mole cricket seizes it, and bites it asunder. "In the middle of April," says White, "at the close of day, these animals begin to solace themselves by a low, dull, jarring note, continued for a long time without interruption, and not unlike the chattering of the goatsucker, but more inward." When the mole crickets fly, they move in rising and falling curves, somewhat like the first species. They are supposed by some persons to be luminous, and that these animals are probably the ignis-fatuus, or jack-o'-lantern.

CHAPTER XII.

NATURAL HISTORY OF THE LOCUST, ETC.

The Idea entertained by the Ancients, by the Arabs—The supposed Meaning of the Letters on their Wings, &c.—Their Food—Ravages—The Description given by Joel—The Beneficial Results from the Locusts, used as Food—Niebuhr's Account—Their Ravages in Barbary, in Transylvania, in Spain—Size of the largest Species—Ravages in Mahratta, and in Africa—The Wart-eating Locust—Prickly Grasshopper—On the Metamorphoses of this kind of Insects.

THE history of the locust is indeed a series of the greatest calamities which human nature has suffered. Kingdoms have been depopulated. In all ages and times, these insects have so deeply impressed the

imagination, that all people have looked on them with superstitious horror. Their devastations have entered into the history of nations, and their effigies have been perpetuated in coins, like those of other conquerors of the earth.

We are the army of the great God, and we lay ninety-and-nine eggs; were the hundredth put forth, the world would be ours—such is the speech the

Arabs put into the mouth of the locust. The Mohammedans say, that after God had created man from clay, of that which was left he made the locust. The feeling which the Arabs entertain of this insect is well shown in the description they give of its pedigree and person. It has the head of the horse, the horns of the stag, the eye of the elephant, the neck of the ox, the breast of the lion, the body of the scorpion, the hip of the camel, the legs of the stork, the wings of the eagle, and the tail of the dragon.

The wings of some being spotted, were thought by many to be leaves from the book of fate, in which letters announcing the destiny of nations were to be read.

Much of this description is quite oriental, but such is the general resemblance to some of the animals mentioned, that in Germany one of its names is grass-horse, and in Italy it is still termed cavalletta. About its neck, too, the integuments have some resemblance to the trappings of a horse, though other species have the appearance of being hooded.

Paul Jetzote, professor of Greek literature at the Gymnasium of Stettin, wrote a work on the meaning of the three letters, which were, according to him, to be seen on the wings of those locusts which visited Silesia in 1712. These letters were B. E. S., and formed the initials of the Latin words "Bella Erunt Sæva," or "Babel Est Solitudo;" also the German words, "Bedeutet Erschreckliche Schlacten," portending frightful battles, "Bedeutet und Erfreuliche Siege," portending happy victories. There are Greek and Hebrew sentences, in which no doubt the professor showed as much learning, judgment, and spirit of prophecy, as in those already quoted.

Not content with the dreadful presence of this plague, the inhabitants of most countries took that opportunity of adding to their present misery by prognosticating future evils. The direction of their flight pointed out the kingdom doomed to bow under the divine wrath. The colour of the insect designated the national uniform of such armies as were to go forth and conquer.

Aldovandus states, on the authority of Cruntz, that Tamerlane's army being infested by locusts, that chief looked on it as a warning from God, and desisted from his designs on Jerusalem.

But to turn from these idle tales to the real horrors of its history. The locust feeds on all green things, though the food is not the same with each kind. Some prefer the rankest and coarsest grass, and leave the finer untouched. They have been known to consume the straw with which the vines were bound to the poles of a vineyard, and pass over the shrub itself. But whatever they fall on they eat with voracity, and leave whole countries, which before were green, quite black, and as if burnt by fire. But though voracious, and though the plains on which they may have happened to alight may not be sufficient to supply the whole of their countless myriads, yet there is a semblance of subordination among them. They are not observed to scramble for the portion which a more fortunate neighbour may have alighted on, but each takes that which falls to his lot.

Pliny has given us many tales of the ferocity of these insects, and Aldrovandus has copied them. That they fall on the snake, and, seizing it by the neck, throttle it; and that one is a match for the serpent. That they consume animal as well as vegetable substances is improbable; they have been known, however, when several have been shut up together, to fall on, attack, and devour each other, in this respect imitating many species of herbivorous caterpillars.

Their numbers are so great that the sun is for hours eclipsed by a flight of these insects. A German author has made a rough estimate of a swarm, which in the year 1693 covered four square miles of ground. He made out that, when he trod on the ground, at least three were crushed, and that in a square German measure, less than an English foot, ten were destroyed; and after determining the number of these square measures in the four square miles, he concludes that ninety-two billions one hundred and sixty millions of locusts were congregated on that surface. This is altogether a moderate calculation, for not only is their number more compact in breadth, but they are often piled knee high on the earth.

No wonder, then, that the swarms which visited the Islands of Formosa and Tayowan, in 1645, caused by their numbers such a famine, that 8,000 men died of hunger; or that the heaps of rotten carcasses, washed on the shore by the sea, caused, according to St. Augustine, such a plague, that in the kingdom of Massinissa alone, 800,000 perished. Franc. Alvarez, in his Itinerario Æthiopico, states, that when in that country, such a host of locusts gathered there, that they expelled the inhabitants of the district, who were unwilling to resort to the means which would have destroyed this pest, lest by so doing they should be thought to rebel against this punishment of the Deity. They witnessed the destruction of all things with sighs and wringing of hands, and at last were driven from their homes to preserve their lives. The melancholy spectacle moved Alvarez much.

The accounts of their ravages, published during the last century, give the liveliest picture of their devastations.

Hungary, 9th June, 1748.—The misery is hourly increasing. The inhabitants are now obliged to sell their kine, for there is no longer any grass to feed them with, and instead of it, the locusts are covering the fields knee deep.

28th June.—The locust has appeared on the Danube and Theisse in such numbers, that we are reduced to the direst necessity. They cover a circle of four miles, and not a blade of grass is to be seen. Their colour is brown, and when we drive them into the water, they swim to the opposite shore. When they have consumed all, they leave an intolerable stench behind. It is all over with harvest; we go out three or four thousand together, driving our cattle before us, to slay these pests, but the slaughter of 100,000 only makes place for 100,000 more.

Vienna, 3d July.—The plague of the locust is extending from Lower Hungary; and the reports from Funfkirchen say, that they have taken wing, and crossed the Danube in such countless myriads as to darken the sun. In one night they have so completely destroyed the grass and the foliage of trees, that they now look like bare brooms.

Clausenberg, 30th June.—The locusts which have taken possession of our district, are red. They have fixed particularly on the banks of the Marasch, near Sarvoras, and have covered a circle of four Hungarian miles, in such numbers, that, independent of those killed by accident, we have felled and burnt four thousand baskets full. They consume the produce of the whole land.

Hermanstadt, 10th July.—Prayers are offered up in all places in which the quail and the locust have not as yet been sent. The latter are coming from Carlsbad here. The vineyards, which are wonderfully prolific, are alone untouched by these insects. Every other thing which they meet with on their march, the herbage, the forest leaves, and even the bread in the houses, is booty and food for them.

24th July.—To-day they have poured in on us in myriads, and we have in vain tried every thing to oppose their victorious career. Six thousand men sallied forth with flails and such other utensils, but all in vain. Yesterday a hussar, coming from the plague committee, saw such a host of these insects near Szanda, that they covered the country for a mile round, and were so thick that the hussar, though on horseback, was obliged to dismount and halt for three hours, until the inhabitants of the district, coming with all sorts of instruments, beat about, and forced, with loud cries, these locusts to quit the spot.

Warsaw, 17th July.—The accounts from Podolia, Volhynia, and the Ukraine, give terrible accounts of the locusts; they cover the country for miles, and are heaped up a foot high.

Breslau, 3d August.—The locusts still infest Podolia and the Ukraine; but as some great hailstones have fallen and crushed myriads, and the storks and other birds are flocking about them, we hope that this plague will be removed. The stench they cause is extremely disagreeable to travellers.

Labycrew, 25th July.—The whole of Starastey is in possession of the locusts, which cover the land in such clouds, one host pushed onwards by another, that in some places it is impossible to pass.

Warsaw, 15th August.—The locusts are within four miles of us. A few of the vanguard ushered in the rest, but none have reached the city. They divided themselves into four divisions, each of which took a separate direction. A certain prince sent out soldiers against them, and they fired not only with small arms, but cannons, upon which they divided, and thus got rid of the danger. On the other hand, the storks and cranes were unluckily frightened, for they consumed many of these insects daily. Travellers who come hither are obliged to walk knee deep among them, and endure a dreadful stench; and when they fly against the naked hand and face, they cause burning blisters on the skin, so that the sufferers become powerless through pain.

Falkenberg, 15th August.—I have just seen a sight which I never before witnessed in my life, the flight of the locusts which are coming from Poland. I never could imagine any thing so terrible. This day is beautiful; but before I could look round, a thick smoke came over us, as if a forest were on fire. This happened at twelve o'clock. A fearful sound accompanied the smoke, like the rumbling of stormy wind. The sun was darkened, and we could not see ten paces before us. The sky never poured down snow so thickly, as it teemed with locusts. Their course is orderly, as they all appear to go to one spot. Those which have settled here consume in a moment all herbage and garden-stuff to the very roots, and after a short halt fly off. It is now three o'clock, and the spectacle is not over.

Breslau.—On the 25th they went towards Biez, and their flight lasted four hours. The sun was so darkened, that they who were without could not discern the city.

London, 15th Aug.—Towards evening a dark black cloud was seen gathering in the east, which turned out to be a swarm of locusts. Many fell in the streets, and others in St. James's Park. They are no doubt a portion of the swarm which devastated Poland. The accounts from Norfolk state, that the trees are as leafless now as in winter. Luckily, however, these islands are and have been comparatively exempted from the awful visitations of this pest. The common people, not content, however, with the terrors of the scene, have added to them, by stating that some of these insects were seen as big as pigeons, the probability being that large birds were forced to take rapid flight, and, being seen to head the swarm, were mistaken for its leaders. Many people, too, have endeavoured to make out that, previous to the flight of the main body, the locusts send out scouts and a quarter-master general to reconnoitre the ground on which the whole are to settle.

It is no wonder, then, that from the earliest times, means have been resorted to to mitigate the horrors which the locust occasions. Pliny states that there was a law in Cyrene which compelled the inhabitants to destroy these creatures three times in the year; the first in their egg state, the second when they were hatched, and the third when the insect was mature. The inhabitants of Lemnos were obliged to bring a certain number to the authorities.

It is after the perusal of the above that we recognise the description given by the prophet Joel of their devastations, as sublimely characteristic: "A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning opened upon the mountains: a great people and a strong. A fire devoureth before them, and behind them a flame burneth. The land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. The appearance of them is as the appearance of horses, and as horsemen so shall they run. Like the noise of chariots on the tops of mountains, so shall they leap; like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. They shall run like mighty men; they shall climb the wall like men of war. And they shall march every one on his ways, and they shall not break his ranks; neither shall one thrust another. They shall walk every one on his path, and when they fall upon the sword they shall not be wounded. They shall run to and fro in the city. They shall run upon the wall. They shall climb up upon the houses. They shall enter in at the windows like a thief. The earth shall quake before them: the heavens shall tremble: the sun and moon shall be dark, and the stars shall withdraw their shining."

The neighbourhood of Arles in France was so infested by locusts, that a reward was offered for so much weight of them killed, and in twenty days the whole were exterminated. The people spread canvass, and going opposite to it set up great cries, which drove the insects against it. They were collected and sent in sacks to the government. In Italy a similar means caused twelve thousand sacks to be collected. Huge graves were made, and these collections rammed down into them and covered with quick-lime.

These insects, terrible scourges as they are to man, are nevertheless ministers of beneficial changes in the economy of nature. They clear away those rank and noxious weeds which choke the soil, and thus allow the earth to appear in a far more beautiful dress, clothed with new herbs, superb lilies, and fresh annual grasses and young shoots of the perennial kinds, affording delicious herbage for the wild cattle and game. They turn up and excavate the surface of deserts, in fulfilling their instinct of depositing their eggs; and as subsequent rains kill both them and their young brood, furnish a manure in places inaccessible to the approach of man.

They also serve as food, not only to birds, but even to man. Pliny mentions that it was an ordinary delicacy among the Parthians; and Diodorus Siculus asserts that the Æthiopians subsisted on them. Whenever visited by these insects, they pursued them with great cries, which causing them to fall they gathered them in heaps, and sprinkling them over with salt, thus preserved them for future use. Leo Africanus says that the Arabians and Lybians rejoiced in the coming of the locust, which they caught and ate either boiled or dried in the sun. Beda mentions that the poor of Palestine soaked these insects in oil and used them as food. In fact, most of the nations who have been visited by this pest have probably, in the first instance, been obliged to feed on the locust through necessity, and have continued it subsequently from choice.

The Jews evidently were not only allowed to consume these creatures, but actually did so, and the rabbins gave the marks by which the clean might be distinguished from the unclean species. It is conjectured too by some Hebrew scholars, that the word which is translated quail in Exodus refers to the locust. This word (selavim) says the anonymous author from whom I quote, was never thought either by the older or the later rabbins to be equivalent to quails, although they did not know what to make of it. Josephus, probably from a similar reason, was the first to translate it by quails, because the Greek word, used in the text of the Septuagint, has a great resemblance with that which signifies quail. And these authorities have been followed by our translators.

It is difficult to conceive how such a number of quails could be gathered together as to cover the surface for miles two ells high, how they could be caught when there, and how preserved sweet during the sojourn of the Israelites ; although all these difficulties disappear if, in the passage alluded to, the word be applied to the locust. Their manners, their forming the food of the surrounding nations, thei long continuance on the spots on which they settle seem to confirm the above conjecture, and leave the miraculous interposition of a special act undisturbed. That the food of John the Baptist, which was said to have been locusts and wild honey, was probably the insect and not any part of a tree, is probable from what has been already said. The earlier commentators of the Testament being ignorant of the fact of grasshoppers being used as food, thought that the achridas, which St. John ate, must have been achrodrica, or the buds of trees, and others read achradas, which, say they, means in Theophrastus the wild pear. A long and learned summary of the dispute is to be found in Aldrovandus.

The following extract from Niebuhr verifies some of the statements which have already been made, especially with regard to their devastations; but he states that the Arabians distinguish several kinds of these insects, to which they give separate names. They refer only to the delicacy of its flesh, and not to the nature of the insect. The red locust is termed Muken, as it is esteemed by the epicures much fatter and more succulent than the light locust, which is called by them Dubbe, because it has a tendency to produce diarrhœa. The inhabitants of Arabia, Persia, Africa, and Syria, are accustomed to eat them. The Turks have an aversion to this kind of food, but if the Europeans express the same, the Arabians remind them of their fondness for crabs, &c. This kind of food, however, is supposed to thicken the blood and produce melancholy. The noise they made, says Niebuhr, in flying, is frightful and stunning, like that of a waterfall, but it is compared by Bochart to the sound of a flame of fire driven by the wind, and the effect of their bite to that of fire.

Dr. Shaw, who was a witness of the devastations of these insects in Barbary in 1724, thus describes their habits. They first appeared in March, when the wind had been southerly for some time. In the beginning of April their numbers were so vastly increased, that in the heat of the day they formed themselves into large swarms, that appeared like clouds, and darkened the sun. In the middle of May they began to disappear, retiring into the plains to deposite their eggs. In June the young brood began to make their appearance, forming many compact bodies of several hundred yards square, which, afterward, marching forward, climbed the trees, walls, and houses, eating every thing which was green in their way. The inhabitants, to stop their progress, laid trenches all over their fields and gardens, which they filled with water Some placed large quantities of heath, stubble, and such like combustible matter in rows, and set them on fire on the approach of the locusts. But all this was to no purpose, for the trenches were quickly filled up, and the fires put out by the great number of swarms which succeeded each other. A day or two after one of these was in motion, others, that were just hatched, came to glean after them, gnawing off the young branches and the very bark of the trees. Having lived near a month in this manner, they arrived at their full growth, and threw off the worm-like state by casting their skin. To prepare themselves for this change they fixed their hinder part to some bush or twig, or corner of a stone, when immediately, by an undulating motion used on the occasion, their heads would first appear, and soon after the rest of their bodies. The whole transformation was performed in seven or eight minutes' time, after which they remained for a little while in a languid condition; but as soon as the sun and the air had hardened their wings, and dried up the moisture that remained, after casting off their sloughs, they returned to their former greediness with an addition both of their strength and agility. But they did not long continue in this state before they entirely dispersed: after laying their eggs, they directed their course northward, and probably perished in the sea. In that country, however, the amazing fertility of the soil, and warmness of the climate, generally render the depredations of these insects of little consequence; besides that many circumstances concur to diminish their number. Though naturally herbivorous, they often fight with each other, and the victor devours the vanquished. They are a prey too of serpents, lizards, frogs, and the carnivorous birds. They have been found in the stomachs of the eagle and different kinds of fowl. They are also used as food by the Moors, who go to hunt them, fry them in oil or butter, and sell them publicly at Tunis and other places.

The following interesting account of the ravages of the locust is given in the 46th vol. of Philosophical Transactions:—

"The first swarm entered Transylvania in August, 1747; these were succeeded by others, which were so surprisingly numerous, that when they reached the Red Tower they were full four hours in their passage over that place; and they flew so close that they made a sort of noise in the air by beating with their wings against one another. The width of the swarm was some hundreds of fathoms, and the height or density may be easily imagined to be more considerable, inasmuch as they hid the sun and darkened the sky, even to that degree, when they flew low, that people could not know one another at the distance of twenty yards; they were to fly over a river that runs by the valleys of the Red Tower, and could find neither resting-place nor food, but being at length tired of their flight, one part of them lighted on the unripe corn on this side of the Red Tower, such as millet and Turkish wheat; another pitched in a low wood, where, having miserably wasted the produce of the land, they continued their journey as if a signal had been given for a march. The guards of the Red Tower attempted to stop their irruption into Transylvania by firing at them; and, indeed, when the balls and shot swept through the swarm, they gave way and divided; but having filled up their ranks in a moment, they proceeded on their journey. In the month of September some troops of them were thrown to the ground by great rains and other inclemencies of the weather, and, thoroughly soaked with wet, they crept along in quest of holes in the earth, dung, and straw, where, being sheltered from the rains, they laid a vast number of eggs, which stuck together by a viscid juice, and were longer and smaller than what are commonly called ants' eggs, very like grains of oats. The females, having laid their eggs, die like the silkworm; and we Transylvanians found that the swarms which entered our fields by the Red Tower did not seem to intend remaining there, but were thrown to the ground by the force of the wind, and there laid their eggs; a vast number of which being turned up and crushed by the plough, in the ensuing spring, yielded a yellowish juice.

"In the spring of 1748, certain little blackish worms were seen lying in the fields and among the bushes, sticking together, and collected in clusters, not unlike the hillocks of moles and ants. As nobody knew what they were, there was little or no notice taken of them, and in May they were covered by the shooting of the corn sown in winter; but the subsequent June showed what these worms were; for then, as the corn sown in the spring was pretty high, these creatures began to spread over the fields, and became destructive to the vegetables by their number. Then the country people, who had slighted the warning given to them, began to repent of their negligence; for as these insects were dispersed all over the fields, they could not be extirpated without injuring the corn. At that time they differed little or nothing from our common grasshopper, having their head, sides, and back of a dark colour, with a yellow belly, and the rest of a reddish hue. About the middle of June, according as they were hatched, sooner or later, they were generally a finger's length or somewhat longer; but their shape and colour still continued. Towards the end of June they cast off their outward covering, and then it plainly appeared that they had wings very like the wings of bees, but as yet unripe and unexpanded; and then their bodies were very tender, and of a yellowish green; in order to render themselves fit for flying, they gradually unfolded their wings with their hinder feet, as flies do; and as soon as any of them found themselves able to use their wings they soared up, and flying round the others enticed them to join them, and thus their numbers increasing daily, they took circular flights of thirty or forty yards square until they were joined by the rest; and after miserably laying waste their native fields, they proceeded elsewhere in large troops. Wherever those troops happened to pitch, they spared no sort of vegetable; they ate up the young corn and the very grass; but nothing was more dismal than to behold the land in which they were hatched, for they so greedily devoured every green thing thereon before they could fly, that they left the ground quite bare. Different methods are to be employed against them, according to their age and state; for some will be effectual as soon as they are hatched, others when they begin to crawl, others, in fine, when they begin to fly; and experience has taught us here in Transylvania that it would have been of great service to have diligently sought out the places where the females lodged, for nothing was more easy than to have carefully visited those places in March and April, and to destroy their eggs and the little worms with sticks and briers, or, if they were not to be beat out of the bushes, dunghills, and heaps of straw, to set fire to them; and this method would have been very easy, convenient, and successful, as it has been in other places; but in summer, after they have marched out of their spring quarters, and invaded the corn-fields, &c., it is almost impossible to extirpate them without thoroughly thrashing the whole piece of land that harbours them with sticks or flails, and thus crushing the locust with the produce of the land. Finally, when the corn is ripe, or nearly so, we have found, to our great loss, that there is no other method of getting rid of them, or even diminishing their number, but to surround the piece of ground with a multitude of people, who might fright them away with bells, brass vessels, and all other sorts of noise. But even this method will not succeed until the sun is pretty high, so as to dry the corn from dew, for otherwise they will either stick to the stalks or lie hid under the grass; but when they happen to be driven to a waste piece of ground, they are to be beaten with sticks or briers; and if they gather together in heaps, straw and litter is to be thrown over them and set on fire. Now this method seems rather to lessen their number than totally to destroy them, for many of them lurk under the grass or thick corn, and in the fissures of the ground, from the sun's heat; wherefore it is requisite to repeat this operation several times in order to diminish their numbers, and consequently the damage done by them.

"It will likewise be of use, when a large troop of them has pitched, to dig a long trench of an ell width and depth, and place several persons along its edges, provided with brooms and such like things, while another numerous set of people form a semicircle, that takes in both ends of the trench and encompasses the locusts, and, by making the noise above mentioned, drive them into the trench, out of which, if they attempt to escape, those on the edges are to sweep them back, and then crush them with their brooms and stakes, and bury them by throwing in the earth again. But when they have begun to fly, there should be horsemen on the watch in the fields, who, upon any appearance of the swarm taking wing, should immediately alarm the neighbourhood by a certain signal, that they might come and fright them from their lands by all sorts of noise; and if, tired with flying, they happen to pitch on a waste piece of land, it will be very easy to kill them with sticks and brooms, in the evening or very early in the morning, while they are wet with dew, or at any time in rainy weather, for then they are not able to fly. I have already taken notice, that if the weather be cold or wet in autumn, they generally hide themselves in secret places, where they lay their eggs and then die. Therefore, great care should be taken at this time, when the ground is freed of its crop, to destroy them before they lay their eggs. In the month of September, 1748, we received certain intelligence, that several swarms of locusts had come out of Wallachia into Transylvania, through the usual inlets, and took possession of a tract of land in the neighbourhood of Clausenberg, three miles in length, where it was not possible to save the millet and the Turkish corn from these devourers."

In Dillon's Travels through Spain, we find the following account of the devastations of a species of locust in 1754, 55, 56, and 57. "The locusts are continually seen in the southern parts of Spain, particularly in the pastures and remote uncultivated districts of Estremadura, but in general are not taken notice of, if not very numerous, as they commonly feed upon wild herbs, without preying upon gardens and cultivated lands, or making their way into houses. The peasants look at them with indifference while they are frisking about in the fields, neglecting any measure to destroy them till the danger is immediate, and the favourable moment to remedy the evil is elapsed. Their yearly number is not very considerable, as the males are far more numerous than the females. If an equal proportion were allowed only for ten years, their number would be so great as to destroy the whole vegetative system; beasts and birds would starve for want of subsistence, and even man would become a prey to their ravenous appetites. In 1754 their increase was so great from the multitude of females, that all La Mancha and Portugal were covered with them, and totally ravaged: the horrors of famine spread even further, and assailed the fruitful provinces of Andalusia, Murcia, and Valencia. These locusts seem to devour, not so much from a ravenous appetite, as from a rage for destroying every thing that comes in the way. It is not surprising that they should be fond of the most juicy plants and fruits, such as melons, and all manner of fruits and herbs, and feed also on aromatic plants, such as lavender, thyme, and rosemary, which are so common in Spain, that they serve to heat ovens; but it is very singular that they eat equally mustard-seed, garlic, and onions—nay, hemlock, and the most rank and poisonous plants, such as the deadly nightshade and the thorn-apple; they will even prey upon crowsfoot, whose causticity burns the very body of beasts; and such is their universal taste, that they do not prefer the innocent mallow to the bitter furze, or rue to wormwood, consuming all alike, without predilection or favour, with this remarkable circumstance, that during the four years they committed such dreadful havoc in Estremadura, the love-apple, or *Solanum lycopersicon* of Linnæus, was the only plant that escaped their rapacious teeth, and claimed a respect to its root, leaves, flower, and fruit. Naturalists may search for their motives, which I am at a loss to discover; the more, as I saw millions of them alight on a field near Almaden, and devour the woollen and linen garments of the peasants, which were lying to dry on the ground. The curate of the village, a man of veracity, at whose house I was, assured me that a body of them entered the church, and devoured the silk garments that adorned the images of the saints, not sparing even the varnish on the altars. Out of curiosity to know the nature of so formidable a creature, I was urged to examine all its parts with the utmost exactness. Its head is of the size of a pea, though longer, its forehead pointing downwards, like the handsome Andalusian horse; its mouth is large and open, its eyes black and rolling, added to a timid aspect, not unlike a hare. In its two jaws it has four incisive teeth, whose sharp points traverse each other like scissors, their mechanism being such as to gripe or cut. Thus armed, what can resist a legion of such enemies?

"The locust spends the months of April, May, and June, in the place of its birth. At the end of June its wings have a fine rose colour, and its body is strong. Being then in their prime, they assemble for the last time about ten o'clock, when the warmth of the sun has cleared their wings from the dampness of the night; the males and females rise together five hundred feet high, forming a black cloud that darkens the rays of the sun; the clear atmosphere of Spain becomes gloomy, and the finest summer's day of Estremadura more dismal than the winter of Holland. The rustling of so many millions of wings in the air seems like the trees of a forest agitated by the wind. The first direction of this column is always against the wind; which, if not too strong, the column will extend about a couple of leagues; the locusts then make a halt, when the most dreadful havoc begins. Their sense of smell being so delicate, they can find at that distance a cornfield or a garden, and, after demolishing it, rise again in search of another; this may be said to be done in an instant. Each seems to have four arms and two feet. The males climb up the plants as sailors do the shrouds of a ship, and nip off the tenderest buds, which fall to the females below."

Many old people assured Mr. Dillon, when so much mischief was done in 1754, that it was the third time in their remembrance, and that they are always to be found in the pasture-grounds of Estremadura, whence they spread into the other provinces of Spain.

There exists several kinds, each of which inhabits various portions of the earth. One of the largest of this tribe measures four inches long, and from the tip of one wing to the tip of the other eight inches. This is salted, and sold in the Levant markets. The females are considered by the epicures to be more delicate and more edible than the males, owing to the ovaries. An immense army of another species devastated the Mahratta country. The column extended five hundred miles, and was so compact, when on the wing, that, like an eclipse, it completely hid the sun, so that no shadow was cast by any object, and some lofty tombs two hundred yards distant were rendered quite invisible. To add to the horror of the scene, they were not the *Locusta migratoria*, but a red species, so that after they had devoured every thing and clustered on the branches, the trees appeared to be dripping with gore.

The South African locust, Mr. Barrow tells us, might be said to cover a surface of the ground for the space of two thousand square miles. So numerous were they, that they effectually hid a large river, and those which lay on the surface were so thick that the water was rendered invisible by them. When these insects attack a cornfield, they mount on the top and pick out the grain before they devour the leaf or stem. And when the larvæ, which are still more voracious than the parent insect, are on the march, it is impossible to make them turn out of their way, which is usually that of the wind. At sunset the troop halts and divides into separate groups, each occupying in bee-like clusters the neighbouring eminences for the night. One of the modes of destroying these destructive creatures is now practised by the colonists, who turn a large flock of sheep among them, and thus secure an immense number of them being trodden to death. In a former visitation of this plague, all the full-grown insects were blown into the sea by a hurricane, drowned, and cast up again in such quantities as to form a bank more than a yard in height and nearly fifty miles long. The stench arising from their carcasses was sensible in Sneeuwberg, a distance of a hundred and fifty miles from the coast.

The species which is termed the wart-eating locust has earned its name from the fact of the common people of Sweden catching them for the purpose of destroying warts on the hand and elsewhere. The creature is made to bite the excrescence, and at the same time it discharges an acrid liquor on it. The mode of cure would doubtlessly be efficacious, provided the insect does bite and does discharge the corrosive fluid, for it is well known that mechanical or chymical injuries to a part possessed of such a low degree of vitality as a wart speedily kill it, and cause it to drop off. The prickly grasshopper, however, would answer the purpose most effectually, if we are to credit Mr. Jackson's account of the powers of its teeth. "I have" (in India) says he, "caught some locusts of an extraordinary size, and very thick in proportion to their length. They have no wings, move slowly, and are easily taken. I soon found it necessary to be careful that they did not bite me, for I am persuaded they could easily have bitten my finger to the bone. I tried one with a twig about as thick as a quill, which it bit through instantly. I then dissected one, and on examining one of its grinders, found it nearly as large as a human tooth, and so hard that I was not able to make any impression on it with my penknife. The grinders were nearly the colour of mahogany. Finding that we were not molested by flies or other insects, and ascribing this circumstance to the excessive heat of the sun at this season, I made the experiment on one of these large locusts by exposing it to the sun, which actually killed it in less than an hour. I also found that flies, when exposed in the middle of the day, fell down almost instantly, and that all kinds of insects must either get into some shade or inevitably perish."

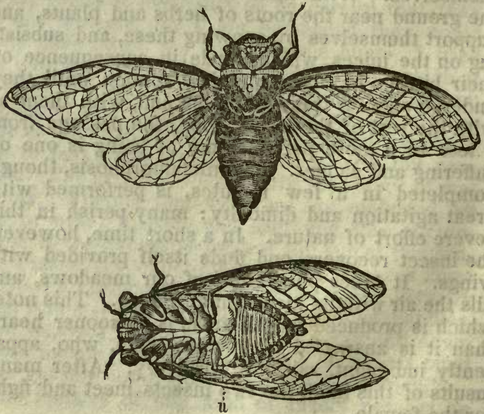
The females of this kind of insect possess an amazing fecundity, and generally lay from five hundred to seven hundred eggs at a time. The ovipositor is composed of two flat blades, which are turned up at their extremities somewhat like a cutlass. With this instrument the eggs are deposited in a little chamber formed in the earth with great art. After they are deposited in a fit place, they remain in their respective chambers, shielded from the cold, during the whole of winter, till the heat of spring begins to hatch and vivify them. About May each egg produces a larva, which at first is quite white, but soon turns of a brown colour. The parent having now fulfilled the purposes of nature, seems speedily to grow old, withered, and decrepit, and dies. The young, however, after having escaped from the egg, remain within the egg-chamber, protected from external injuries, until they have acquired bulk and strength sufficient to protect themselves. The larvæ now begin to shift for themselves. With their two legs they excavate the ground near the roots of herbs and plants, and support themselves by gnawing these, and subsisting on the juices, which exude in consequence of their bites. In this state they remain until they undergo another transformation, and, with them as with the rest of the insect tribe, the passage from a less to a more perfect state of being is one of suffering and danger. The metamorphosis, though completed in a few minutes, is performed with great agitation and difficulty: many perish in this severe effort of nature. In a short time, however, the insect recovers, and finds itself provided with wings. It takes possession of our meadows, and fills the air with its incessant chirpings. This note, which is produced by the male, is no sooner heard than it is answered by another male, who, apparently indignant, raises a shrill cry. After many insults of this kind, the two insects meet and fight for the female.

CHAPTER XIII.

NATURAL HISTORY OF THE CICADA.

Organs of Sound—History of the North American Species—Its Habits—Its Metamorphosis—Probably two Varieties—Eaten by Animals—Its Ovipositor—Manner of laying its Eggs—Period of Life—Used in making Soap—History of the Cuckoo Spit—Its Metamorphosis—Its Habits—History of the Cicada goudoti—Its Envelopement in the Sap of Plants—How discharged like Rain—Quantity—Whether any Pernicious Qualities—History of the Cicada limbata—Its Wax, &c.

We call that sound the voice which is emitted from the lungs through a windpipe. Insects which have neither of these organs cannot be said to possess a voice. If, however, we extend the significa-



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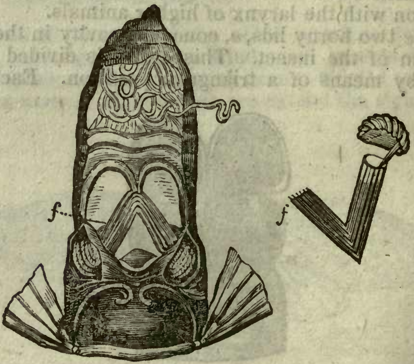
tion of the term, and call those sounds vocal by which animals determine others of their own species to perform certain actions, then insects may be said to have vocal organs; and those of the cicadæ amply merit our attention.

On the under surface of the male insect, two semicircular pieces, of a horny substance, are placed, as represented in the lower figure by the letter *u*. If these be lifted up, we cannot fail being struck with the complicated apparatus which is now exposed to view. The same care, the same excellence of workmanship, is displayed in contributing to the wants of these insects, as in those of man; and the organs by which the cicada calls its male will bear a comparison with the larynx of higher animals.

The two horny lids, *u*, conceal a cavity in the abdomen of the insect. This cavity is divided into two by means of a triangular partition. Each of

the two cells or cavities appears to be lined with a looking-glass, *m*; and children, who amuse themselves by catching these insects, are pleased with the rainbow teints which they see when the light falls obliquely on these lustrous membranes. Such is their transparency, that the cicada appears to have two windows, through which the curious eye is permitted to look into the interior of its mysterious organization. As soon as it is known what is under these windows, it appears probable that the two cells, and the membranes so accurately extended in them, are destined to modify those sounds, which, however inharmonious to our ears, are doubtlessly pleasant music to those for whom they are intended. The transparent membranes have been supposed by many to be a kind of drum, which, being struck, produces the peculiar sound of the cicada. Nevertheless, none of the parts already described are the true organs, for these are only to be seen when the dissection of the insect is made from the back. The two strong muscular bands are attached to two hol-



low, uneven, membranous bodies, *f*. When the muscles contract, the membranous bodies, which are fixed, become indented in some part of their circumference; and when the muscles are relaxed, the part resumes its former shape; and it is by this play of an elastic membrane, which becomes alternately concave and convex, that the peculiar sounds of this insect are produced. The air, agitated by the membrane, is modified by the other cavities. In order to make the proof quite clear, the reader has only to indent those membranous bodies with a pin, and the membrane will speedily resume its ordinary form; in doing so he will be gratified by hearing the much vaunted melody of a cicada, although it may have been long dead.

All this complicated apparatus is put into use by these insects with incessant industry. They begin their shrilling music early in the morning, and continue their clamorous invitations to the female during the heat of the noontide sun. To many the animated chirp of the cicadæ is very agreeable. The country people associate it with a presage of fine weather, plentiful harvest, and the sure return of a propitious spring. The Greeks loved the music and kept the cicada in cages for the pleasantness of their sound. They gave the same name to the sound of the harp and to the chirp of the insect. The symbol for music was a cicada sitting on a harp, which is said to have been founded on the following tale. Two rival musicians, Enomus and Ariston, were alternately contending for the prize; when one of them had the misfortune to break a string of his lyre, a cicada immediately settled on his instrument, and supplied the defective string so efficiently by the melody of its own notes, that the favourite candidate obtained the victory. At Surinam the sound of a species of cicada is still supposed so much to resemble the notes of the harp or lyre, that they are called harpers, liermann, or lyre-player. The Athenians were so attached to these insects that they were accustomed to decorate their hair with golden images of them, implying, at the same time, a boast that they themselves, as well as the cicada, were terræ filii. They were everywhere regarded as the gladdest and most inoffensive of creatures.

"Happy creature! what below
Can more happy live than thou,
Seated on thy leafy throne,
Summer weaves the verdant crown.
Sipping o'er the pearly lawn,
The fragrant nectar of the dawn.
Little tales thou lov'st to sing,
Tales of mirth—an insect king.
Thine the treasures of the field,
All thy own the seasons yield;
Nature paints thee for the year
Songster to the shepherds dear;
Innocent, of placid fame,
What of man can boast the same.
Thine the loudest voice of praise,
Harbinger of fruitful days;
Darling of the tuneful nine,
Phœbus is thy sire divine;
Phœbus to thy note has given
Music from the spheres of heaven;
Happy most as first of earth
All thy hours are peace and mirth,
Cares nor pains to thee belong,
Thou alone art ever young.
Thine the pure immortal vein,
Blood nor flesh thy life sustain;
Rich in spirits—health thy feast,
Thou art a demi-god at least."

However agreeable the sound of the cicada may have been to Grecian ears, all have not been disposed to find the same enjoyment in their music. In the hotter months of summer, says Dr. Shaw, especially from the mid-day to the middle of the afternoon, the cicada is perpetually stunning our ears with its most excessively shrill and ungrateful noise. It is, in this respect, the most troublesome and impertinent of insects, perching upon a twig, and squalling sometimes two or three hours without ceasing, thereby disturbing the studies or the repose which is frequently indulged in those hot climates at these hours. Those of Africa may be heard half a mile off; and the sound of one in a room will put a whole company to silence. Thunberg asserts that those of Java utter a sound as shrill and piercing as that of a trumpet. Capt. Hancock informed Mr. Kirby that the Brazilian cicadæ sing so loud as to be heard at the distance of a mile. The sound of the North American has been compared to the ringing of horse-bells. The tettix of the Greeks must have had quite a different voice, more soft, and surely more melodious, otherwise the fine orators of Homer, who are compared to it, can be looked upon as no better than loud loquacious scolds. To excel the cicada in singing was the highest commendation, and the music of Plato's eloquence was only comparable to the voice of this insect.

The females are not capable of making any noise, which appears to have been well known to the ancients, for the Rhodian poet Xenorchus says,

> "Happy the cicadas' lives,
> Since they all have voiceless wives."

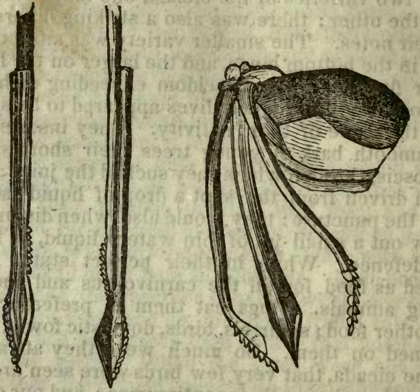
Aristotle mentions these insects as a delicious food; he preferred the young males, but more especially the females prior to their laying their eggs.

The simultaneous appearance of the *Cicada septemdecim* over a vast extent of country, and the countless myriads of their numbers, equally arrest our attention. We are informed that "they have made their appearance at Marietta, Ohio, North America, at three different periods since their first settlement, viz.: in the year 1795, again in 1812, and again in 1829; they commence their ascent from the earth the last days of May and first days of June, and disappear the beginning of July, two or three days earlier or later, according to the temperature of the season.

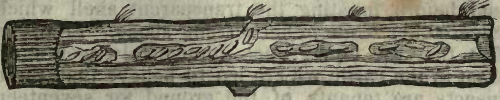
"The month of May," in the year 1829, "was very warm, and the cicadæ made their appearance rather earlier than before. By the 15th of the month they had risen so near to the surface of the earth, that the depth of a common furrow in ploughing, turned them out in their chrysalid state. By the 24th they had begun to arise from the earth, burst their transparent covering, and expand their wings. From this time to the 10th of June their numbers daily increased, until woodlands and orchards were filled with countless multitudes; a continual singing or screaming was kept up by the males, from sunrise till evening, and so loud that on a calm morning the sound was heard a full mile.

"They appeared only in situations which were covered with trees, as was the fact when they were here in 1812, thereby proving that they had not wandered far in their journey of seventeen years. The earth was perforated like a riddle with holes about a third of an inch in diameter. In an orchard in this town, the observer counted twenty-five holes in a square foot; and an intelligent friend told him that he had seen more than double that number in the same space. When the trees were not near each other, the ground underneath them was covered with their skins or cast-off robes to the depth of two or three inches. These shells retain the exact figure of the insect when it leaves the earth, with a rent on

the back, through which the cicada creeps, as from a coat of mail, and then firmly fastened by the feet to the bark and twigs of trees and bushes until it is thrown down by the wind or rain, instinct leading it to seek the nearest tree, bush, or post, as soon as it leaves the earth: there it remains until it has left its shell for some hours, or until its wings are dry and sufficiently strong for flying. There appeared to be two varieties of the cicada, one much smaller than the other: there was also a striking difference in their notes. The smaller variety was more common in the bottom lands, and the larger on the hills. Their flight was short, seldom exceeding eight or ten rods, and their whole lives appeared to be spent near the place of their nativity. They inserted in the smooth bark of young trees their short sharp proboscis, through which they sucked the juice; and when driven from the spot a drop of liquid issued from the puncture: they would also, when disturbed, throw out a small jet of thin watery liquid, as if in self-defence. While in their perfect state, they served as food for all the carnivorous and insect-eating animals. Hogs eat them in preference to any other food; squirrels, birds, domestic fowls, &c., fattened on them. So much were they attracted by the cicada, that very few birds were seen around our gardens during their continuance; and our cherries remained unmolested. By the fourth or fifth day after they left the earth, the female began to deposite her eggs in the tender branches of most kinds of orchard and forest trees. She generally selected the wood of the last year's growth, and commenced her task on the underside of the twig, by slitting the bark with her puncturing instrument." This is made of two files, which are so held together by a third piece as to allow them to play alternately, and, at the same time, to keep them parallel to each other, in order that the alternate movement of these two files should be exactly in the same plane. There is a beautiful arrangement of ridges and furrows to receive them in the different pieces composing the ovipositor, so nicely adjusted, that, while we marvel at the skill of the contriver, we cannot but be surprised at the perfect ease with which the effect is produced. After the insect had made a hole in an oblique direction to the pith of the branch, she withdrew the instrument



a little way, and deposited an egg through the tube in the punch. This was repeated until from ten to twenty eggs were deposited on each side of the centre of the pith, the centre wood having been previously comminuted and cut up, so as to make a soft bed for the eggs, and afford food for the embryo until it was hatched. There was daily an evident increase in the size of the eggs until they were hatched, and an evident diminution of the comminuted woody fibres and enlargement of the cells containing the eggs, so that they must have derived some sustenance from the juices of the twig. Another proof that they did so was, that the eggs invariably perished in those branches which withered and dried up soon after the punctures were made. This work continued from day to day, until the female had expended her stock of eggs, which, so far as our author ascertained amounted to about 1000; other writers reckoned only 600. When this operation was completed, the



object of her existence seemed to be fulfilled, and in a few days she dwindled away and died; the whole period of the life of a single individual, from her leaving the earth to her death, averaged from twenty to twenty-five days. The life of the male continued for nearly the same time. When the cicadæ first leave the earth, they are plump and full of oily juices, so much so that they were made use of in the manufacture of soap, but before their death they were dried up to mere shells; and they have been seen to fly a few feet after one half of their body was wasted away, and nothing remained but the head, wings, and thorax. From the time the eggs were deposited to the period of hatching, was, as nearly as could be ascertained, sixty days, and almost daily attention was given to the subject. When first placed in the twigs, the eggs are about the sixteenth of an inch in length, and the thickness of a coarse hair, appearing through a small magnifying-glass of the shape and size of a grain of rye. At the period of hatching they had increased about one third in size. They are white and transparent just before hatching, with a black spot on the large end. They are placed very closely by the side of each other, in an oblique direction to the line of the twig. Several portions of the branch of an apple-tree, full of the eggs ready to hatch, were placed on a bowl of earth, with a glass tumbler inverted over them, in the afternoon. By morning nearly a hundred young cicadæ were found in the earth, and a few on the surface, who had just left the woody cells. They were about a twelfth of an inch in length, with the exact shape, colour, and appearance of the parent when she first comes to the air, and before bursting the transparent shell which covered her while in her terrene abode. From the fact that the young ones immediately seek a retreat in the earth, we are led to believe that these insects are tenants of the ground for seventeen years, and until He who created them again calls them forth to propagate their kind, to fulfil their destiny, and die.

Another species is peculiar for being always found imbedded in a white froth, generally called cuckoo spit, which is often to be seen on the branches of plants and the blades of long grass. If this be carefully examined, a little grub or larva of the *Cicadæ spumaria* will be discovered immersed in it. This mass of froth is found during the advanced stage of summer, and is the production of the included larva, which, from the time of its hatching from the egg, deposited by the parent insect, continues at intervals to suck the juices of the stem on which it resides, and to discharge it in the form of very minute bubbles; and, by continuing this operation, completely covers itself with a large mass of froth, which is sometimes so overcharged with moisture that a drop may be seen falling from its under surface. When the insect is about to undergo its change into a perfect state, it ceases to absorb any longer the juices of the plant, and to discharge the projecting froth, which, at this period, forms a vaulted canopy over the insect, instead of entirely investing it as before. Its colour, when perfect, is brown, with two whitish bands across the fore wings. It has the power of springing to a great distance, which has caused it to be commonly called the froghopper, from a supposed resemblance to that animal in miniature.

In the Island of Madagascar is found a species, which, in some respects, agrees with the one just described. During the mid-day heat, a copious and refreshing supply of limpid dew, or rather rain, may be seen to fall from the branches of the trees, which is caused by the larvæ of *Cicada* (*Aphrophora*) *Goudoti.* The larvæ are found in clusters, enveloped by a whitish froth very similar to the cuckoo spit. They are in constant agitation, and pressing eagerly upon each other in their attempts to apply themselves to the surface of the bark, from which they extract the sap in such quantity as to maintain their bodies in a state of saturated humidity. This sap is afterward discharged, and forms drops of small size, which are gradually collected into larger drops, and appears to escape from the bodies of the larvæ with a rapidity proportioned to the action of the solar rays. The activity of the larvæ is, in fact, increased in a corresponding degree with the increase in the atmospheric temperature. Towards evening, and when the influence of the solar rays is sensibly diminished, the production of the fluid, thus singularly secreted, is partially suspended, and the drops fall slowly; as the night advances a few rare and tardy drops are heard at distant intervals, until at last they altogether cease, to be renewed with the first rays of the morning sun. When fifty or a hundred such clusters of larvæ are placed, as often happens, on the same tree, it may well be imagined that the secretion may become sufficiently copious to assume the appearance of actual rain. In a mass of sixty or seventy individuals, about half grown, the sun being powerful, the drops were very large, and fell in quick succession. The observer estimated, that setting aside the loss by evaporation, and by the animals which drank from the vessel, he could have filled a bottle, containing about a quart, in an hour and a half. The limpid character of the water encouraging the belief that it was free from any pernicious qualities, he tasted it, and found no unpleasant flavour: he also gave it to some fowl, without producing any inconvenience. When exposed to the air, however, it speedily loses its transparency. Even after the insect has obtained its perfect state, it continues to emit, at different intervals, small drops of liquid.

The Chinese are indebted to a species of cicada for a white wax, which is much valued. The larva of the *Cicada limbata* forms a sort of grease, which adheres to the branches of trees and hardens into wax. In autumn the natives scrape it from off the trees, melt, purify, and form it into cakes. It is white and glossy in appearance, and, when mixed with oil, is used to make candles, and is said to be superior to the common wax, for use. Sir George Staunton informs us, that he saw them busily employed upon the small branches of a shrub. They did not much exceed the domestic fly in size, and were of a very singular structure. They were in every part covered with a kind of white powder, and the branches they most frequented were entirely whitened by this substance strewed over them.

CHAPTER XIV.

NATURAL HISTORY OF THE EPHEMERA OR MAYFLY.

An account of the Larva and Pupa—Their Differences—The formation of their Fins or Breathing apparatus—The Larva of another kind of Ephemera—Their Habitations—Habits of the perfect Insect—Manner of changing its Skin—Of laying their Eggs, &c.

The insect whose habits are now to be described, has long been known to the naturalist as a delicate and fragile creature; while the moralist has at all times found an apt emblem of human life in the history of this "being of a day." To some, indeed, even this short length of perfect life is not allowed, since their existence does not extend beyond a few hours, which is sufficiently long to enable the insect to soar from the waters into the air, to perpetuate its kind and die.

The ephemera or Mayfly, however, undergoes the same number of metamorphoses as the rest of insects. As worm and nymph it is an inhabitant of the waters, where it acquires its growth so slowly, that with regard to the length of these portions of its life, it has been at least as well treated as the rest of insects. Swammerdam asserts that the ephemeræ continue two or three years in their larva and pupæ states; and that it is only when they have attained to the utmost perfection of which their organization is susceptible that they so speedily perish.

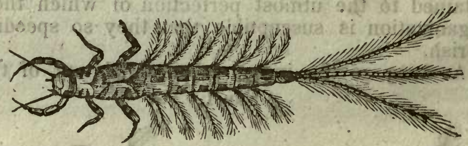
As long as the insect is an inhabitant of the

Fig. 1.

Fig. 2.

waters, its form, under the states of larva and pupa, varies so little as to deceive all but the keen eye of an entomologist. Nevertheless, the winglets attached to the pupa (fig. 1), will in vain be sought for in the larva (fig. 2); in every other respect there is similarity of form and of function. Some of these worms pass their lives in habitations, each one in his own. This is nothing but a hole formed in the bed of a river; others, on the contrary, may be termed wanderers; and they are sometimes seen to swim, sometimes to walk on the various substances found in the water; and sometimes they remain tranquil and concealed under a stone.

Those which are stationary offer the spectator a very amusing spectacle. On each side of the body of the insect little prolongations gush out, which are



moved with the rapidity of lightning, described as fins by some; while, on the contrary, others have regarded them as oars; and the little insect thus fashioned has been compared to an antique galley. But a moment's consideration will suffice to rectify the error; for it is observed, that the time during which the supposed fins or oars are in the greatest agitation, is that at which the larva is in repose.

The oars or fins, however, are the instruments by which the insect breathes its lungs. To those who are not familiar with the study of comparative anatomy, it will appear strange that the lungs should be placed on the outside of the body of any animal, and that the function of respiration should be performed by a rotatory motion of little tubes. Nevertheless, the gills of fishes present a familiar example of the essential parts of a similar fact; these are the breathing organs of this class of animals, and in them the blood is vitalized by the contact of such air as is contained in the water, as the latter fluid is admitted or ejected by the alternate opening and shutting of these organs.

In examining the structure of these organs in the different kinds of ephemeræ, the reader will be astonished to find such a variety of form in parts destined to perform the same function. In the two following figures the construction of this singular apparatus is admirably shown. Fig. 1 represents

FIG. 1.

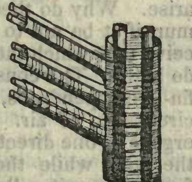


FIG. 2.

one of the tracheæ or breathing-tubes magnified, which has been removed from that kind of ephemera that has been likened to a galley. A common trunk gives rise to two large branches, from each of which smaller ones, of a conical form, are given off diametrically opposite each other and at equal distances.

Of the smaller branches, those which are nearest to the common trunk are the largest, and those farthest from it the smallest, consequently the general arrangement of these tubes is conical. The second figure represents a small portion of the branch, which has been cut off and much magnified. The large branch, which appeared simple in its construction in the first figure, is here seen to contain within its cavity two tubes; each of the filaments which project from the large branch is also to be seen hollow, and to contain within their respective cavities two still smaller tubes. These vessels, which preserve their shape under all circumstances, and consequently cannot be membranous, are thus far similar to the air-tubes of insects. In order to be convinced of the fact of their being the respiratory organs of the ephemera, we must examine the body itself of the insect, and we shall find at the origin of each fin two air-tubes, which terminate at that part of the common trunk from which the two branches arise. Why do these air-tubes go there, says Reaumur, if it be not to carry air to these fins, or to receive that which the fins bring to them; or rather, to do both? The constant and rapid action of these fin-like appendages, seems necessary for a prompt circulation of air. Probably the turning of these organs in one direction may further the entrance of the fluid, while the turning in the contrary may further its exit. Reaumur conjectures, that a complete knowledge of the mechanism of respiration in this species of ephemera would afford valuable hints for the improvement of our pumps.

The larvæ of other kinds of ephemera have their respiratory organs planted perpendicularly along the whole length of their bodies (fig. 1). At first sight each fin appears to be composed of two leaves (fig. 2), but on closer inspection it will be seen that this appearance arises simply from the peculiar manner in which each fin is folded. By spreading it out it exhibits a semicircular expanse, in which the air-tubes ramify like the veins in a rose-leaf (fig. 3). These veins or nervures are hollow and cartilaginous. The insect, like the other already described, moves the fins constantly; not, however, in a circular direction, but from before backwards, and the reverse.

FIG. 1.

FIG. 2.

FIG. 3.

In a third species of ephemera the fins are laid flat along the back, and in these the organs of respiration consist of two distinct leaves. Each leaf is divided into two nearly equal parts by a large hollow tube, which traverses it, and thus probably conveys the air, by means of little thread-like ves sels which arise from its sides, to the minute emi

nences which fringe the edges of the leaf. This species of larva rarely swims about, but remains concealed in little holes which they have pierced in the banks of the river. These holes are ordinarily directed horizontally, and their apertures are oval (fig. 1). At first sight these innumerable holes appear to be placed confusedly and without any symmetry; nevertheless it may be observed, on a nearer inspection, that some are much larger than others, and that the large ones are very oval and stand isolated, while the small ones are more circular, and are placed in pairs on the same horizontal line; after a slight examination, the reason of the proximity of the smaller circular holes is apparent, for the two apertures are found to belong to one habitation, and the dwelling of our ephemeræ observed to be not so simple as that of the earth-worm. It is, in fact, a bent tube (fig. 2); and the advantages of such a construction are evident. The insect, after entering, can go out without crawling backwards, or without making that awkward turn which it would be forced to do if in a straight hole; in fact, our ephemera has a door for going in and another for coming out. The large oval holes are caused by the parti-

FIG. 1.

FIG. 2.

tion between the two smaller ones being washed away. These habitations are always made in a soft soil; but, should necessity force the insect to provide a habitation in a coarser soil, it takes especial care to protect its tender body by lining the inside of its dwelling with fine earth.

As the entrances to its dwelling are situated below the surface of the water, the insect is surrounded by the element, and lives for two years in perfect security within its retreat. With this, as with many other insects, its house not only shelters, but feeds it; for it is easy to perceive through its transparent body that its intestines are filled with the same earth in which it has constructed its dwelling: it is probable that the soil is impregnated with some nutritious substance which the insect's organization appropriates After having sojourned within these dens for nearly two years, and changed them as often as its increase of bulk demanded a more spacious lodgment, the insect undergoes those transformations which permit it to enjoy in another element a momentary existence.

Nevertheless, short as this term of life is, they are surrounded at the very threshold of their new existence with the most imminent peril. The transformation which is to convert the aquatic into the aerial being is attended with all those risks which we have seen attend the gnat: the ephemera is at the mercy of a gust of air; if once thrown off its balance while endeavouring to extricate itself from its larval skin it is lost for ever, for it has nothing to dread so much as the element in which it has lived so long. When, however, the insects have once become fitted for their new mode of life, they burst at sunset from the banks of the river which they have inhabited, in such incredible numbers as to offer a spectacle which can only be adequately described in the words of Reaumur. "The cries of my gardener,' says this naturalist, "attracted my attention to a spectacle which is scarcely to be conceived, much less expressed. The snow, when it falls most thickly and in the largest flakes, could not fill the air more than it was filled by these ephemeræ." The steps on which Reaumur stood were covered by layers of these insects, measuring in no place less than two or three inches in depth; in most, more than four. The surface of the water was covered for a space of six feet square by a mass of these insects, and as the current slowly bore them onward, the space was speedily filled by an equally plentiful supply. This living rain more than once obliged him to quit his station, for his mouth, nostrils, and eyes were filled by the incessant showers of these insects, which, striking his face, incommoded him much. They who held torches were surrounded by swarms of these insects, which, arranging themselves in innumerable circles around the flame, attracted the attention of the most incurious. Whether this was an optical delusion, as Kirby shrewdly conjectures, or whether they really were zones of living beings flitting round the pure element, is not quite clear. But the individuals which composed these circles ranged only for a very few seconds round the torch, and then fell on the ground, or perished on the earth.

It is thus that these creatures burst forth from the waters: it would appear, however, that though the time of the year in which they become aerial beings differs in different countries, yet the insects of the same country appear at the very same time each year; nay, further, the very hour of the day at which they should rise from the water into the air is fixed to such a nicety, that on each succeeding day these swarms of insects come forth at the precise instant at which they had appeared the preceding day. "Whatever," says Reaumur, "may have been the temperature, whether the day has been sunny or rainy, the hour at which our ephemeræ begin to extricate themselves from their skin is invariably the same; and there is another hour fixed, later than which it is not permitted them to commence their task. In less than two hours these insects quit the water, form immense clouds, fall in thick and continuous showers, and then leave the air. It is in vain to venture to conjecture on the nature of these influences, which act on such myriads of living beings simultaneously. The fact that the wonderful and complicated organs of such myriads of isolated insects should be set into motion at once for purposes which are evident, incontestably excludes all idea of chance, and proves order and design."

No insect executes an operation at once so important and laborious with equal celerity. We do not draw our arms from the sleeves of a coat more quickly than the ephemera extricates its body, wings, legs, and the long caudal appendages, from a sheath in which these various parts are folded and cramped up. We could hardly expect that an insect, which, when perfect, is so frail and delicate, could exert in its imperfect state so much force as the act of getting rid of its larval skin appears to demand. It would seem, however, that the address and strength necessary to effect its emancipation, is supplied at the moment of need by a power independent of the will of the insect. Swammerdam's experiments prove that every part of the body of the insect is in itself capable of its full development. He detached a wing still enclosed within its larval skin; it immediately unfolded itself, and attained all the natural dimensions which it would have acquired had it still remained in its natural situation, communicating with the vessels of the insect's body. Reaumur crushed the head of these creatures while in the very act of transformation; nevertheless the metamorphosis was performed with the same celerity as if the cruelty had not been practised. Neither did immersion in spirits of wine prevent the completion of the change. The insect burst through its trammels, and instantly perished.

This operation must not be compared, however, to the one by which we throw off a simple vest. The aerial insect has no need of those implements with which it dug its little cavern, and lived and moved in the waters; consequently all those parts peculiar to the aquatic insect, such as teeth, pincers, the air-fins, and all its wonderful play of organization, are cast away in a moment by the prodigal hand of nature.

The females of the ephemera seem to be born only to perpetuate their species, and accordingly, as soon as they can use their wings, so soon they begin to lay their eggs; a creature whose life in a perfect state is comprised in a few hours, cannot afford to waste the precious moments; nature, therefore, has foreseen and contrived that her object should be thoroughly attained in the shortest time; and few insects are more prolific than the ephemera. They lay about eight hundred eggs, nevertheless they are deposited in a shorter time than another insect would consume in laying only one. The creature is so organized, that the whole of its eggs are neatly arranged into two packets, each a quarter of an inch long, and about one line broad, and are glued together in each pocket by a cement soluble in water; and these are ejected at the same moment. Is there no design manifested in the arrangement of this part of the insect's organization, no forethought displayed in regulating the exigences of its functions to the shortness of its life?

These two bunches of eggs are deposited by the parent in the water, where, from their greater specific gravity, they sink to the bottom, and the grains separate; so great, however, is the necessity of laying, that instinctive selection does not appear to have been granted to our insects; for Reaumur remarked, that the eggs were deposited on all substances indiscriminately. Hurried as the operation is in such creatures, one would naturally suppose that they who had so much to do in their short life, surrounded with the same dangers as if the natural term of existence were longer, would not be required to do more in that short period than the rest of their tribe, but would be exempted from ordinary labours; but nature has crowded into their short life an operation to which other insects are not subjected. After they have gone through the ordinary metamorphoses common to most insects, and when they are apparently perfect insects, they again cast their skins and change a vestment which has scarcely time to become old.

CHAPTER XV.

THE NATURAL HISTORY OF VARIOUS OBNOXIOUS SPECIES OF DIPTEROUS INSECTS.

Distribution of Species and Individuals—Housefly—Structure of its mouth—Power of walking against Gravity—Ovoviviparous Flies—The Blowfly and Blue-Bottlefly—Wheatfly—Hessianfly German Wheatfly—Choral Dances of Summer and Winter Midges—Midnight Gyrations of Midges—Gnat.

One of the most interesting questions connected with zoological science, is that which has reference not only to the numerical distribution of the *species* of animals, but to that of *individual specimens* of any given species. In a state of nature, it is perhaps undoubted, that the larger the animal the fewer will be the individuals of which its species is composed; although it cannot be questioned that the quantity of each is limited by a far higher consideration, namely, that of apportioning the number of each to its allotted work in the grand system of the creation. This is a point of view in which zoologists in general seldom look at the subject, their attention being rather directed. in the majority of instances, to the peculiarity of structure of any particular animal; and if they do endeavour to trace the intimate connexion between "uses and things," it is rather with a view of ascertaining the connexion between a particular structure, and the function which it is destined to perform: yet it will not be denied, that in a far higher and more philosophical spirit, the plan of the creation, or, as St. Pierre has not unaptly expressed it, "the harmonies of nature," must be studied with reference to the general agency, not of individuals, but of the varying masses of living objects of which each species is composed.

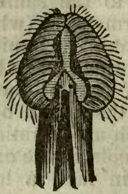
Leaving out of our present consideration the interesting portion of this question which has reference to the proportion of vegetable feeding animals, and limiting our inquiry to the legitimate object of these volumes, we find that the order of two-winged dipterous insects, although far below some of the other orders in point of number of species, far exceeds them in the quantity of individuals. There is, perhaps, not a spot upon the earth, not even excluding the polar regions, in which some one species of gnat or fly will not be found, swarming in every place, or filling the air at almost every season with their countless legions. We therefore propose, in this and the following chapter, to bring before the notice of the reader the natural history of several of the more interesting species of which this order is composed.

Of all insects, perhaps the most widely distributed and abundant in number of individuals, is the housefly, *Musca domestica*, a species which, from its constant occurrence in every situation, will render any precise description of it unnecessary; and yet many of our readers are, perhaps, unaware, that of the flies which crawl up our windows, there are not only several distinct species, but also that the insect at whose tormenting attacks upon our legs in the showery days of summer we are so often enraged, does not even belong, notwithstanding its apparent identity, to the same genus. If one of these annoying tormentors (which is the *Stomoxys calcitrans*) be caught and examined, it will be found that the mouth is formed into a horny, sharp-pointed weapon, capable of piercing the flesh, while the soft blunt apparatus of the mouth of the musca is quite incompetent to such an operation, being fitted only for the sipping of fluids, or the extraction of honeyed sweets; forming, in fact, a long tubular sucker,

A B

Head of the fly, with the mouth extended; *A.* seen sidewise, *B.* seen from above.

jointed in the middle, so as to fold back close to the head (Fig. A and B), and armed at the base with a pair of exarticulate feelers, and at the extremity with two fleshy lobes, which are employed as instruments of suction. This organ possesses very great muscular power, and we have seen the insect, by its assistance alone, carry off pieces of sugar much larger than its head. The under surface of the terminal lobes is also transversely ridged, which must necessarily give greater facility to the actions of the organs, by enabling it to adapt itself more readily to rough surfaces (Fig. c). It is essential, however, that the mouth should be provided



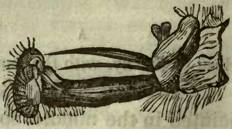
C

Extremity of the sucker of the fly, showing its annulated appearance.

with some instrument for piercing even the soft substances of which the food is composed, and we accordingly find a fine point (the tongue) arising near the elbowed part of the proboscis, which is for safety lodged in a stronger point (the labrum), both when at rest fitting into the canal of the proboscis, as represented in our figure B.

In figure D we have exhibited the mouth in an-

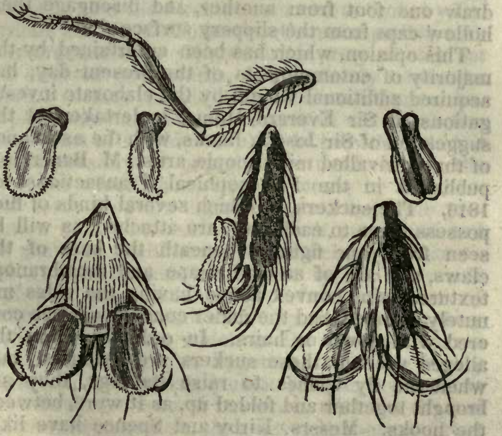
D



E

other position, showing the sharpened upper lip raised from the fleshy proboscis, and in figure E the mouth of the blue-bottlefly is represented, having the tongue disengaged from the superior stronger labrum.

Another interesting peculiarity observable in the domestic fly, arises from the structure of its feet, enabling it to walk with the greatest facility, not only upon upright surfaces, but also upon the ceilings of rooms, back downwards, without its position being disturbed in consequence of being contrary to gravity. Much diversity of opinion has taken place among naturalists upon this curious subject, and even in the latest works we find the matter still forming a "questio vexata." Dr. Derham, in his "Physico-Theology," speaking of the



Leg of the fly highly magnified, with the terminal joint still more increased, seen in different positions, to show the suckers.

means whereby insects maintain their position upon smooth substances, states, that "divers flies and other insects, besides their sharp-hooked nails, have also skinny palms to their feet, to enable them to stick on glass and other smooth bodies by means of the pressure of the atmosphere, after the manner as I have seen boys carry heavy stones with only a wet piece of leather clapped on the top of the stone." Gilbert White, of Selborne, adopted Derham's opinion, adding, that although the flies are easily enabled, from their lightness and alertness, to overcome the weight of air in warm weather, yet that, in the decline of the year, this resistance becomes too mighty for their diminished strength, and we see flies labouring along and lugging their feet in windows as if they stuck fast to the glass, and it is with the utmost difficulty that they can draw one foot from another, and disengage their hollow caps from the slippery surface.

This opinion, which has been entertained by the majority of entomologists of the present day, has acquired additional weight by the elaborate investigations of Sir Everard Home, undertaken at the suggestion of Sir Joseph Banks, with the assistance of that unrivalled microscopic artist, M. Bauer, and published in the Philosophical Transactions for 1816. The suckers, of which several kinds of flies possess three to each foot, are attached, as will be seen from our figures, beneath the base of the claws, and are of an oval shape and membranous texture, being convex above, having the sides minutely serrated, and the under concave surface covered with down or hairs. In order to cause the alleged vacuum, these suckers are extended, but, when the fly wishes to raise its legs, they are brought together and folded up, as it were, between the hooks. Messrs. Kirby and Spence have likewise adopted this opinion, considering it as "proved most satisfactorily." Other authors of no mean repute have, however, entertained a different opinion, and have entirely rejected the idea of a vacuum being produced; thus Dr. Hooke describes the suckers as palms or soles, beset underneath with small bristles or tenters, like the cone teeth of a card for working wool, which he conceived gives them a strong hold upon objects having irregular or yielding surfaces; and he imagined that there is upon glass a kind of smoky substance, penetrable by the points of their bristles. The same opinion is also given by Shaw in his "Nature Displayed," and, more recently, Mr. Blackwall has considered that the motions of the fly are to be accounted for upon mechanical principles alone; thus, upon inspecting the structure of the parts of the suckers (regarding which great want of accordance exists in the descriptions of authors), "it was immediately perceived that the function ascribed to them by Dr. Derham and Sir E. Home is quite incompatible with their organization. Minute hairs, very closely set and directed downwards, so completely cover the inferior surface of the expanded membranes, improperly denominated suckers, with which the terminal joint of the foot of flies is provided, that it cannot possibly be brought into contact with the object on which those insects move, by any muscular force they are capable of exerting; the production of a vacuum between each membrane and the plane of position is therefore clearly impracticable, unless the numerous hairs on the underside of these organs individually perform the office of suckers; and there does not appear to be any thing in their mechanism which in the slightest degree countenances such an hypothesis. When highly magnified, their extremities, it is true, are seen to be somewhat enlarged, but when they are viewed in action or in repose, they never assume a figure at all adapted to the formation of a vacuum." Moreover, on enclosing a housefly in the receiver of an airpump, "it was demonstrated to the entire satisfaction of several intelligent gentlemen present, that the housefly, while it retains its vital powers unimpaired, can not only traverse the upright sides, but even the interior of the dome of an *exhausted* receiver, and that the cause of its relaxing its hold, and ultimately falling from the station it occupied, was a diminution of muscular force, attributable to impeded respiration." Hence Mr. Blackwall is induced to believe, in the memoir above referred to, that insects are enabled to take hold of any roughness or irregularity of surface, by means of the fine hairs composing the brushes, the most carefully polished glass not being found free from flaws and imperfections, when viewed in a favourable light with a powerful lens.

A still different opinion has been maintained by other authors upon this subject; who, setting aside all idea of a vacuum, have conjectured that the suckers, as they have been termed, contain a glutinous secretion, capable of adhering to well-cleaned glass; thus the Abbé de la Pluche states, that when the fly marches over any polished body, on which neither her claws nor her points can fasten, she sometimes compresses her sponge, and causes it to evacuate a fluid, which fixes her in such a manner as prevents her falling, without diminishing the facility of her progress; "but it is much more probable," he adds, "that the sponges correspond with the fleshy balls which accompany the claws of dogs and cats, and that they enable the fly to proceed with a softer pace, and contribute to the preservation of its claws, whose pointed extremities would soon be impaired without this prevention." Notwithstanding the ridicule which has been thrown upon this opinion in a recent entomological work, it appears, from still more recent investigations, to be the best founded of any hitherto advanced. Thus, an anonymous writer has published an account of various experiments and examinations upon this subject, which appear satisfactorily to prove, that it is not by the application of extremely small points to invisible irregularities on the surface of glass, that the pulvilli or suckers are attached, but by simple adhesion of the enlarged ends of the hairs, assisted by a fluid that is probably secreted there, and the author is therefore reduced to refer the effect to molecular attraction only. It is also stated, that when the foot of the fly is detached, a distinct fluid trace will often be left by each individual hair, the spotty pattern thus left on the glass appearing to be of an oily character, for if breathed on it remains after the moisture is evaporated. The contrary opinion, although contained in a review of Mr. Blackwall's Memoir above noticed, was evidently written in ignorance of the subsequent observations of that author contained in the appendix of the volume in which it appeared, and in which several facts are stated, which appear "quite inexplicable, except on the supposition that an adhesive secretion is emitted by the instruments employed in climbing;" and it is subsequently affirmed, that careful and repeated examinations, made with lenses of moderately high magnifying powers, in a strong light, and at a favourable angle, speedily convinced Mr. Blackwall that his conjecture was well founded, as he never failed to discover "unequivocal evidence of its truth."

We have had a twofold object in thus setting before the reader, at considerable length, the various opinions promulgated upon the subject,—the first being occasioned by the interest attached to so peculiar a phenomenon; and the second resulting from a desire to show that, even in the commonest insects, there are most ample materials of no ordinary or uninteresting kind for the full exercise of the mind of the ingenious observer of nature. It will seem extraordinary, but it is nevertheless true, that there is scarcely any domestic insect of whose economy we are more ignorant than of that of the *Musca domestica*.

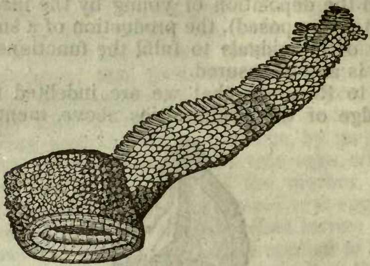
Other species exhibit another remarkable phenomenon, which is almost without a parallel throughout the countless myriads of the insect tribes. The blowfly (*Musca carnaria*) belongs to the modern subgenus Sarcophaga, so named in allusion to its feeding upon flesh, carrion, &c. This insect, and several of its congeners, instead of laying eggs, as do the majority of insects, deposite their young in the state of larvæ or footless grubs, the eggs being previously hatched within the body of the parent. These insects have been termed viviparous by some authors; this term has, however, been objected to, in consequence of the embryos of none of these insects being nourished, as in the true viviparous animals, within a uterus, by means of a placenta, but developed within true eggs, which are hatched within the body of the mother, as was proved by De Geer, who discovered real eggs within the body, as well as newly-hatched larvæ; whence the term ovo-viviparous, a term applied to the similar mode of production which occurs in the vipers and other reptiles,—has been suggested by Messrs. Kirby and Spence, to designate this species of parturition.

Perhaps there could not be adduced a more striking instance of that "harmony of nature," of which we have before spoken, than is afforded by the flies at present under consideration; their function is to consume and cleanse the surface of the earth from dead and putrefying animal matter. Now, for this purpose it is requisite, not only that no time should be lost in the development of the agents employed in this task, but also that their numbers should be increased in proportion to the extent of their duty. Here, therefore, we find both these objects attained in the fullest manner, but by extraordinary means: the eggs of the fly being hatched within its own body, no time is lost when they are deposited upon a carcass, neither is there any danger of their being destroyed by being placed in the midst of the putrefying mass, which might have been the case had eggs been there deposited. Further, from the immense number of young produced from a single fly (and it is ascertained that the *Musca carnaria* will produce 20,000 young), as well as from their exceedingly rapid growth (scarcely a fortnight ensuing between the birth of one generation and the deposition of young by the insects of which it is composed), the production of a sufficient number of individuals to fulfil the functions of the species is amply ensured.

It is to Reaumur that we are indebted for our knowledge of the peculiarities above mentioned;

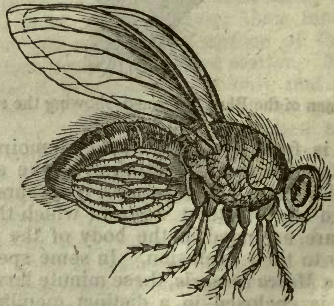
Abdomen of the Blowfly opened, showing the spiral roll of Larvæ.

and it is from his invaluable "Memoirs," that the following figures, in illustration of the subject, are derived. From his researches it appears that there are two very distinct ways in which these young grubs are arranged in the body of the parent previously to their exclusion. In some species, including the *Musca carnaria*, these minute larvæ (each of which is enclosed in a distinct membrane of the most delicate texture) are arranged side by side, and in a spiral direction, resembling the mainspring of a watch, or a roll of riband; and, according to Reaumur, who had the perseverance to unrol one of these coils, it was found to be about two inches and a half in length.



The spiral coil of Larvæ of the Blowfly removed from the Abdomen, and partly unrolled.

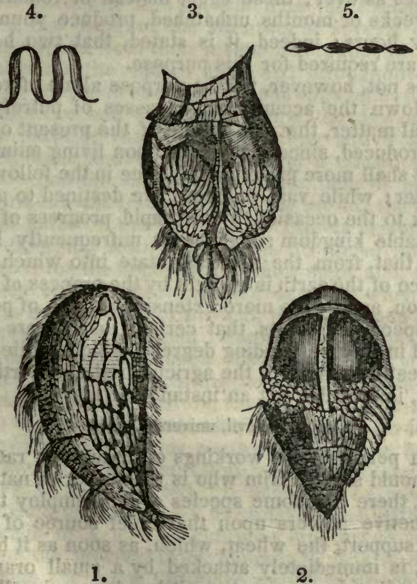
Another insect, evidently congenerous with the blowfly, but of which the species is not recorded, was likewise observed by Reaumur to be ovo-vivipa-



Large Gray Blowfly magnified, with the Abdomen opened beneath, showing the already hatched Maggots.

rous; but the larvæ, instead of being coiled up in a spiral direction, were found to be arranged longitudinally, without much order, being merely laid parallel to each other.

There are, however, some species of fleshflies, such as *Musca vomitoria*, or the great blue-bottlefly, in which this mode of production does not take



1, 2, 3. The Abdomen of the Blue Fleshfly opened, and seen in different positions, to show the arrangement of the enclosed Eggs.
4. Portion of the Membrane in which the Eggs are enclosed.
5. The same extended.

place, the eggs being protruded in the ordinary manner, being of an oblong form, and forming, previous to exclusion, two masses, arranged on each side of the abdomen, each, however, being enclosed in a delicate membranous sac, connected at one end with that which is immediately in contact with it. Here, however, we find nature still as fertile in her resources as ever; these eggs, instead of remaining for weeks or months unhatched, produce young in a few hours: indeed, it is stated, that two hours only are required for this purpose.

It is not, however, for the purpose alone of keeping down the accumulating masses of putrefying animal matter, that the insects of the present order are produced, since many feed upon living animals, as we shall more particularly notice in the following chapter; while vast numbers are destined to put a check to the occasionally too rapid progress of the vegetable kingdom; and it not unfrequently happens that, from the artificial state into which the surface of the earth is brought by the process of cultivation, and by the more extensive growth of peculiar species of plants, that certain insects are produced in a corresponding degree; which, while it is of great detriment to the agriculturist and horticulturist, is probably but an instance of that

"All partial evil, universal good,"

which pervades the workings of nature, or rather, we should say, of Him who is the author of nature. Thus, there are some species which employ their destructive powers upon that chief source of our daily support, the wheat, which, as soon as it blossoms, is immediately attacked by a small orange-coloured midge (or gnat, as it has been miscalled), of a very delicate form, which deposites its eggs among the glumes of the florets of the wheat, by the assistance of its ovipositor, which is very long and retractile within the body, like the joints of a telescope. The wings are broad, and covered with very fine hairs, but they are almost entirely destitute of nerves; the antennæ are also very beautiful microscopic objects, being composed of a number of small knobs, each of which is surrounded by a whorl of fine long hairs; the legs are also very long and slender.

The history of this fly, which is the *Cecidomyia triticea*, has occupied the attention of several entomologists, and from their researches it appears, that it is towards the end of June and throughout July that the operation of depositing the eggs takes place. The flies are said to repose during the day on the lower parts of the stems, becoming active about sunset, their activity depending in a considerable degree upon the sun's being either near or below the horizon; and frequenting during the day the most shaded parts of the crop. The insects prefer the ears emerging from the vagina to those farther advanced for the deposition of their eggs, and, from one side only of the ear being exposed when the plant is in this stage of growth, the other side generally remains uninjured. Sometimes as many as thirty-five flies have been observed upon a single ear, in the act of depositing their eggs, which are generally found in clusters, varying in number from two to ten upon the inner chaff; they are also to be observed in the interior parts of the flower, being fixed by a glutinous secretion, with which they are covered when deposited. It seems to be one of the objects of the female fly to fasten the anthers, by means of a similar glutinous matter, so as to prevent the flowers from blooming; this is done to enable the larva the more easily to attack the anthers, upon which it feeds; and it often happens, that so intent are the females when thus employed, that they become entangled in the corolla, and fall a sacrifice to their maternal affection, or rather to the instinct which impels them to perform this act.

The larvæ are hatched in eight or ten days, when they immediately commence feeding upon the pollen, which is only sufficient, however, for their supply in the first instance, after which they crowd round the lower part of the germen, where they probably feed upon the matter which had been destined to form the grain. As many as forty-seven larvæ have been counted in a single flower, so that an idea may be obtained of their minute size.

It appears, moreover, that this little insect abounds in some seasons to such a degree, that it destroys at least one twentieth part of the crop. After arriving at their full size the larvæ quit the ears of wheat, and fall to the ground, beneath the surface of which they are transformed into pupæ. At the period when Messrs. Kirby and Marsham commenced their investigations of this insect, three minute hymenopterous flies were observed prowling about the ears of wheat, and it was afterward discovered that some of these flies were produced from the maggots found attacking the grain; hence it became the general opinion of unscientific persons, that these minute flies were the parents of the maggots, and the origin of all the mischief. In pursuing their investigations, it was however discovered that these three different species of hymenoptera were parasites attached to the wheatfly, and appointed by an all-wise Creator to prevent their too great increase.

While the wheat of our own island is thus subject to the attack of one species of cecidomyia, it would appear that that of America is ravaged to a far greater extent by another species, to which the name of the Hessianfly is given, and it has been recently described under the name of *Cecidomyia destructor.* This species attacks the young wheat as soon as it appears above ground, and entirely destroys the plant by eating into the stem, so as to cause it to break. When it first made its appearance in Long Island, in 1776, the devastation which it produced must have been truly formidable, threatening, in fact, the total abolition of the culture of wheat. So great, indeed, was the general dread of the ravages of this fly, that the British Privy Council sat daily for the purpose of considering the means best adapted for guarding against the importation of so formidable an enemy, and the account of their deliberations occupies not less than two hundred pages. It is moreover stated that "their numbers were so incredibly great, that in wheat-harvest the houses swarmed with them, to the extreme annoyance of the inhabitants; they filled every plate or vessel that was in use, and five hundred were counted in a single glass tumbler exposed to them for a few minutes, with a little beer in it."

The midges, belonging to the same Linnæan genus as the wheat-flies, *Tipula*, afford another striking example of the almost infinite number of individuals produced in certain situations, belonging to a single species. To these insects the name of gnat has often been applied, but it appears to us that it would be more proper to restrict that name to the insects composing the Linnæan genus *Culex*, whose biting propensities are so well known.

Like the Ephemeræ, of which they seem to be the counterparts, these midges may be seen, especially in serene sunny evenings, assembled in vast troops, alternately rising and falling in the air, so as to exhibit one of the most pleasing spectacles. These dances are kept up from about an hour before sunset until the dew begins to fall. Messrs. Kirby and Spence have described a beautiful scene exhibited by these insects, accompanied by ephemeræ, which swarmed in infinite myriads, and appeared in the sunbeams as numerous and more lucid than the drops of rain, and as if the heavens were showering down brilliant gems. At another time, from some cause in the atmosphere, the insects at a distance looked much larger than they really were, the choral dancers alternately rising and falling in the full sunbeam, and appearing so transparent and glorious that they scarcely resembled any thing material—they reminded the observers of angels and glorified spirits, drinking life and joy in the effulgence of the divine favour.

> "Thick in yon stream of light, a thousand ways
> Upward and downward thwarting, and convolved,
> The quivering nations sport; till, tempest-wing'd,
> Fierce winter sweeps them from the face of day.
> Even so luxurious men unheeding pass
> An idle summer's life in fortune's shine—
> A season's glitter! Thus they flutter on,
> From toy to toy, from vanity to vice,
> Till, blown away by death, oblivion comes
> Behind, and strikes them from the book of time."
>
> THOMSON'S SEASONS.

No one will deny the beauty of these fine lines, and we are persuaded that their force will not be considered in the least diminished, although some of the tribes of these "quivering nations" are able to bear the sweeping storms of winter.

The winter midges *Trichocera* (*hyemalis*) afford another instance of the numerical excess of certain species, and also of that spirit of sociality which is not uncommonly observed in insects. These delicate little creatures may often be seen, throughout the winter and early spring months, assembled in troops, alternately rising and falling with rapid revolutions, in some sunny nook, even though the ground may at the time be covered with snow. It is a pleasant sight to watch their motions at a time when all the rest of nature seems to be suffering beneath the iron blast of "fierce winter's breath intensely keen." The opinion, that in these assemblages midges and other insects are under the influence of a principle of sociality, has been considered by a recent author to be more poetical than correct; their congregating together being supposed to arise neither from gregarious feelings nor for mutual assistance, but merely because they are produced in numbers in the same places, and are attached to peculiar haunts. We, however, feel induced to consider that both these opinions are correct to a certain extent; but for the solution of the question it is necessary to attend to the fact that the artists, in these natural dances, are generally males, the females very rarely taking part in the dance. In the winter-midges this fact is not easily ascertained, because there is but little external difference in the appearance of the two sexes; but, in the chironomi, the beautifully feathered antennæ of the males will at once be perceived, in almost every specimen which may be captured in the dance. Supposing, then, that a swarm of these male insects make their appearance in the perfect state at the same time, the immediate object of each is to seek its partners; and it appears to us that each is induced to join and continue with the troop, in the hope of meeting with the favourite object of its search among the crowd of which it forms a part.

Among the species of midges which pursue their myriad dances in the air, is one of a very small size, of a jet black colour, with snow-white wings. At times an individual or two finds its entrance to our apartments in an evening, probably attracted by the light of candles or lamps; and we have repeatedly observed what might be easily mistaken for a continuance of their gambols,—indeed, at the present moment (9 o'clock, P. M., 1st of August, 1832) there are a pair creeping and flying about on a sheet of paper upon which we are writing, at no great distance from the light. Now one of them rises, taking a few turns round the light, falling again with considerable force upon the paper, sometimes dropping on its wings; now it takes a shorter flight, and comes dashing about upon the paper. From attentively observing their proceedings we are convinced that, like moths which enter a lighted room, they have become dazzled and bewildered by the light towards which they fly; and then, again, attracted by the whiteness of the paper, which they evidently mistake for the "viewless air," they rush down to it in the hope of making their escape, sometimes on their backs, just as we see the housefly flying up and down the pane of a window, with its back towards the glass: hence we are not of opinion that this circumstance is sufficient to prove that these insects fly, in general, with their back downwards, as has been supposed by a recent writer, although the analogous case of the boatflies is brought forward in support of such opinion. Indeed, we have no hesitation in saying that there is no foundation for such a supposition, because we have repeatedly watched swarms of midges hovering over our meadows in an evening after sunset, within a very short distance from our head, and we have distinctly seen that they fly in the ordinary direction, with the back upwards.

Hence, it appears evident that the gyrations of our two little midges, which might easily be mistaken for a display of their powers of "tripping on the light fantastic toe," are but the result of bewilderment, and consequently afford no proof against the social principle exhibited by their out-of-door brethren; but there is also another circumstance which strongly supports our view of the subject, which we have also noticed, namely, they took not the slightest notice of each other. Now this is so contrary to the behaviour of the gay, gallant, whiskered chironomus, that we at once conclude that the natural feelings and affections of our little visiters were completely overcome.

No sooner, however, have we thus, to our own mind at least, settled the cause of the motions of these midges, than our ears are assailed by the piping of an insect which, in the deep stillness of a summer's evening, seems increased to a tenfold degree, and whose motions, on its approach towards us, seem to overthrow all our reasoning. The sound increases (authors have written dissertations on the question whether it is loudest on approaching or receding from the hearer), and a gnat, belonging to a genus closely allied to the chironomus, after playing a short time near the light, settles on our hand, and commences its operation of working its sucker into our fingers, although, for the purpose of witnessing its mode of proceeding, we have advanced our hand quite close to the light.

Should this circumstance be put in opposition to our former argument, we would merely observe, that the habits, as well as the proceedings, of the two insects, are so totally different, that a comparison ought not to be made between them.

CHAPTER XVI.

THE NATURAL HISTORY OF VARIOUS OBNOXIOUS SPECIES OF DIPTEROUS INSECTS CONTINUED.

Moscheto—The Black Fly of America—Domestic Fly—The Hungarian Fly—Gadflies—Breeseflies—Structure of Mouth of Tabanus and Gnat—Females only bloodthirsty—The Zimb—The Forest-fly.

If it were merely for the purpose of showing to mankind that insects are not such insignificant objects in the scale of creation as they have been assuredly considered by many persons, perhaps no more available "argumentum ad hominem" could be produced than that afforded by those species which formed the subject of the last paragraph of the preceding chapter; but there are many others, which, from the severity of their attacks both upon man and beast, seem fully competent to revenge the slight which is so often cast upon the race of animals to which they belong.

Of these, the moschetoes are perhaps the most widely distributed. They swarm in the sultry climes of Brazil and India, where one of the greatest luxuries of life is an insect-proof moscheto-curtain; and they are not less obnoxious to the inhabitants of the polar regions, where even those hardy people find it necessary to protect their bodies from the attacks of these insects by rubbing themselves over with grease and other disgusting unguents. This insect belongs to the same family as the English gnats. From the abundance of the insects in North America, we find the name of *Moscheto Bay*, the *Moscheto Country*, and the term Moschetoes, given to various places. It appears to us, that the name moscheto has been applied generally to any species of the family of gnats found in foreign countries which are particularly tormenting to man. A recent author has, however, thought proper to overthrow the received opinions of all previous travellers and authors, and to give the name of moscheto to another group of dipterous insects belonging to a distinct family, *Tipulidæ*. It is true indeed that the insects of this genus (*Simulium*) possess great irritating powers, and abound in various northern countries. Thus lately an interesting account was given not only of the transformations of this genus, but also of the molestations produced by swarms of these flies in Lapland; and the observer *thinks* that the moscheto may be congenerous or allied to simulium. Lambert also, in his travels through Canada, thus mentions the tormenting powers of a dipterous insect, which he has not described, but which is unquestionably a simulium. "They are so very small as to be hardly perceptible in their attacks, and your forehead will be streaming with blood before you are sensible of being among them. I have sat down to write, and have been obliged to throw away my pen in consequence of their irritating bite, which has obliged me every moment to raise my hand to my eyes, nose, mouth, and ears, in constant succession."

In considering this insect to be a simulium and not a stomoxys (as another author has conjectured), we are guided by its very minute size. A small species, from the account of its tormenting propensities, is known in North America by the name of "the blackfly," &c., and we feel ourselves warranted in retaining the name of moscheto for the various exotic species of gnats.

Even the common domestic fly, although unprovided with the powerful apparatus possessed by the gnat for piercing the flesh, is in some parts of the world as tormenting a pest even as the moschetoes. It is seldom in England that we suffer in any great degree from their numbers or pertinacity, but in more southern and hotter climates these insects become perfect nuisances, when, to use the words of Mr. Spence, "they literally almost fill the apartments. Every traveller in the south of Europe during the hot months will confirm the assertion of Arthur Young, that they are the first torments in Spain, Italy, and the olive districts of France. It is not that they bite, sting, or hurt, but they buzz, tease, and worry. Your mouth, eyes, ears, and nose are full of them; they swarm on every eatable, and if they are not incessantly driven away by a person who has nothing else to do, to eat a meal is impossible; and it is evident, from various incidental notices in the journals of travellers, that they are to the full as great a plague in the hot climates of other portions of the globe. To omit other instances which it would be tedious to cite, Mr. Stewart, in his recent valuable work on North America, speaks on three several occasions of the annoyance which he suffered from flies, which he seems to have found a worse torment than the moscheto." In the memoir from which the preceding extract is taken, Mr. Spence has published an account of a very singular and simple plan, adopted in some parts of Italy, for excluding the housefly from apartments, of which the windows are nevertheless allowed to be wide open for the admission of air.

If the boasted supremacy of man is thus set at naught by these minute creatures, it is not to be supposed that the beasts of the field should escape unattacked. And we accordingly find that the order of insects to which the gnat belongs, comprises also he chief tormentors of the quadruped tribes. We believe, however, that no instance has been yet recorded of the attacks of the moschetoes upon cattle, although several species of simulium are stated to attack the horse and ox. Thus, the *Culex equinus*, which " infests horses in infinite multitudes, running under their manes and attacking them with great fierceness, being not easily driven off," is evidently, from the description and figure of Linnæus, a simulium.

But one of the worst of all animal tormentors is a minute fly, to which Fabricius first gave the name of Rhagio Columbaschensis. This terrible creature is only a line or two long, and appears in immense quantities in the spring and early summer months in Sienna and the Bannat, attacking the cattle, penetrating various parts, and by its poisonous bite destroying them in the course of four or five hours. It is also found in the southern parts of France, and has been discovered in the environs of Paris. Latreille states, that having once been bitten by one of them, he had experienced excessive pain. Much injury was sustained in 1813 from this insect, in the palatinate of Arad in Hungary, and in the Bannat. In Banlack not fewer than two hundred horned cattle perished from its attacks, and in Vershetz five hundred. It appears in such indescribable swarms as to resemble clouds, proceeding, as some think, from the region of Mehadia, but according to others from Turkey. Its approach is the signal for universal alarm. The cattle fly from their pastures, and the herdsman hastens to shut up his cows in the house, or, when at a distance from home, to kindle fires, the smoke of which is found to drive off this terrible assailant. Of this the cattle are sensible, and, as soon as attacked, run towards the smoke, and are generally preserved by it.

How beautiful a picture of rural quiet and repose is given by the poet of the Seasons, of the shepherd and his herds during the sultry heat of the summer's sun.

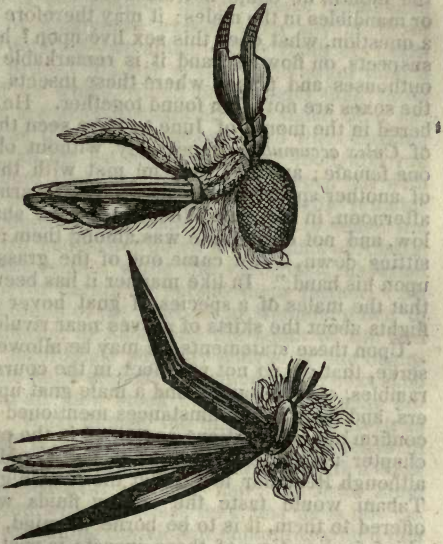
> "Amid his subjects safe
> Slumbers the monarch swain; his careless arm
> Thrown round his head, on downy moss sustained.
> Here laid his scrip, with wholesome viands filled;
> There, listening every noise, his watchful dog."

And with what contrast does he proceed to describe the confusion produced by the approach of some of the insect tribes.

> "Light fly his slumbers, if perchance a flight
> Of angry gadflies fasten on his herd,
> That startling scatters from the shallow brook,
> In search of lavish stream. Tossing the foam,
> They scorn the keeper's voice, and scour the plain
> Through all the bright severity of noon,
> While from their labouring breasts a hollow moan
> Proceeding runs, low bellowing round the hills.
> Oft in this season too, the horse, provoked,
> While his big sinews full of spirit swell,
> Trembling with vigour, in the heat of blood,
> Springs the high fence, and o'er the field effused
> Darts on the gloomy flood withs teadfast eye,
> And heart estranged to fear."

The insects which produce so much confusion among cattle are generally termed gadflies and breeseflies, but the application of these names is by no means fixed, either to the species of insects, or even to the nature of their attacks. Thus, some species of the genus *Œstrus*, which deposite their eggs upon the backs of oxen, instil into these animals so much dread, that they may be observed scampering along, with the tail stretched out at full length, until they reach some neighbouring pond of water; and it is probably these insects to which the poet alludes, when speaking of a flight of gadflies, although the *Œstrus* is more commonly known by the name of the botfly, while the term gadfly seems more generally applied to the various species of the Linnæan genus *Tabanus.* The latter insects, indeed, from their large size, as well as from the very formidable apparatus of lancets with which the mouth is provided, are well capable of instilling terror into cattle, although they do not appear to torment oxen and sheep so much as they do horses, which are often driven almost wild with the exceedingly painful wounds made by them. We can well speak from experience, for often in our rambles have we been intolerably teased by some of the species, which have continued to hover over us, until they have found an opportunity of settling upon some part of the exposed hand or face, when they would immediately introduce their lancets with a pain equal to that of the sting of a wasp.

On comparing the figures here given of the mouths of a tabanus and a gnat with those of the domestic fly in a preceding page, a very great difference will be observed in the structure of the two organs. Here, indeed, we find the various parts of the mouth reaching their fullest degree of development, while other parts, of which not even the rudiments were to be observed in the fly, are here completely organized. In the bloodthirsty gnat, however, we find the same number of organs as in the *Tabani*, and it is very remarkable that no other dipterous insect is furnished with so completely developed a mouth, thus showing the intimate connexion of habits corresponding with identity of structure. According to Leuwenhoeck, the sucker of the gnat consists of only four pieces, while Reaumur found five, and Swammerdam six, including the lower lip,



in which they are enclosed as in a canal. We have, however, found seven pieces; namely, the lower and upper lips, the tongue, and two lancet-like mandibles, and the same number of maxillæ, being of equal length with the latter. The same number of organs (exclusive of the pair of hairy palpi) is also found in the *Tabani*.

Another circumstance in which both the gnats and *Tabani* agree is, that the females alone appear to possess these sanguinary propensities, the males contenting themselves with the nectar of flowers;

and it has been stated by an observer, in confirmation of this fact, that "by a careful dissection of the mouth, he could not discover either a tongue or mandibles in the males; it may therefore become a question, what does this sex live upon? he rather suspects, on flowers; and it is remarkable that, in outhouses and places where these insects abound, the sexes are not often found together. He remembered in the month of June to have seen the males of *Culex accumulatus* repeatedly, without observing one female; and last May he met with the males of another species flying in a large swarm in the afternoon, in Coombe Wood, in a dark shady hollow, and not one female was among them; but, on sitting down, a few came out of the grass, and lit upon his hand." In like manner it has been stated, that the males of a species of gnat hover in small flights about the skirts of groves near rivulets.

Upon these statements we may be allowed to observe, that we do not recollect, in the course of our rambles, ever to have found a male gnat upon flowers, and that the circumstances mentioned seem to confirm our observations contained in the preceding chapter upon the swarming of gnats. Moreover, although Reaumur found that the female gnats and Tabani would taste the sugary fluids which he offered to them, it is to be borne in mind, that the chief feeding-time of these insects is past, since it is only during the larva state. It is thus that we would account for another circumstance connected with these and other bloodthirsty insects, such as the bedbug, &c., namely, that in their native haunts they are often found abounding to the greatest extent, although it is impossible for them ever to taste blood; this is indeed particularly the case with the gnats, which swarm in damp situations, "where the footstep of man ne'er trod." In like manner the bedbug has been known to thrive and multiply to a most intolerable degree in empty houses, the wainscoting and other woodwork swarming with them.

There is yet another insect whose formidable powers of annoyance exceed even any of those hitherto detailed—we allude to the Zimb or Tsaltsaya of Bruce. Its size is very little larger than a bee, and its wings, which are broader than those of a bee, are placed separately like those of a fly. As soon as this plague appears, and their buzzing is heard, all the cattle forsake their food, and run wildly about the plain till they die, worn out with fatigue, fright, and hunger. No remedy remains for the inhabitants on such spots but to leave the black earth, and hasten down to the sands of Albara, where they remain while the rains last, the cruel enemy never daring to pursue them farther. All the inhabitants of the seacoast of Melinda, down to Cape Gardafui, to Saba, and the south of the Red Sea, are accordingly annually obliged, at the beginning of the rainy season, to remove to the next sand to prevent all their stock of cattle from being destroyed. What though the Ship of the Desert, as the camel is emphatically called, be immense in size and strength, and his body covered with a thick skin defended with a strong hair; the little Zimb pursues him with relentless fury, and he is not capable of sustaining the violent punctures which this fly makes with its proboscis. His body, head, and legs break out into large bosses, which swell, break, and putrefy, to the certain destruction of the creature. Even the elephant and rhinoceros, which, from their enormous bulk, and the vast quantity of food and water which they daily require, cannot shift to desert places as the season demands, are compelled to roll themselves in mud and mire, which, when dry, coats them all over like armour, and enables them to stand their ground against their winged foe; and yet Mr. Bruce found some of the tubercles upon almost every elephant and rhinoceros which he saw, and which he attributed to this cause.

We have already alluded to the remarkable mode of production which takes place in the Linnæan genus hippobosca, the most common species of which is known by the name of the forestfly (*Hipp. equina*). This insect is generally found upon the horse, whose blood it sucks, adhering so firmly to the skin of this animal, by means of its very powerful hooked claws, that it is with the greatest difficulty that it can be removed. In the New Forest, Hants, they are found in such profusion, that upwards of a hundred individuals have been taken from the flanks of a single horse. It would seem that white or light-coloured horses are more subject to their attacks than dark-coloured ones; a remark confirmed by the stable-keepers in the neighbourhood of the forest. The body of this insect is covered with a skin of so hard a texture as to resist the greatest pressure that can be applied to it by the hand. This species is occasionally found upon cows and dogs (indeed, Geoffroy has termed it "La Mouche-à-chien"), and, it is said, even upon man himself. It has the instinct to place itself in those parts of the body of the horse which are most denuded of hairs; and where it cannot be reached by the mouth of the horse, as beneath the belly, between the head, legs, and tail, &c. Although incapable of causing much mischief, it is the cause of great irritation to the animal attacked, especially when it occurs in considerable numbers. To the ass they are the objects of the greatest dread. Their legs are elevated at the sides of the body, whence they have considerable resemblance to spiders:—indeed, they have been occasionally termed spiderflies. They run with great agility, and have the faculty of moving sidewise, or even backwards, like crabs.

It is to Reaumur and Degeer that we are indebted for a knowledge of their remarkable mode of transformation. The female deposites a single egg-like mass, almost as large as her own body, and from this the perfect fly shortly afterward bursts forth, without undergoing any other transformations. When first deposited, this egg is of a milky-white colour, with a large, black, shining patch at one end; it is rather circular in form, and somewhat flattened at the sides, with a semicircular impression at the end where the black spot is perceived, which impression corresponds with the notch at the extremity of the abdomen of the parent fly. At first this egg is soft, except the black patch; but in the course of a day or two it acquires a sufficient hardness to resist any ordinary pressure, and the whole assumes a blackish colour. It is about one sixth of an inch long in the longest part, and somewhat less when measured across, thus nearly equalling the size of the body of the parent, and rendering it difficult to conceive how the insect can deposite so large a body. The abdomen of the hippobosca, however, rather resembles a bladder than a scaly covering, and is consequently capable of great distention; the egg, also, is not of so large a size when first deposited as it acquires shortly afterward: it is endowed with a slight motion, and each side is furnished with a row of spiracular points.

In these insects, therefore, nature appears to quit those paths by which she leads the majority of the insect tribes to their perfect state; since here, instead of the regular gradation of egg, larva, pupa, and imago, we find only one state, which, from analogy, we might be tempted to believe was that of the egg, from the circumstance of its being deposited by the female. When, however, we find the perfect fly bursting from it at once, we are compelled to regard it as the pupa; as we know, however, that it is during the larva state that all insects feed and grow, we are convinced that the larva state of the hippobosca must have been undergone previous to the assumption of this form, and consequently previous to its being deposited by the female fly. And the statement of Reaumur, that the outer envelope of this egg is nothing else than the hardened and contracted skin of the larva, is a corroborative of this opinion. Reaumur adds, that when the perfect insect escapes from its oviform case, it is the exuvia of the pupa which it leaves behind. The researches of Degeer, however, prove that it is not only the exuviæ of the pupa, but also the indurated skin of the larva, which is thus quitted, this author having opened one of the cases and found the real pupa enclosed, having the legs clearly folded over the breast, just as in the fleshflies, and in any other dipterous insects. It was only by the most unwearied assiduity that these distinguished authors arrived at a knowledge of the true nature of these curious insects, and for the purpose of showing the zeal which enabled them (and which alone can enable others who would tread in their footsteps in similar pursuits), to overcome the great difficulties attending the necessary investigations, it may be mentioned, that after the servants of Reaumur had with great diligence found him female flies ready to deposite their burdens, so anxious was he to observe their transformations, that, in order to secure to them the natural warmth which they enjoyed upon the body of the horse, he carried them about in his pocket by day, and actually took them to bed with him by night, for several weeks.

The hardness of this cocoon, as we must now regard it, proves of the greatest service in defending the enclosed insect against the attempts of the animal upon which it is deposited, to injure it. It might, however, seem at first likely to obstruct the escape of the enclosed insect when ready to burst forth, weak as it must necessarily be upon assuming the winged state.

Here, however, we find the difficulty overcome by one of those beautiful instances of precaution which are nowhere more manifest than in the insect world. The rounded tip of the cocoon corresponds with the head of the fly, and resembles a scullcap, divided into two equal portions, the union of which with the remainder of the cocoon is marked by a faint line, perceptible only by the assistance of a magnifying-glass. The insect, therefore, upon pushing against this cap with its head from within, causes it to fall off, whereupon the fly creeps forth in its winged state, and immediately commences feeding upon the animal upon which it was deposited by the parent fly. We will only further mention that the true larva of this insect has not yet been observed, and that it is most probably nourished in the abdomen of its parent by the blood of the horse, of which the latter takes such copious draughts. It would moreover prove a curious subject for investigation in a physiological point of view, to ascertain the real egg-state of the insect, and to discover what becomes of the exuvia of the egg after the insect has burst forth. We trust that some patient inquirer will endeavour to supply these interesting links in the history of the forestfly

CHAPTER XVII.

THE NATURAL HISTORY OF VARIOUS SPECIES OF SAWFLIES.

An account of the Ovipositor, and Sawing Apparatus—An account of the Rose Sawfly—Description of their Eggs, Larvæ, the Effect of Rain—Description of their Cocoon—their Perfect State—its ravages on Turnips.

Of all the admirably adapted instruments with which insects are furnished to enable them to accomplish the various ends of their existence, we know of none which can be compared, in the beauty of their construction, to the organs which are employed for the purpose of depositing their eggs by the females of a large family of insects, to which the French have very appropriately given the name of *mouches-à-scie*, and which we term sawflies; although, as we shall subsequently see, the formation of the organs in question is, as indeed might naturally be expected, much more complex and interesting in a mechanical point of view, than the tool from which the flies derive their name.

These insects belong to the same order (*Hymenoptera*) as the wasp and the bee, which they somewhat resemble; instead, however, of having the hind part of the body separated from the thorax by a very narrow waist, as we may term it, it is merely a continuation of the body without any visible contraction. Moreover, instead of being provided with a sting like these insects, it is plainly perceived that that instrument of terror is here replaced by the much more harmless, but not less effective instrument, to which we have already alluded.

Many of these insects are of a tolerably large size; and as there are at least two hundred and fifty different species of them to be found in Great Britain, opportunities for investigating their habits and economy are not wanting to those who may be desirous of verifying our account of them. The perfect insects are generally found upon various kinds of plants, upon or within which the females deposite their eggs, and which they are instructed by instinct to place in small grooves formed in the bark, wood, or leaves of the plant, upon which the future progeny are to be nourished. It is necessary, therefore, that the female should be furnished with an instrument capable of making a proper incision, and we accordingly find the ovipositor admirably formed for this purpose. The under surface of the body exhibits near its extremity a narrow slit, formed of two horny, jointed grooves or sheaths, between which, when unemployed, the ovipositor or auger itself lies concealed; when, however, the insect wishes to deposite her eggs, she bends the extremity of the body downwards and inwards, protruding the instrument at an angle with the body from the base of the slit formed by the two grooves.

The ovipositor itself is composed of two broad but very thin saws, which are projected and withdrawn by the female during the act of cutting the channel in which the eggs are to be placed, by the assistance of strong muscles at the base of each saw. These saws do not act in concert together, but while one is pushed forward the other is withdrawn from the incision made in the stem or bark. This appears to us to be owing to the circumstance of the saw, which remains in the slit, serving the purpose not only of a saw, but also of a wedge, keeping the mouth of the channel open until the other saw is thrust deeper into the wound. These two saws are not straight, like handsaws used by carpenters, but are of a curved form, somewhat like a flattened S. Like the common handsaw, each of these saws is lodged in a distinct piece, formed of two membranaceous plates, similar to the handle of a pocket-knife; which must, doubtless, be of great service, by giving support to the saws when in motion; but it is here observable, that instead of being fixed in these back plates, like the handsaw, each saw works backwards and forwards in its own groove. Moreover, the teeth of these saws, instead of being simple, like the carpenter's saw, are themselves still more finely toothed; each tooth, in fact, under a high-powered lens, considerably resembling the entire saw as seen with a lower power. It is in the last place to be noticed, that each of these saws has its outer flattened surface transversely scored and channelled; so that, as Messrs. Kirby and Spence well observe, while the vertical effect of this double instrument is that of a saw, it at the same time acts laterally as a rasp; and when, by the alternate motion of these saws, the incision or cell is made sufficiently deep, the two saws, receding from each other, conduct the egg between them into it. This is effected, according to Valisnieri, by means of two canals between the component membranes of the back-supports of the plates of the saws. When in action these saws do not, as might be supposed, cut two parallel courses, but work in the same cut; and, consequently, though the teeth are extremely fine, the effect is similar to a saw with a wide set.

The following is an account of the proceedings of the rose sawfly (*Hylotoma rosæ*):—"In the fine days of summer, towards about ten o'clock in the morning, the female is seen traversing with eagerness all the branches of this shrub, one after the other. She usually rests on that one which is nearest to the extremity of the principal stem, and there makes an aperture with her saw: when she has judged that the hole is of suitable dimensions, she deposites an egg in the cavity; she then remains quiet for a few moments, always having her ovipositor engaged in the branch; a moment after, she draws away quickly the largest part of it, and emits at the same time a frothy liquid, which rises as far as the external edges of the notch, and sometimes beyond them. Some authors have thought that the use of this liquid was to bedew and moisten the eggs, but Valisnieri believes that it serves to prevent the aperture from closing. Be this as it may, after the female has emitted this fluid, she withdraws her ovipositor, and proceeds to the fabrication of another hole. Sometimes she makes but four in a line, one after another; most frequently, however, she makes about a score. The part of the branch which is notched in so many places presents nothing remarkable the first day of the operation, and it is not until the following day that it begins to assume a brown colour; and in the sequel all the wounds become raised, and acquire more and more convexity every day. This growth is owing to the *augmented volume of each egg*, as it daily grows larger. It forces the skin of the branch upwards, and the aperture to grow larger. This last finally becomes considerable enough to give passage to the larva, which, in coming out of the egg, quits its retreat to seek the leaves of the shrub on which it is nourished."

The singular fact of the increase in size of the eggs after deposition, and previous to the bursting forth of the young, is quite at variance with the ordinary circumstance that the eggs of oviparous animals attain their full size previous to their being deposited. An analogous case, however, exists, not only among the gallflies and ants, but also in the eggs of fishes, whose size in like manner is said to increase previous to the exclusion of the young. Reaumur considered that it was in consequence of imbibing nutriment in some unknown manner through the membranous covering from the vegetable juices which surround them; the eggs at their full size being nearly twice as large as when first deposited. We, however, suggest, that the growth of the enclosed larva is attributable rather to fluid nutriment contained within the egg than to any imbibition of fresh matter. The subject is, nevertheless, highly worthy of attention.

The larvæ which are hatched from these eggs are often to be noticed in great quantities, and are the most destructive to the vegetable world of any of the insects in the order to which they belong. The gooseberry, currant, raspberry, cherry, rose, &c. being often entirely stripped of leaves by various species; this is especially the case when several females, each of which deposites a very considerable number of eggs, have selected the same tree. When this takes place, and the leaves are, in consequence, entirely consumed, the appearance of these grubs is, of course, attributed to blight: the willow and birch are no less subject to their attacks, and even the wheat and barley are often seriously injured by them.

These larvæ greatly resemble in form the caterpillars of butterflies and moths, being of a cylindrical form, with a scaly head, furnished with very powerful jaws, and having three pairs of scaly legs attached to the first three rings of the body, and several other pairs of fleshy membranous legs (varying in number in the different species) attached to the hinder segments of the body. They may, however, be readily distinguished from the caterpillars of the *Lepidoptera*, by the peculiar attitude which they assume when disturbed, coiling themselves up in a spiral form, with the head in the centre of the coil, and lying motionless upon their sides. When feeding upon a leaf, they commence their attack on it upon that side which they hold between their six forelegs; they are extremely voracious, feeding very fast, and without intermission.

The larvæ of many of the smaller species live gregariously, numbers feeding upon a single leaf, and the positions into which they throw their bodies, when undisturbed, are often very extraordinary; indeed, the feats of muscular dexterity which they exhibit are not less surprising than those of our great posture-masters exhibited in our Christmas pantomimes. Sometimes they will remain for a great length of time standing, as it were, upon their heads; others throw out their bodies in a horizontal position; while some assume the form of an S, the tail being elevated in the air.

These insects are said to be much affected by falls of rain, which render the leaves upon which they feed too moist, and which produce a kind of diarrhœa, causing them to die in a very short time. Hence we may conclude that by watering plants which are infested by them they may be got rid of without difficulty; fumigation by means of sulphur has also been efficaciously tried.

When the larvæ have acquired their full size, they generally let themselves fall to the ground, and bury themselves beneath the surface, to undergo their transformations. Here they generally spin an oval silken cocoon; some, however, content themselves with merely forming an oval cell, by rounding the earth in the immediate neighbourhood of their new lodging, by violently striking their bodies against the sides of the cell. Their proceedings may be easily inspected by placing some of them, when full fed, in a glass box, with a layer of earth at the foot; and if this layer be sufficiently shallow, they will descend to the bottom, and commence the operation of forming their cells upon the glass surface. Some species, however, affix their cocoons to the branches of the trees upon which they had fed. We may often observe a rose or gooseberry bush entirely covered with these larvæ, and in a couple of days afterward not a single grub is to be seen, neither are their cocoons to be found attached to the branches; and unless we were well convinced that they had descended to the earth, their sudden disappearance might just as rationally be attributed to their being borne away by the wind, as that their equally sudden appearance is owing to their being brought *as blight* by the east wind.

Having completed their cells or cocoons, they remain enclosed in a state of inactivity, and under the form of larvæ, for a considerable time, without changing to nymphs; indeed, as there is but one generation of them in the course of a year, and they only remain about a month in the active larva state, it must follow that this state of inactivity must last more than three quarters of a year, after which they become inactive pupæ, under which form they only remain for about a fortnight or three weeks; in this state their future limbs are all plainly visible, the wings, legs, and antennæ being folded along the breast.

From the great similarity in form which exists between the larvæ of the sawflies and the caterpillars of the lepidoptera, it is not surprising that the insidious ichneumon-flies attack the former as well as the latter, which are their more ordinary prey. Several instances of this have come under our own knowledge, and in the Magazine of Natural History will be found an account of their ravages upon one of the larger British species of Tenthredinidæ.

It is very seldom that the larvæ which we have endeavoured to rear have arrived at the perfect state when kept in breeding-boxes, owing to the difficulty of preserving the earth at a proper degree of moisture; indeed, Geoffroy states, that notwithstanding all the care which he took in rearing upwards of three hundred larvæ, not more than four or five specimens arrived at the state of the winged insect.

Many species, when arrived at the latter state, feed only upon the nectar of flowers; but there are some species, such as the water and green sandflies (*Tenthredo scrophulariæ* and *viridis*), which prey with much avidity upon other soft-bodied insects, even attacking the beetles commonly termed soldiers and sailors (*Telephoridæ*), which are themselves equally ravenous towards other insects. It certainly appears a remarkable circumstance that some species, which in their larva state are eminently herbivorous, should become, in their perfect state, real cannibals; unless, indeed, it be supposed that they were actually starving for want of their appropriate food; but these species even devour their prey in the midst of flowers, especially those of the umbelliferous kinds, the honey of which they will leave for that purpose, as we have repeatedly witnessed; indeed, it would seem that they select these kinds of plants in order to seize upon the numerous flies, &c. which frequent them.

The antennæ of these insects are strongly vibratile, and appear to perform the office of feeling the surrounding objects. The small species instantly fold these organs, as well as the legs, upon the breast, and fall to the ground immoveable on the least approach of danger.

The history of one of the species of this family is recorded by Mr. Marshall, in the Philosophical Transactions for 1783: it attacks the turnip after it has escaped the ravages of the turnipfly, or Black Jack (*Haltica nemorum*), and often occasions so much damage that whole districts are sometimes nearly stripped; indeed, in that year many thousands of acres were obliged to be ploughed up in consequence of their attacks. The sudden appearance of such vast numbers of these insects appears to have given rise to various conjectures; Mr. Marshall, indeed, states, that it was the general opinion in Norfolk that they came over the sea; and a farmer actually declared that he saw them arrive in clouds so as to darken the air; and the fishermen asserted that they had repeatedly seen swarms of them pass over their heads when they were at a distance from the land.

CHAPTER XVIII.

NATURAL HISTORY OF PARASITICAL INSECTS FOUND ON PLANTS, AND PARASITICAL PLANTS FOUND ON INSECTS.

History of the Gall found on the Brambles—Its parasite—History of the Cimex which attacks Flowers—History of a Beetle which attacks Leaves—History of the Caterpillar peculiar for forming Galls—History of the Insect which forms resinous Galls on the Pine-tree—An account of the Fungus found attached to the Melolontha or May Bug—An account of the Vegetating Wasp—An account of the Plant found on the Pupa of a Cicada, on Moths, and on Larvæ—The supposed Causes of these Phenomena—An account of portions of Flowers being found attached to Insects.

In further illustration of the parasitical insects which form the galls, of which we have given a short account in the former volume, we proceed to describe those which are observed on the brambles in the months of July and August, but which become more numerous in September. "It is upon," says Reaumur, "the stems and branches that we noticed the galls, which are sometimes nothing else than the stem and branches themselves, equally swollen on all sides for the space of an inch; beyond there is a swelling of the shape of a spindle. This swelling varies in length, and occasionally it is found only upon one side of the stem. The shape of these tubercles varies considerably, but the part thus enlarged is always harder than those which retain their natural size. If we cut one of these galls either transversely or longitudinally, more than twenty or thirty larvæ, of an amber colour, will be found in each of them. They seem placed in the space left by the detachment of the fibres from each other, and they gnaw all that surrounds them; the interior of old galls is filled with particles of fibre reduced to a kind of black powder, which is all that separates these worms from each other, and which does not prevent their meeting. These larvæ not only differ in colour from the ordinary ones of the oak, and many other trees, but they also differ in the form of their parts. They are terminated anteriorly by a little point, the apex of which is brown; if this part be investigated from beneath with a powerful lens, no vestige is discovered of those two brown teeth common to the other worms of a multitude of galls, each of which is situated at an equal height upon each side of the head, and which close together, but in lieu we perceive a small brown mark. Upon closely examining this brown mark, and touching it with any pointed instrument, it is found to be of a consistence as hard as horn; and we then distinguish that the end of it nearest the head is not only larger than the other, but that it consists of two straight parts, almost parallel to each other, but which do not touch. The simplest and most distant from its apex passes out of an aperture which is apparently the mouth, into which the fragments ground by the furcate portion, or the juice extracted from them, enter; we can, however, but guess upon this subject, for we cannot hope to observe such delicate parts in action, particularly in an insect which is so ill at ease when exposed to the light." Reaumur detected in the galls much smaller worms, which were almost white, but coloured red or yellow within. These larvæ are supposed to be parasites on the true gallfly. The latter is considered a two-winged insect, while the former is conjectured to have four.

We will now mention one which attacks the flowers of the chamædrys, and while the majority of them are in full bloom. Reaumur observed some which were considerably larger and more swollen than the others were when they opened, and which were, nevertheless, closed. Each of the latter supplies a dwelling for an insect, and the only one he was acquainted with of its class which lives in monstrosities analogous to galls. These insects, which were in their pupa state, were supposed by that naturalist to be transformed into cimicides. He afterward carefully examined the plants when in blossom, to see if any were materially swollen; in all that he observed so, he constantly saw either the pupa of the cimex or field-bug, or the cimex itself, or at least the exuvia, when the insect had escaped. The insect from its birth is nestled in the bud of the flower, which it sucks with the rostrum with which it is furnished. The flower thus sucked has more nourishing liquid than those from which it has not been extracted, it grows faster, but so that it cannot open like them; the lip which ought to disengage itself from within the calix formed by the others, is retained there by its having acquired too much bulk. The little pupa has consequently always a closed dwelling. The cimex into which it changes is very pretty; it is of an ashy gray, produced by a mixture of white and light brown.

On the leaves of the shrub, which is called *viorne* or *viburnum*, will be found flattened spongy galls of a circular form; they rise on each side of the leaf, yet but little elevated above its surface; the centre of both the top and bottom is marked by a small nipple. One single leaf contained frequently forty such galls, many of which Reaumur opened, and in the interior of each found a white larva. He endeavoured to obtain the insect which these galls produced, by dissecting the stalks of several leaves which were almost covered with them, in a small vessel filled with water; this was placed upon a sheet of white paper, spread upon a very flat table. This arrangement admitted of the leaves remaining fresh during the whole time the worms of these galls required for their full development, and the insects, howsoever minute they might prove, could be readily detected upon the sheet of paper. These larvæ changed into small coleopterous insects.

There are also galls formed by caterpillars, in which they undergo their metamorphoses into a butterfly. Reaumur relates that he received some galls from the Island of Cyprus. They grew upon a species of *limonum*, and each is borne like fruit by a short stalk. They are of about the figure and size of a nut, and seem to have a kind of small head or crown at the part opposite to the stalk. When first received they were of a pale gray, their surface tolerably smooth, but a little cottony. They must be classed with the woody and indurated galls; their first layers, those nearest the exterior envelope, are, notwithstanding, spongy, but the interior layer, that which forms the coat of the cavity, is very hard. This cavity is much larger than that of the majority of the galls; it is a very large dwelling, and is inhabited by a true caterpillar. He opened many of these galls, in each of which he found the caterpillar dead and dry, and consequently in a state that did not admit of description; all that he could discern was that it was smooth, but he could not detect the number of its prolegs, which were too much withdrawn within the body. Although the caterpillar was no longer alive, yet some of its modes of life could be easily distinguished; it apparently gnawed the interior of the gall in the manner of the larvæ of the willow-gall. When its time of change arrives it pierces the gall, which it does by a foresight similar to what we have admired in some caterpillars of wheat. This caterpillar consequently changes the gall itself while in this state, and, having teeth, it pierces a hole, which it could not do when a butterfly,—the aperture by which it makes its escape. When the hole is made, the caterpillar no longer takes food; it spins a cocoon of white and brilliant silk, the tissue of which is very thin, but compact. This cocoon lines the interior of the cavity, and even that of the hole, and also forms a kind of beak which enters the aperture. Although this cocoon is attached to the sides of the cavity, it is not for the purpose of supporting it, for the cocoon which Reaumur extracted, after removing by degrees portions of the gall, retained its full distention. In one of these cocoons was found a butterfly, which perished before it had finished disencumbering itself of its pupa-case, and was therefore not in a condition to make us acquainted with its characters, as its body and wings were not fully developed; the latter, however, were of a whitish gray.

During all seasons, but more especially in autumn, small resinous lumps may be seen on the branches of the young pine. These, which at first view appear to be similar to the gummy exudations of the cherry and other fruit-trees, are, in reality, galls—not produced by chance, the rays of the sun, or any mechanical cause, but by a little moth, and intended as a habitation for its young. Degeer, who first discovered this curious insect retreat, was no less astonished than pleased by his discovery. These resinous galls vary in size, the largest being about one inch in diameter and the same in length. Their external surface is rough, their shape oval, and they are fixed to one side only of the branch on which they adhere. The branch itself increases, for the most part, so much in size, as to become monstrous. If one of these resinous galls be cut longitudinally, and parallel with the branch, it will be found that it contains a species of kernel, in the middle of which the caterpillar lies buried. Between the walls of the kernel and those of the enveloping gall there is an empty space. The cavity is commodious enough; its inner surface is lined with a thick layer of brown excrescence, which the caterpillar has arranged around its habitation apparently for the purpose of convenience and cleanliness, to ensure which it covers this layer with a fine sheeting of resin. Sometimes, however, it is more convenient for the insect to remove the excrement altogether from its habitation. In this case Degeer has seen it pushed out through a small door, which has been subsequently closed with fresh resin by the caterpillar.

In some instances Degeer found no kernel within the resinous gall; but even in these there was the same attention to order and cleanliness exhibited as in the others. The insect had partitioned off its habitation by means of a resinous wainscoting, so as to divide it into two chambers, in one of which it lodged, while the other contained the excrement, which it had pushed through a small door or hole at the bottom of the dividing substance. The caterpillar feeds on the branch of the pine to which its nest is attached, and gnaws into its substance. The insect is about half an inch in length. From its conformation it would appear that air was necessary to its existence, although the compactness of the resinous galls appears to seal up their inhabitant hermetically. About October, if these galls be opened, the caterpillar will be found placed with its head downwards, and so intensely torpid, that even a rude touch does not put it in motion. In this state it remains during the winter, against the rigours of which, however, it has provided, by spinning round itself a layer of silk. In the spring following it is reanimated by the sun, and now the head of the insect is once more turned towards the superior part of the resinous gall.

It will be recollected that oil of turpentine is one of the most deadly poisons to insects. The odour of this substance penetrates their stigmata, or breathing-pipes, and speedily kills them. One of the most remarkable facts, therefore, connected with the history of our caterpillar is, that it should live and feed on the very substance which is so fatal to its kindred tribes. Degeer made experiments, all of which proved that neither the odour of turpentine, nor the substance itself, when applied to the insect's body, caused death. About the middle of May the caterpillar, having previously gone through the chrysalis state, escapes from its habitation in the shape of a small agile moth. If the thickness and tenacity of the walls of the resinous gall be looked to, it is not a little surprising how a little feeble moth, altogether unprovided with instruments capable of piercing such a substance, should contrive to effect its escape. It is evident that the moth cannot, and, in fact, does not, do it directly.

In all those galls from which the perfect insect has escaped, a small circular hole may be observed, to the edges of which the skin of the chrysalis remains attached in such a way that one half of it remains within, the other half without the gall. It is certain then that the moth, while as yet enveloped by the skin of the chrysalis, makes use of the sharp hard head and horny skin to effect its escape. It pushes these through the resinous walls of its prison, and after a natural tunnel, as it were, has been formed, it then, and not till then, opens its chrysalis skin and seeks the air.

Having thus given an additional account of those insects which are parasitical on plants, we will now offer the reader a history of those plants which are sometimes found attached to insects, whether in their perfect or imperfect states, showing the various means which nature has ordained for checking too rapid an increase of plants and animals.

We will mention them in scientific order, beginning with a species of melolontha, which the Americans term Maybug, the larvæ of which are found in great profusion in meadows at certain seasons of the year, when it is not unusual to find some which have attached to them a vegetable sprout. In some instances this sprout is three inches in length; it generally proceeds from between the head and the under part of the thorax, and in a few instances from the mouth. There is generally one to each grub, though some are found with two; and the larvæ are not only dead, but in a state of decay, and the sprout rising above the ground indicates where they are found. It is a vulgar but prevailing notion, that such grubs are changed to briers. A species of curculio in the perfect state, from Mexico, has also been mentioned as having long slender filaments attached to various parts of its body; and another specimen of the same was remarkable for having one on the rostrum or beak, which gave it the appearance of an additional horn.

A species of hymenopterous insect was first made known under the name of vegetating wasp, by a Spaniard, named Father Torrubia, at Madrid, in the year 1754. The following curious account was given by him. He found, two leagues from the city of Havana, in New-Spain, in 1749, some dead wasps in a field: from the belly of each wasp a plant germinated, which grows about five spans high. The natives call this plant Gia, and it is full of sharp prickles, which are supposed by them to proceed from the belly of the wasp. Edwards, in his work on birds, has copied the figures. They are represented as having taken possession of the plant, and are flying away with their booty attached to their bodies, though the original observer stated that he found them dead in the field. Some others were found in the Island of Dominica; they had very much the appearance of the drone after they buried themselves in May; they began to vegetate towards the end of July, or rather they are found so about that time. When the tree has arrived at its full growth, it resembles a coral branch about three inches high, bearing several little pods, which are supposed by the inhabitants to "drop off and become worms, and from thence flies." This plant is considered to be a species of clavaria, similar to the one which is sometimes found on dead horses' hoofs. An interesting account has been given by a gentleman who, while botanizing in America, found lying on the ground a wasp's nest, which had, by some means unknown to him, been separated from a branch of a laurel, near which it had fallen. The creatures were in a strange condition after this disaster to their dwelling; some were flitting about over their cells, and by the softness of their wings and the faintness of their colours, were easily known to have been hatched but a short time. Many of them were lying dead on the ground; and on examining these he instantly perceived vegetables proceeding from their bodies, which were uniformly attached to the thorax. He collected about fifty of the vegetating wasps. On inspecting the nest, he found a considerable proportion of the cells empty; this, however, was not the case with them all, for there were still some that contained young wasps in the state of larvæ. He drew them from their cells, and satisfied himself that there was an incipient vegetation, and moreover that its progress had kept pace with the growth of the insect. Yet, in some instances, the vegetation is considered to commence only when life has ceased. In confirmation of this opinion, it is related that in Trinidad a wasp was found apparently in a perfect state, glued somehow by one of its wings to a leaf of a tree. From all parts of its body issued filaments from one to three inches long: they were shining black, and resembled the plant called Spanish beard.

The pupæ of a species of cicada which is common in Martinique and Dominica, have been found with a plant attached to them. As they bury themselves under the dead leaves to wait their change, it is supposed that, when the season is unfavourable, many perish. The seed of the fungus finds a proper bed on this dead insect, and grows. Mr. Edwards considers that they are not dead pupæ, but that before the insect is about to change, the fungus dries and falls off. Messrs. Kirby and Spence mention one of this genus in their cabinet, "with a kind of Sphæria with a twisted thickish stipes and oblong head, springing up in the space between the eyes." Dr. Hill says, in speaking of the cicada, "This you may be assured is the fact, and all the fact, though the untaught inhabitants suppose a fly to vegetate; and though there exists a Spanish drawing of the plants growing into a perfoliate tree, and it has been figured with the creature flying with this tree upon its back."

> "So wild are the imaginations of man,
> So chaste and uniform is nature."

Some imago specimens of lepidopterous insects have been brought from the tropical regions, covered with long slender filaments. They are always in a very decayed state. In China is found a geometrical larva, which has a long, rather thick stem, growing from the head; this is about two inches and a quarter long, while the insect itself is not quite one inch and a half in length. Father Parenin, who sent it to France, observes, in his account of it, that it was a scarce plant; being found only at the palace of Pekin there, where also it was not a native, but brought from the mountains of Tibet, and some other places on the confines of the Chinese dominions. This father had never seen the leaves or flowers of the plant, but only its roots, which were in high esteem there, not only because of their miraculous changes, but from their possessing the virtues of the ginseng. This plant, we are informed, is still in great estimation by the Chinese nobles. The roots had nothing particular in their figure or appearance; but with these the father sent home those which were supposed to be changed into a worm, for which they are called hiatsiotonetcheon, that is to say, a plant which, at a certain time of the year, changes into a worm. The Chinese suppose that this is a plant during the summer season; but that in winter its stalk dies, and the root becomes a worm; concerning which the father observed, that nothing could more exactly express a worm or caterpillar; the head, the eyes, the feet, and the mouth, being all plainly distinguishable, as well as the several folds and cuttings in of the body. This account was found to be perfectly true; but the mistake was owing to the want of proper accuracy in the observation: for the body, which was supposed to be the root transformed, had in reality never been any part of the plant, but was found to be really and truly a caterpillar. Some fanciful persons have supposed, that when the time of its change approached, it always selected the roots of this plant as of proper size and dimensions for its purpose; and gnawing off the end, hollowed away the stump, so as to introduce its tail into the cavity, where it remained covered with the bark of the root, which so nicely joins to it, that those who observe it in a slight way cannot but mistake it to be a part of the root, or the remainder of the root a continuation of the body. On opening the body of a larva, however, we find that the root of the fungus entirely occupies the whole interior portion from the head to the opposite end.

Most authors have supposed that the seeds are swallowed by the larva and cause its death, and that after that event it becomes the soil or base upon which the vegetables fasten themselves, and thus germinate in the decaying remains. On the other hand, if it be supposed that they are propagated by seeds in the ordinary mode, it plainly appears that the seeds would, on being wafted through the air, alight upon the most exposed part of the unhatched insect that was accommodated for its reception, and this would, of course, be near the head. Being there fixed, the plant would increase with the enlargement of the insect, and, drawing nourishment from its body, would continue to grow, even after it had attained its last and perfect state, until the plant has destroyed the life of the insect. The opinion now laid before the reader is more likely to be the truth. As insects often pass no small portion of their life in a state of torpidity, in which they remain chiefly without motion, it will not seem wonderful, should any partial moisture accidentally accumulate upon them, that it affords a seed-plot for certain minute fungi to come up and grow in.

Some insects have been found with portions of flowers attached to various parts of their bodies. Thus the stamina have been detected on bees, and even on coleopterous insects. Christian, a German writer, has described some very singular appearances which he observed on the first joint of the four posterior tarsi of *Hylocopa latipes*. These were battledoor-shaped laminæ, fixed in pairs by means of a footstalk to the joint, and are sometimes very numerous. He conjectures that the insect uses them for the purpose of collecting the pollen. But Messrs. Kirby and Spence have remarked, that some specimens do not possess this apparatus. They therefore imagine that these appendages are the anthers of flowers, and are spoils which the bees in question have filched from the blossoms of some plants.

CHAPTER XIX.

NATURAL HISTORY OF SOME INSECTS WHICH ARE OBNOXIOUS TO TREES.

History of the Larva which is termed the Oak-pruner—History of he Larva which causes Tumours on Fruit-trees—History of Hylesinus Destructor—History of the brown-tailed Moth.

SOME insects cause very great mischief to trees, many of which are peculiarly infested by certain kinds. Of such magnitude are the ravages sometimes committed, that whole forests have been destroyed by them; therefore it becomes necessary for man to exert his best endeavours to stop the progress of such an evil. Before he can accomplish this object, he must make himself well acquainted with the peculiar modes of life of the insect or insects which have thus attacked them; and perhaps the history of several may not prove uninteresting to the general reader.

For several years past, the ground beneath the black and white oaks of America has been observed to be strewed with small branches of those trees from eighteen inches to two feet in length. Some of them have been found five feet in length and an inch in diameter. The falling of these branches is occasioned by the larva or grub of an insect, which, from this effect of its labour, may be called the oak-pruner. When its feeding or larva state is nearly complete, it eats away the wood in a circular direction, leaving only the bark entire; this is broken by the first strong breeze, and the branch, with the larvæ in it, falls to the ground. Several branches containing larvæ were placed in a vessel covered with a piece of window-glass to prevent the escape of the perfect insects if any should be disclosed, and to retard the drying of the mould, as a certain degree of humidity is necessary to favour the development of the parts of the perfect insect while it is in the nympha state: in the body and larger branches of trees, the moisture is sufficient for this purpose, but in these small branches, which are killed, the moisture would be exhaled by the action of the sun and wind, if they remained on the tree, whereas, by their falling, and being placed nearly or quite in contact with the moist earth, their humidity is preserved. It was not precisely with this view that the prepared branches were treated as above mentioned; but the purpose was attained. The vessel was kept in a warm room, the wood was kept moist, and one perfect insect made its appearance in November, and another in December; but it was supposed that they would not have been disclosed till the spring if the branches had remained abroad. The insect belongs to a tribe called capricorn beetles, or wood-eaters, and is probably diffused over a large portion of the United States, wherever the oaks, which it prefers, are found. The falling of the branches, with the larvæ in them, enables us, though we cannot destroy the species, to check its ravages in some degree. The branches should be collected from the time they begin falling till they cease to fall, and should be carefully burnt.

The plum and cherry-trees are often disfigured with irregular swellings on the younger branches. The seat of this disease is in the bark. The sap is diverted from its regular course, and is absorbed entirely by the bark, which is very much increased in thickness; the cuticle bursts, the swelling becomes irregular, and is formed into black lumps, with a cracked, uneven, granulated surface. The wood, besides being deprived of its nutriment, is very much compressed, and the branch above the tumour perishes. On taking off a thin slice of the tumour, on the 27th of June, it was found to be inhabited by living larvæ, and they were supposed to be the cause of the tumour. Some branches were placed in a vial, to observe their progress to maturity. On the 6th of July, the observer perceived that the larvæ had left the tumour, and were uneasy in the bottom of the vial. A vessel of earth was immediately prepared: the larvæ, when turned into it, buried themselves instantly. On the 30th of the same month the perfect insects began to rise. They proved to be insects which had long been known to occasion the fall of peaches, apricots, and plums, by the larvæ eating into the kernel of those fruits long before they had acquired half their growth. The evil produced by this insect cannot be wholly remedied; but something may be done to diminish the mischief by cutting off the diseased branches, provided this be done at the right season, and by the joint labour of the whole neighbourhood at the same time. Those insects which furnished the data above set down, ceased to feed on the 6th of July, rose from the earth on the 30th, and were soon ready to deposite their eggs in healthy branches; but, if the diseased branches are cut off before the end of June, a great number may be most effectually destroyed by burning the branches on which the tumours are seen. It is possible that in some situations they may be disclosed earlier; it will therefore be necessary to prune away the tumours as soon as they appear. The insects which cause this mischief belong to the Linnæan genus *Curculio*.

The elm-trees of St. James's and Hyde Park were attacked, in 1824, by an insect known to entomologists by the name of *Hylesinus destructor*, which caused great havoc, especially in the Mall and Birdcage walk. The elm-trees in both parks, and particularly in St. James's Park, were being rapidly destroyed; and unless decisive measures had been taken to resist the progress of the contagion, we might have had to regret the dissemination of the evil throughout the vicinity of London. The devastation committed by these animals is at times so great, that it is clearly worth while to make experiments to obviate it, although it is difficult to conceive how such experiments can ever be made philosophically, by persons who do not, in the first instance, make themselves acquainted with the natural history of that particular species of destructive insect which may have occasioned the mischief.

A small beetle, with its head rather covered with hair, having a polished black thorax and brown wing-cases, may be seen in numbers running over the trunks of the elms from the end of March to the first days of July, but principally about the end of May or the commencement of June. It may be seen to enter into holes, with which the bark appears perforated as though with a gimlet. It insinuates itself into these holes, or into the crevices of the bark, for the purpose of depositing its eggs. On stripping off a piece of the loose bark, we may easily, at any season, understand how the barking of trees is effected by these minute insects, for the surface of the wood thus exposed presents to the view innumerable impressions. The middle or body of this singular impression marks the path of the perfect female insect, while employed in laying her eggs, which is to her, as to most other winged insects, the immediate forerunner of death. From this tubular path, however, in which she deposites her eggs, the larvæ hatched from these eggs, in the shape of little white worms, proceed nearly at right angles, eating their way in parallel smaller tubes, which, lying close to each other, effectually serve to separate the bark from the tree. The larvæ remain feeding in the tree, generally between the bark and the wood, throughout the winter season. About the commencement of spring they assume the pupa or nympha state, and, before the end of this season, the bark of an infected tree begins to appear as if all its crevices were full of a very fine sawdust. The last change of the insect takes place; and being now winged, it tries to arrive at the external air, for the purpose of propagating its species, and laying its eggs in other trees. Each hole, which now appears as if made with a gimlet, marks the exit of a perfect insect. In the first instance the voracity of the larvæ, and in the second the endeavours of the perfect insects to liberate themselves from the wood, particularly where such attempts are made by almost infinite numbers, soon occasion the bark to fall in large pieces. The consequence is, that the new leaves only make their appearance to wither, and the tree perishes. It is advisable for those persons who have elm-trees which are attacked by these animals, to inspect them twice every year: first in summer, when the perfect insect is on the wing; and secondly in winter, when the trees which are much infected ought to be cut down. Such trees ought, if possible, to be burnt with the larvæ in them, or, if this be not convenient, they should immediately be subjected to such heat or fumigations as may destroy the larvæ, which at this season are near the surface, and therefore not so difficult to kill. To rest content with having cut down the trees without destroying the larvæ, or even removing the trunk from the vicinity of sound wood, is, in reality, to do no good at all. In the year 1780, an insect of the same kind appeared in infinite numbers in the pine forests of the Hartz, and was neglected. In two years afterward whole forests had disappeared, and, for want of fuel, an end was nearly put to the mining operations of this extensive range of country.

In 1782 the public attention was excited by the unusual appearance of an infinite number of large white webs, containing caterpillars, conspicuous on almost every hedge, tree, and shrub in the vicinity of London. In many parishes subscriptions were opened, and the poor people employed to cut off and collect the webs at one shilling per bushel, which were burnt under the inspection of the parish officers. At the first onset fourscore bushels were collected in one day in the parish of Clapham. Some writers went so far as to assert that they were a usual presage of the plague, others that they would destroy all kinds of vegetables, and thus starve the cattle in the fields. Prayers were even offered up in some churches, on account of their great number, which was considered by some sufficient to render the air pestilential. This idea is founded on the grossest ignorance, and carries with it its own refutation; the health of the public was by no means affected by them, either immediately or remotely.

The pest which caused these ravages and fright, is the caterpillar of the brown-tailed moth, the young caterpillars of which are hatched early in autumn. As soon as they quit the egg they set about spinning a web, and having formed a small one, they proceed to feed on the foliage, by eating the upper surface and fleshy part of the leaf, and leaving the under side and ribs. It is curious to observe with what regularity they marshal themselves for this purpose. Thus they proceed daily, spinning and enlarging their web, to which they retreat every night and in bad weather, and extending their depredations. In the course of a few weeks their operations begin to be visible on the trees; their web as yet is not so conspicuous, as those leaves which are stripped of their green part assume a dead appearance. Now is the time to destroy them, while their nest is small, and their ravages just visible, by collecting the twigs and branches on which they lie hid in their web, and then burning them, merely to prevent their returning again to the trees and shrubs. If this operation is performed early it will save the autumnal verdure of the foliage. Should the web, however, be left till winter, it will have acquired a stronger and tougher texture, so as to bear pulling off, which should be preferred to pruning in certain cases, especially where it regards the fruit-trees. In short, no other remedy will avail. When benumbing winter arrives, they confine themselves entirely to their silken habitation; they then not only secure the general web on all sides as strongly as they can, to exclude impertinent intruders, but each individual spins a thin case for itself. Here they rest in a state of torpid security till the genial warmth of the spring animates them afresh, and informs them that the all-bountiful Author of Nature has provided food convenient for them. Thus apprized, they issue forth in the daytime and in fine weather, as before; but having acquired stronger powers, and the foliage they have now to encounter being more tender, they become less scrupulous in their feeding, and devour the whole of it. A disposition to associate continues with them till they have changed their last skins, when they usually separate, each endeavouring to provide in the best manner for itself. At this period many are attacked by the ichneumon-fly. Some, however, continue together, when each spins a separate web, in which it changes to a chrysalis; this usually takes place about the beginning of June. It remains about three weeks in a state of perfect quietude, when it changes in July to the moth, which is perfectly white, except that at the end of the abdomen is a tuft of brown down, with which the female covers her eggs after they are laid.

The most probable causes of their appearance are, the peculiarity of the weather, and the plenty or scarcity of the enemies of the insect. As to the former, warm and dry weather is universally allowed to promote the generation of insects; violent winds, heavy and long-continued rains, or extreme cold, are, on the contrary, supposed to check and destroy them. It is, however, wonderful to observe with what address they secure themselves from the effects of the two former. Such as feed on boughs, on such occasions, creep from them to the large branches or body of the tree, where they rest unshaken; and those which reside in webs are so secured as to suffer little injury from any of those causes. It appears that the only mischief these caterpillars are capable of occasioning is to rob particular trees and shrubs of their foliage and blossoms: it remains to consider how far the trees and shrubs will be injured by such a loss, and how far it may be injurious to their owners. It has been found, by repeated observation, that those trees and shrubs which have been entirely stripped have not been killed thereby, but as soon as the caterpillars have removed to change to chrysalis, they have put forth fresh foliage: the only loss, therefore, the owner sustains from their depredations on those trees which are not cultivated for the sake of the fruit, is some check to their growth, and a temporary deprivation of the beauties of spring and autumn. But the gardeners sustain more serious injuries by these insects, as they destroy the blossoms in the bud as well as the fruit.

CHAPTER XX.

THE NATURAL HISTORY OF THE FLEA.

Its supposed Manner of Appearance—Its eggs—Rösel's Opinion with respect to the Young—Defrance's Opinion—The Manner of preparing Food for the young Larvæ—Description of its Pupa and Cocoon—Perfect Insect, its Habits.

Ewlin, in his book of Travels in Turkey, has recorded a singular tradition of the history of the flea and its confraternity, as preserved among a sect of Kurds, who dwelt in his time at the foot of Mount Sindshar. "When Noah's ark," says the legend, "sprung a leak by striking against a rock in the vicinity of Mount Sindshar, and Noah despaired altogether of safety, the serpent promised to help him out of his mishap if he would engage to feed him upon human flesh after the deluge had subsided. Noah pledged himself to do so; and the serpent, coiling himself up, drove his body into the fracture and stopped the leak. When the pluvious element was appeased, and all were making their way out of the ark, the serpent insisted upon the fulfilment of the pledge he had received; but Noah, by Gabriel's advice, committed the pledge to the flames, and scattering its ashes in the air, there arose out of them fleas, flies, lice, bugs, and all such sorts of vermin as prey upon human blood, and after this fashion was Noah's pledge redeemed." Setting aside all the marvellous contained in this legend, it is not difficult to trace in it the germes of that vulgar error which attributes the production of various small but noxious species of insects to the existence of what is termed "a blight," an error founded upon the most untenable ideas of natural history, but which is, nevertheless, so deeply rooted, that it requires "line upon line, and precept upon precept," to dislodge it from the minds even of well-educated persons.

Descending, however, from fiction to plain matter of fact, we propose in this chapter to detail the natural history and series of transformations which the insect first mentioned undergoes previous to appearing in its perfect state, and which, although our readers may probably have no idea of their existence, are not less remarkable than those of the butterfly or the beetle.

It appears that Aristotle was the first author who was acquainted with any of these changes, since he noticed not only that the flea has distinct sexes, but that it produced σκώλης ὠοειδεῖς; from not, however, tracing the insect through its different states, he fancied this progeny was completely *sui generis* and imperfect, and that the perfect insect was generated spontaneously in the earth. just as at the present day plant-lice, turnip-flies, &c., are supposed to be generated spontaneously in the air. Indeed, as Mr. Mac Leay observes, it is always either at the egg or pupa state that Aristotle, and, we may add, many other naturalists, have lost sight of the metamorphosis, and, in the absence of experiment, have had recourse to fancy. Hence, the name given to this insect by the Romans, *Pulex*, is stated by Isidorus to have been derived from pulvis,* dust, quasi pulveris filius. So likewise Mouffet tells us, that the flea is produced from the dust, especially when moistened with urine, the smallest ones springing from putrid matter; and Scaliger relates that they are produced from the moistened humours among the hairs of dogs.

The Dutch naturalist Leeuwenhoeck was, how-

* Our English name Flea, and the German Flock, are evidently deduced from the quick motions of this insect.

ever, the first author who traced the insect from the egg to the perfect state. The German naturalist Rösel was also equally successful; and he has illustrated the subject with a complete series of figures. It appears that the female deposites about a dozen white slimy eggs, of a rather large size in proportion to the size of the insect. According to the last-named author, these eggs are deposited at random, but we shall subsequently find that this is scarcely correct. During the summer the young larvæ burst forth from the egg at the end of five or six days; at their birth they are white, and subsequently assume a reddish tinge. They are long, cylindric, and destitute of legs, so that, in fact, they resemble small worms. They are extremely active, and constantly in motion, rolling themselves up in a spiral or serpentine form; the body is distinctly divided into thirteen rings, and the head is scaly, and furnished with a pair of very small antennæ and a mouth; the last segment of the body is also furnished with several small appendages, which are employed in locomotion. Down the back of these larvæ may be observed a longitudinal vessel, similar to that which is perceived along the back of the silkworm. It is stated that these larvæ feed upon the fleshy portions of feathers, and the blood of animals, and that they are found in the greatest profusion in dove-cots.

From the recent investigations of M. Defrance, however, it seems questionable whether Latreille has not fallen into some error in these statements —at all events, we should not be surprised if some of our ladies, who allow their lapdogs to repose on their sofas, do not endeavour to clear up some of the many points in the history of these insects which yet remain. The eggs, from eight to twelve in number, are of an oblong form, of an equal size, and rounded at each end; they are quite smooth and dry, capable, upon the least motion, of rolling about like drops of quicksilver, and of falling into the lowest crevices in the substance upon which they have been deposited, and in which the larvæ, when hatched, may be protected. To convince ourselves of these facts it is sufficient to examine, especially during the summer, a fauteuil, upon which a dog or cat is accustomed to lay, where these eggs may be found in profusion, between the body of the animal and the seat of the sofa.

If we were not prejudiced against these insects on account of their attacks upon us, we might naturally feel anxiety for the fate of the larvæ which proceed from the eggs, thus apparently left unprotected. Nature, however, ever careful towards all her productions, has provided for their support in a most remarkable manner. With the eggs may be found numerous small black grains, which evidently have fallen from the animal upon which the parent insect has been feeding, and which, in fact, are to become the food of the larvæ, being nothing else than dried drops of congealed blood, which, upon being moistened, immediately resume a liquid state and red colour. These grains have generally been considered as the excrement of the parent insect; but M. Defrance states several reasons which have induced him to doubt whether they have such an origin. Among these may be mentioned the circumstance, that, had these drops of blood passed through the body of the insect, they would have lost the colour and fluidity of blood, and that no instance is known of animals providing so nauseous a repast for their progeny as their own excrement. These reasons do not, however, appear to us quite satisfactory, since every one has observed that, in killing a well-fed flea, its body is completely filled with what appears to be nothing else than red blood; and it does not follow that these grains are really excrementitious, since numerous instances might be adduced, in which the food laid up in store for the future larva has first undergone a system of cooking, if we may use such a term, in the body of the parent, before it is fit for the use of the progeny. M. Defrance, indeed, considers that the female has the sagacity to inflict a wound upon the animal for the purpose not only of supplying its own wants, but also those of its offspring, by causing a slight trickling of the blood, which, however, from the warmth of the animal, immediately dries up. Our author considers this to be proved by the circumstance that these grains are found only among the hairs of the animal attacked, or in the places where it has lain; whereas, had it been excrementitious matter, they would have been found in other places where the fleas abound. Be this, however, as it may, the existence of these grains cannot be regarded otherwise than as one of those admirable instances of instinctive care which is bestowed by the Creator upon the meanest of his creatures, for the due support of a yet unborn progeny, and the consequent preservation of the species.

That these grains form the food of the larvæ is evident from the observations of M. Defrance, who expressly states that he fed the young larvæ with some which he had found with the eggs. These larvæ creep along very quickly; their progressive motion resembling that of a worm in stretching the head forward, and then drawing the rest of the body after it. They were not, however, able to ascend the sides of the box in which they were placed. Neither these larvæ nor the cocoons which they spin, are ever to be found upon the animals attacked by the parent; indeed, from their being very soft and unable to protect themselves in this state, it is improbable that they should be generally met with in such a situation. M. Defrance presented to the larvæ several flies, and some of them did not seem unwilling to feed upon the fleshy parts of their bodies, which were exposed in certain situations where the thorax had been injured; they would not, however, attack uninjured flies.

On the 9th of September some of these larvæ (which burst forth on the 28th of the preceding month, from eggs deposited on the 23d) commenced weaving their cocoons. Before taking this step, however, they entirely voided the remains of their undigested food, as is the practice with the majority of larvæ, after which they appeared quite white and transparent.

Rösel, however, observed, that while some of the larvæ incased themselves in a cocoon, others underwent their transformations naked and without covering. The cocoon which they weave is of a silky texture, and of an ellipsoid form, of a white colour within and grayish externally, and often covered with powder; they are generally affixed to the surrounding objects. The pupa bears great resemblance to the perfect insects, with the difference only of the legs being folded closely upon the belly, and the insect itself being covered with a thin pellicle, the eggs being enclosed in distinct cases. Of course, at this period, the insect is quite inactive. The colour of the pupa is at first a dirty white, but it afterward assumes the teint of the perfect insect.

According to some authors, however, those larvæ which are not hatched from the eggs until the end of the summer, pass the winter in that form. The period of the duration of the pupa state varies from eleven to sixteen days, at the expiration of which the insect sheds the thin pellicle which had previously enclosed it, and appears in its perfect and active form.

And now commence those annoying attacks upon our persons, from which none are exempt, and against which various remedies have been proposed; on which subject the following pleasant piece of satire, by Poor Humphrey, will be read with a smile.

"A notable projector became notable by one project only, which was a certain specific for the killing of fleas, and it was in form of a powder, and sold in papers, with plain directions for use, as followeth:—The flea was to be held, conveniently, between the thumb and finger of the left hand; and to the end of the trunk or proboscis, which protrudeth in the flea, somewhat as the elephant's doth, a very small quantity of the powder was to be put from between the thumb and finger of the right hand. And the deviser undertook, if any flea to which his powder was so administered should prove to have afterward bitten a purchaser who used it, then that purchaser should have another paper of the said powder gratis. And it chanced that the first paper thereof was bought, idly as it were, by an old woman, and she, without meaning to injure the inventor or his remedy, but of her mere harmlessness, did innocently ask him, whether, when she had caught the flea, and after she had got it as before described, if she should kill it with her nail it would not be as well. Whereupon the ingenious inventor was so astonished by the question, that, not knowing what to answer on the sudden occasion, he said with truth, to this effect, that without doubt her way would do too. And according to the belief of Poor Humphrey, there is not as yet any device more certain or better for destroying a flea, when thou hast captured him, than the ancient manner of the old woman's, or, instead thereof, the drowning of him in fair water, if thou hast it by thee at the time."

Although, however, water, soap, and the broom of the housewife be the most efficacious instruments in getting rid of these torments, Poor Humphrey is in error in thinking that immersion of them in fair water is equally serviceable. In like manner, the idea is equally erroneous, that causing dogs which are tormented with them to go into the water is sufficient to kill the fleas. It has been ascertained that fleas which had been kept under water for twenty-two hours, had revived on being taken out; even several females had remained unhurt when immersed for eleven hours.

The inhabitants of Dalecarlia place the skins of hares in their apartments, in which the fleas willingly take refuge, so that they are easily destroyed by the immersion of the skin in *hot* water. But in this, as in the case of other similar plagues, cleanliness is the best remedy.

CHAPTER XXI.

THE NATURAL HISTORY OF VARIOUS SPECIES OF CRABS, AND OTHER CRUSTACEOUS ANIMALS.

History of the Lobster, the mode of casting its Skin, its Parasite—History of the Land-crab—History of the Hermit-crab—History of the Pea-crab.

THE crab, lobster, shrimp, prawn, and numerous other species of aquatic animals, although regarded by Linnæus as belonging to the class of insects, have been established by Cuvier, from a comparative examination of their peculiarities of respiration, circulation, &c., with those of the true insects, into a distinct class, to which, from the hardness of the crust or covering of their bodies, the name of *Crustacea* has been applied. Still these animals, as well as the spider, the scorpion, the centipede, and many others, agree with the insects not only in the number of their legs, which are composed of several joints, but also in the articulated structure of the body; hence the whole of these animals (insects we can scarcely call them) have been again brought together, constituting the sub-kingdom *Annulosa* or *Articulata* of modern authors.

It would be out of place in a work like the present to enter at length into those physiological peculiarities which distinguish the classes *Crustacea*, *Arachnida*, and insects. We shall therefore proceed to lay before our readers the natural history of several of the more interesting species belonging to the first-mentioned class.

The Lobster (*Astacus gammarus*, *Cancer gammarus*, Linn.), first claims our attention. This species is specifically distinguished by the produced spine of the front of the shell having three teeth in each side, with a double tooth at the base. The antennæ are very long, and the claws large, by which it is easily distinguished from the spiny lobster (*Palinurus quadricornis*, Fab.), in which the forelegs do not exceed the following in size. The lobster inhabits all the rocky shores of England, but chiefly where there is a depth of water. They are brought in vast quantities from the Orkney Islands, and many parts of the eastern coast of Scotland, to the London markets. Sixty or seventy thousand are annually brought from the neighbourhood of Montrose alone. It is, however, from the coast of Norway that the London market is chiefly supplied. The lobster was well known to the ancients, being found as far as the Hellespont. It is well described by Aristotle, and is called at Constantinople liczuda and licpuda. The habitation of this species is in the clearest water, at the foot of rocks which impend over the sea. The mode of capturing the lobster is in pots, a sort of trap formed of wicker-work, and baited with dead animal matter, upon which they feed, as well as, it is said, upon the weeds; the pots are formed in the shape of a wire mousetrap, so that when the lobster gets in there is no return; they are fastened to a cord sunk in the sea, and their place marked by a buoy. They begin to breed during the spring, and continue breeding through the summer months. They are extremely prolific, Dr. Baxter having counted not fewer than 12,444 eggs beneath the tail, besides others which remained within the body unprotruded. They deposite their eggs in the sand, where they are soon hatched.

The following account of the remarkable circumstances connected with a singular trait in the economy of these animals, namely, the periodical casting of the skin, extracted from Dr. Roget's admirable Bridgewater Treatise, will be read with interest.

"The process by which the periodical casting and renewal of the shell of lobsters are effected has been very satisfactorily investigated by Reaumur. The tendency in the body and in the limbs to expand during growth, is restrained by the limited dimensions of the shell, which resist the efforts to enlarge its diameter. But this force of expansion goes on increasing, till at length it is productive of much uneasiness to the animal, which is in consequence prompted to make a violent effort to relieve itself; by this means it generally succeeds in bursting the shell; and then, by dint of repeated struggles, extricates its body and its limbs. The lobster first withdraws its claws, and then its feet, as if it were pulling them out of a pair of boots; the head next throws off its case, together with its antennæ, and the two eyes are disengaged from their horny pedicles. In this operation, not only the complex apparatus of the jaws, but even the horny cuticle and teeth of the stomach, are all cast off along with the shell: and, last of all, the tail is extracted. But the whole process is not accomplished without long-continued efforts. Sometimes the legs are lacerated or torn off in the attempt to withdraw them from the shell, and in the younger crustacea the operation is not unfrequently fatal. Even when successfully accomplished, it leaves the animal in a most languid state; the limbs, being soft and pliant, are scarcely able to drag the body along. They are not, however, left altogether without defence.

"For some time before the old shell was cast off, preparations had been making for forming a new one. The membrane which lined the shell had been acquiring greater density, and had already collected a quantity of liquid materials proper for the consolidation of the new shell. These materials are mixed with a large proportion of colouring matter, of a bright scarlet hue, giving it the appearance of red blood, though it differs totally from blood in all its other properties. As soon as the shell is cast off, this membrane, by the pressure from within, is suddenly expanded, and, by the rapid growth of the soft parts, soon acquires a much larger size than the former shell. Then the process of hardening the calcareous ingredient commences, and is rapidly completed; while an abundant supply of fresh matter is added, to increase the strength of the solid walls which are thus constructing for the support of the animal. Reaumur estimates that the lobster gains, during each change of its covering, an increase of one fifth of its former dimensions. When the animal has attained its full size, no operation of this kind is required, and the same shell is permanently retained.

"A provision appears to be made, in the interior of the animal, for the supply of the large quantity of calcareous matter required for the construction of the shell at the proper time. A magazine of carbonate of lime is collected, previous to each change of shell, in the form of two round masses, one on each side of the stomach. In the crab these balls have received the absurd name of crabs' eyes; and during the formation of the shell they disappear.

"It is well known, that when an animal of this class has been deprived of one of its claws, that part is, in a short time, replaced by a new claw, which grows from the stump of the one which had been lost. It appears, from the investigations of Reaumur, that this new growth takes place more readily at particular parts of the limb, and especially at the joints; and the animal seems to be aware of the greater facility with which a renewal of the claw can be effected at these parts; for if it chances to receive an injury at the extremity of the limb, it often, by a spontaneous effort, breaks off the whole limb at its junction with the trunk, which is the point where the growth more speedily commences. The wound soon becomes covered with a delicate white membrane, which presents, at first, a convex surface; this gradually rises to a point, and is found, on examination, to conceal the rudiment of a new claw. At first this new claw enlarges but slowly, as if collecting strength for the more vigorous effort of expansion which afterward takes place. As it grows, the membrane is pushed forward, becoming thinner in proportion as it is stretched, till at length it gives way, and the soft claw is exposed to view. The claw now enlarges rapidly, and in a few days more acquires a shell as hard as that which had preceded it. Usually, however, it does not attain the same size, a circumstance which accounts for our frequently meeting with lobsters and crabs which have one claw much smaller than the other. In the course of the subsequent castings, this disparity gradually disappears. The same power of restoration is found to reside in the legs, the antennæ, and the jaws."

All the species of crustacea belonging to the great division to which the lobster is referred, and which have the eyes placed at the extremity of footstalks (*Malacostraca podophthalma*), are supposed, from analogy, to undergo a similar series of moultings to those described above; but it is a curious circumstance that the exuviæ even of the commonest species, such for instance as the crayfish (*Astacus fluviatilis*), found in all our rivers, are very rarely indeed to be met with, hence various conjectures have been raised as to what becomes of them.

The description of a remarkable parasitic animal has been recently published, and which we have repeatedly noticed. They are of minute size, and are found fixed upon the gills of the lobster, beneath the sides of the shell, often in considerable numbers. The shape of this little animal is very extraordinary; it, in fact, somewhat resembles a butterfly, with four extended wings, but destitute either of head or abdomen. On examining it, however, more minutely, a very diminutive abdomen is seen, composed of four joints, and terminated by several bristles; the head seems pushed between the shoulders, and is provided with a pair of small eyes and two antennæ; the organs of the mouth consist of a pair of claws and four pairs of cleft articulate feelers, serving also, as it would seem, as organs of locomotion in the earlier state of the creature's existence, previous to its becoming fixed to the branchiæ of the lobster, as there are no other locomotive organs. The sides of the body are greatly dilated, forming, in fact, the two anterior appendages, which have been likened to the forewings of the butterfly; the hinder pair of wings is represented by a pair of large oval sacs, distended by eggs. The entire length of the body of this curious little creature does not exceed 1-24th of an inch. It is a singular subject for inquiry, how this small animal, unprovided as it almost appears to be with locomotive organs, can attain its singular situation within the body of a large active creature like the lobster. All the individuals yet discovered have been females, having the sacs distended with eggs; and it is suggested, among other interesting speculations, that it is in a very young state, before the oviferous sacs have attained their distended size (at which latter period the animal seems quite destitute of motion), that the *Nicothoe astaci* (by which name this parasite is designated) possesses more extensive locomotive powers, and is enabled, from its small size, to find its way to the interior of the shell of the lobster.

The Land-crab (*Gecarcinus ruricola*) is an inhabitant of the Bahama Islands, as well as most tropical countries; it feeds upon vegetables, and is remarkable for the curious economy which it exhibits in its annual voyages from its retreats in mountainous districts to the seacoast. The majority of crabs are inhabitants of the sea or the seacoasts, but the land-crabs, as their name indicates, reside upon land, even in elevated districts, where it is said that they live in a kind of orderly society. Once a year, however, during the months of April and May, they undertake a march of the most laborious description to the coast, to the number of several millions. Sallying forth from the stumps of hollow trees, from the clefts of rocks, and from the holes which they have dug for themselves in the ground, the whole surface of the earth is so completely covered with this band of adventurers, that there is no setting down the foot without treading upon them. In their passage to the ocean they preserve, in a remarkable degree, a direct line, a shorter course could scarcely be found, turning neither to the right nor left, be the obstacles in their path ever so great; indeed, it is even said, that if they meet a house in their way they will attempt to scale the walls rather than turn from the line of route. The procession sets forth with all the regularity of a well-disciplined army, under the direction of an experienced general. They are divided into three battalions, the first consisting of the strongest and boldest males, which, like pioneers, march forward to clear the way, and face the greatest dangers; then follows the main body of the procession, consisting of females, which do not quit their retreats until the rain has set in, in columns of fifty paces broad and three miles deep. A few days afterward the remainder of the procession appears, consisting of straggling males and females, neither so robust nor so vigorous as the former. When, after a fatiguing march, and escaping a thousand dangers, they arrive at the coast, the females immediately prepare to cast their spawn; this, at first, is seen beneath the tail of the crab, like the spawn of the lobster; but the crab, seeking the shore, casts off this spawn into the water, leaving it to hatch at random. The eggs which escape from the ravenous fishes which attend the arrival of the army, for the purpose of sharing in the annual banquet afforded by the eggs, are soon hatched in the sand, and shortly afterward millions of little crabs are seen quitting the shore, and slowly ascending the mountains. The old crabs have much less energy, and do not return until they have cast their skins, and obtained a new and hardened coat.

The Hermit-crab (*Pagurus Bernhardus*) is a common British species, which exhibits in its economy one of those interesting intimacies of connexion which are so universally found to exist between the structure and habits of animals. Unlike the majority of crabs, the tail of this species is quite fleshy; if exposed, therefore, the animal would be found to possess no sufficient defence against any accident which might happen to it in the tempestuous element in which it resides, against those species of fish and other marine animals which would devour it. Hence nature has directed it to take refuge in the deserted shells of various molluscous animals, which it seems to select almost indiscriminately according to its size, from the smallest nerite to the largest whelk. Having the hinder-part of its body introduced within this shell (which it accommodates to its wants in a remarkable manner), it may be seen crawling about with much agility, thrusting out its larger claw to seize upon its food, and with which it is unable to pinch very hard. It is curious to watch the manœuvres of this crab when its old house has become too small for it, and it is in search of a new one. Crawling slowly along the line of empty shells and pebbles formed by the last wave, and unwilling to part with even an incommodious habitation before it has acquired a new one, it is seen stopping, first at one shell, turning it about, examining it, and passing it by; then proceeding to the next, which seems more convenient, slipping its tail out of its old shell and trying it in the new, and again returning to the old one if this should not suit it. In this manner it proceeds until it has found one sufficiently light and commodious, which it selects, although it should even be so large as to hide the body of the animal, claws and all. Combats even sometimes occur between two crabs for the possession of some well-looking shell upon which they may both have fixed, and of which each endeavours to take possession, striking at and biting each other with their claws, till the weakest is obliged to give up all pretensions to the object of dispute. When this crab is laid hold of it emits a slight noise or cry, and endeavours to seize its adversary with its nippers; and, should it succeed in laying hold, it will rather die than quit its grasp.

The Pea-crabs (*Pinnotheres Pisum*) exemplify, in a no less degree than the hermit-crabs, the same admirable adaptation of habits to the structure of an animal which we have already alluded to in speaking of the latter. They are of small size, and, unlike the latter, are parasites upon various living molluscous animals, which inhabit bivalve shells, which the females never afterward quit, and enclosed in which the females not only grow but breed. Muscles are occasionally infested with these crabs; and it is interesting to observe, that the small rounded form of this animal especially adapts it for making its way through the valves of the shell of an animal which would instantly endeavour to close the passage were it a larger one, or one unable to slip readily through the entrance. Aristotle was acquainted with these crabs, since he says, "There breed in some shells white and very small crabs; the greatest numbers are found in that species of muscle which have the shell protuberant; next in that of the pinnæ, whose crab is named pinnotheres. They are also found in cockles and oysters. These little animals never grow in any sensible degree, and the fishermen imagine that they are formed at the same time with the animal they inhabit." He likewise supposed that their lives are so dependant upon each other, that if the muscle loses its little crab, both shortly afterward perish. "The pinna," according to Pliny, "is never found without its companion, which is a little shrimp; in some places a small crab which bears it company, in order to partake of its food. The pinna gaping wide, and showing her naked body to tempt the little fishes, they soon make their approaches, and, when they find they have full license, grow so bold as to enter in and fill it; this being seen by the guardian shrimp, by a slight rap he gives the signal to the pinna, who thereupon shuts her shell and suffocates whatever it encloses, giving a share of booty to her companion." Oppian still more absurdly supposed that the pinnotheres, finding the shells of the bivalve open, throws a small stone between them to prevent their closing, and so enables it to devour the inhabitant; while Hasselquist as ridiculously tells us, that the crab goes out to cater for the pinna, and, when it returns, cries out for the shell to be opened, which the grateful inhabitant immediately complies with.

CHAPTER XXII.

ON THE METAMORPHOSES OF INSECTS.

Metamorphoses of Insects — Larva — Pupa— partial—complete— semi-complete — subsemi-complete — incomplete — obtected—coarc tate.

In this chapter we will confine ourselves to the illustration and description of the metamorphoses of insects. In many we find the state of the larva, or that which immediately succeeds the escape of the insect from the egg, distinguished by the ordinary terms of grubs, maggots, gentils, worms, &c., which names appear to be indiscriminately employed in common language, not only for the soft-bodied larvæ of different orders, but also for many of the underground feeding larvæ of moths, as well as for real worms. Hence it appears to us to be injudicious to attempt to apply any or either of them definitely to the contents of any one particular order, as some persons have attempted to do, considering that such a step would not tend in the least degree to clear up the confusion, since the names are evidently considered and employed as synonymous terms. Thus the larva of the tipula is called "the grub," and that of the cheese and baconfly (*Piophila casei*), a maggot; while the latter name is also given to the larva of the nut-weevil (*Balaninus nucum*); in like manner those of the *Tenebrionidæ* and *Elateridæ* are termed meal-worms and wire-worms, while those of some species of gnats are usually named blood-worms.

In this state the insect is never provided with wings; it feeds voraciously, sheds its skin several times, and generally attains its largest size; the majority of winged insects being smaller than the full-grown larvæ from whence they have sprung.

To this state succeeds, in some of the orders, a state of inactivity, somewhat similar to that of the chrysalis of butterflies; but in the other orders the insect continues to feed and move throughout this period, for which, whether active or quiescent, we possess no other term than nymph to distinguish it from the chrysalis state of the butterfly. Some peculiarity is, however, observable in the nature of the transformations of each order, which we will now proceed shortly to notice.

In the first place, however, we will observe, that although in the introduction to our former volume we have divided the metamorphoses of insects into two kinds—*partial*, in which the insect does not vary in its form, so that it may be recognised in all its states as the same individual—and *complete*, in which the pupæ take no food, and are incapable of motion, and the change is such that nothing but the evidence of our senses would convince us of the identity of the insect in its first and last states—this mode of distribution requires some modification, since the pupæ of the dragonfly, as may be perceived from the figures in our first volume, are active and voracious, although their broad form would scarcely be supposed likely to produce so elegant and slender-shaped an insect as the *Libellulæ*. Moreover, the gnat is very active during the pupa state, although its larva is of a totally different form; and in the caddice-flies the pupæ become active towards the period of their disclosure as perfect insects

The first peculiarity noticeable in the transformations of insects is that exhibited by spiders, scorpions, mites, harvest-men, &c., composing the class *Arachnidæ*, and by centipedes, millepedes, lice, sugar-lice, &c., comprising the class *Ametabola*. In these animals the only change which takes place consists in the shedding of the outer skin, without any variation of form taking place, except in a few instances, where an increase is made to the number of legs or to the segments of the body. It is to this kind of transformation, or rather to its pupa state, that Linnæus gave the name of *complete*—because at this period it has its various members developed in a greater degree than in any other pupæ, and capable of being employed in the economy of the animal. Some authors, including the celebrated Dr. Burmeister, overlooking this circumstance, have considered the term *complete* to have been applied to the *kind of metamorphosis*, and, consequently, to have been improperly used, the *transformation* being, in fact, the *least complete* of any undergone by insects.

It may likewise be considered serviceable to remind the reader of the complete difference between insects and vertebrated animals, whence the necessity of these continued moultings will be at once perceived. In the latter, the skeleton to which the muscles are attached is permanent and internal; but in insects the reverse takes place, the skeleton being external, and, of course, preventing any increase of size, except at the periods of moulting.

To the preceding kind of transformations the domestic bug (*Cimex lectularius*) appears at first sight to be referrible, from the circumstance of wings not being developed; rudiments of them, however, exist, whence, as well as from other characters, the relationship of this insect to the winged land and water bugs, composing the order *Heteroptera*, is established; the latter, although active and voracious in all their states, and retaining the same general form, possessing in the active pupa state rudiments of wings. These pupæ Linnæus accordingly termed *semi-complete*.

In like manner, if a young frog-hopper (*Tetti* *gonia*), cuckoo-spit insect (*Aphrophora spumaria*), or plant-louse (*aphis*), composing the order *Homoptera*, be examined, the resemblance with the perfect insect will be found to be not less striking.

If, again, the preparatory states of the grasshopper, cricket, locust, or praying mantis be noticed, these insects will be found to possess through life the same general form, the larvæ being destitute, and the pupa possessing merely the rudiments, of wings. These insects differ from the preceding groups (which are suctorial) in having the mouth formed for mastication; they have, consequently, been formed into a separate order named *Orthoptera*. The cockroach (*Blatta*), and the earwig (*Forficula*), likewise undergo similar transformations, and have the mouth formed for mastication, whence they are considered by some authors to belong to the same order, although Dr. Leach, from some differences in the perfect state, formed them into two distinct orders, named *Dermoptera* and *Dictyoptera*.

The next variation is that exhibited by the dragonflies and the Mayflies, forming a portion of the order *Neuroptera*. In these two groups the larva and pupa are active, and resemble each other, except that the latter is furnished with the rudiments of wings; but the organs of the mouth are of a very different construction from those of the perfect insect. The general resemblance, also, which these insects bear in their preparatory state to the perfect fly, is much slighter than in the preceding groups, although it is evident, from the activity of the pupæ, that they are not widely separated from them in this respect. Mr. MacLeay has applied the term *subsemi-complete* to this kind of transformation.

In all the preceding instances we have observed that the insect continues in an active state from the period of its exclusion from the egg until that of its death. In the following variations, however, a state of inactivity occurs during the time in which the insect undergoes its pupa state, although, as we shall subsequently notice, there are certain insects in which it is only during a portion of the time occupied in this stage that this inactivity continues. Thus, in the caddice-flies, composing the order *Trichoptera*, Mr. Kirby has pointed out the curious circumstance, that, shortly before the insect throws off its pupa skin in order to appear as a winged fly, it is endowed with activity, its legs are put in motion, and, by the assistance of a pair of curious hooks on the head, the meshes of the net, which it had, previous to becoming a pupa, spun at the mouth of its cage, are cut; the object of which is very evident, since, were such not the case, the insect could not be able to join its brethren in their mystic dances in the air; the larva being aquatic, it is requisite that, previous to throwing off the pupa skin and appearing in the winged state, the insect should quit its former native element, and make its way into one which will be better suited to its future state.

The next variation of metamorphosis (to which indeed the *Trichoptera* are in strictness referrible), is generally termed incomplete, and comprises a far greater number of insects than any of the other kinds, the body of the pupa being covered with a thin skin, having the various organs, as the legs, wings, antennæ, &c., enclosed in separate sheaths, which are laid along the breast during the inactive pupa state, and from which the insect, on arriving at the perfect state, draws out its limbs, just as we do our fingers from a glove; these limbs are, consequently, not so closely applied or fixed to the body as in the true chrysalides, and they therefore allow the form of the various parts to be easily observed. The numerous tribes of beetles (order *Coleoptera*), bees, wasps, sawflies, &c. (order *Hymenoptera*), ant-lion-flies (*Myrmeleonidæ*), goldeneyed flies (*Hemerobiidæ**), and some other families of the order *Neuroptera*, as well as the flea, forming the order *Aphaniptera*, all belong to this division. We, however, possess specimens of *Coleopterous* and *Hymenopterous* insects in the pupa state, which have the legs and wings as closely applied to the breast as in the true chrysalides of butterflies; so that it is from analogy alone that we are convinced that the limbs must be enclosed in distinct sheaths.

Shortly previous to the disclosure of the perfect insect, the pupa in this state acquires a slight degree of activity, moving its legs, while yet covered by their sheaths, in order to make its way out of its narrow retreat; but there are other insects which are generally regarded as undergoing an incomplete metamorphosis, in which the limbs of the pupa, although incased in distinct sheaths, are incapable of being employed in locomotion; this is the case with the gnats† and some other species of dipterous insects.

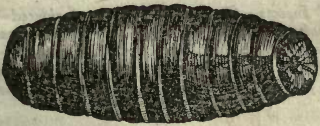
The transformations of the butterflies and moths (*Lepidoptera*) are termed obtected, from the various organs of the pupa, chrysalis, or aurelia, being en-

* In our first volume, page 187, we have detailed the history and figured the larva of the *Hemerobius*, which is furnished with legs, jaws, and antennæ, and which, having spun a globular cocoon, is therein transformed into an inactive pupa, having the limbs disengaged from the body, but enclosed in distinct sheaths.

† We have already (vol. i., p. 193,) figured the larva and pupa of the gnat. In the former state the body is destitute of legs, but in the pupa, instead of being inactive, like that of the syrphus, blowfly, &c., it is capable of moving briskly about in the manner of a shrimp; its activity being produced, not by the real locomotive organs, but by repeated jerkings of the body: moreover, it does not appear that it takes any food while in this state, whence it must be considered that its activity is analogous to the writhing of the chrysalides of butterflies rather than to the voracious activity of the pupa of the dragon-fly, &c., whose limbs are endowed with locomotive powers, while those of the gnat are all enclosed in a common sheath.

closed in a mummy-like case, which gives them a swathed appearance.

The last kind of metamorphosis which we have to notice is that undergone by the majority of two-winged flies (*Diptera*), and which is known by the name of the coarctate species of transformation. Here we find the pupa enclosed, not in a cocoon spun by the larva, as in the moths, but in a hardened case formed of the outer skin of the larva itself, which in these insects is not cast off as in the remainder, and within which the real pupa, having its limbs enclosed in distinct cases, is to be found. Here, however, two variations occur, in the first of which the skin of the larva retains its old form, as in the *Stratiomidæ* and some other families; while in the second, of which the blowfly is an example, the larva by degrees loses its elongated form, and assumes the appearance of a small oval, barrel-shaped mass,* the skin being hard and brittle, on



Barrel-shaped pupa-case of the blowfly, formed of the skin of the larva.

breaking which the enclosed pupa is found to occupy the whole space; whereas, in the former, the pupa is much smaller than the larva, several seg-

* In our former volume, page 185, we have figured the footless larva of the syrphus, which feeds in the former state upon the aphides, and which contracts itself by degrees into a cocoon, in which the real pupa is enclosed: and in page 205, we have represented the pupa of the botfly (*Œstrus*), which also belongs to the same class of transformations. This pupa, or rather pupa-case, is, however, capable of a slight motion by means of numerous recurved hooks upon the rings of the body.

ments of which are, of course, completely hollow. There is still another variation in the nature of the transformations of the insects of this order, which occurs not in the changes themselves, but in the situations in which they are undergone. Thus some species of flies, as the blowfly, hatch their eggs previous to their exclusion from the body; while others, as the forest-flies, retain the larva, not only until they are full grown, but until they have assumed the pupa state, at which period, from their large size, one only is capable of being produced at a time.

CHAPTER XXIII.

HINTS FOR STUDENTS.

Collection of Insects—Charge of Cruelty considered—Advantages of the Study of Entomology—Number of Species—Means of obtaining a Knowledge of Forms and Classification—Number of Generic Divisions—Terms—Instruments for collecting—Easiest Modes of putting to Death, &c.—Localities of Insects—Store-Boxes.

HAVING given a series of the histories of various insects, some of our readers might, after their perusal, from the singularity of the facts therein stated, be induced to pursue further the interesting and healthy science of entomology—a science which cannot but cause the most lively interest, as it opens the road to a still higher and more advantageous result than the mere study itself, by the expansion of the mind to the contemplation of the wisdom and power of Him who caused all created beings to exist.

Many objections have been raised against this attainment of a knowledge of the habits and economy of insects, from the supposed cruelty which entomologists are said to commit by taking the lives of a few individuals for the purpose of placing them in drawers, the object of which is to form, when they are placed side by side, an idea of their variations, and of the surprising differences which they exhibit. "Cruelty," say Messrs. Kirby and Spence, "is an unnecessary infliction of suffering, when a person is fond of torturing or destroying God's creatures from mere wantonness, with no useful end in view; or when, if their death be useful and lawful, he has recourse to circuitous modes of killing them, where direct ones would answer equally well."

This charge of cruelty is not brought against sportsmen or anglers, &c., whose only object is to add to the general stock of food in their larders; while the entomologist's object is to add to the general stock of mental food, and, at the same time, to endeavour to discover, for the benefit of the world in general, the means of destroying the many species of insects which are very injurious to our gardens, and more especially to our fields. The total failure of a crop of turnips in Devonshire, in 1786, was not less in value than £100,000; would it not therefore be worth while to find out a remedy for an evil of such enormous magnitude? In the first place, it becomes necessary, in such a case, to ascertain which of the several insects that have attacked the crop, whether the *Haltica nemorum*, termed by the farmer the turnip-fly, or black jack, *Centorhynchus contractus*, or the black larva of a sawfly, or the caterpillar of the cabbage butterfly, is the true cause of the mischief, as each of these various kinds of insects is different in habits, and in its modes of destroying the turnip. When this knowledge is obtained, a remedy can much better be proposed; but only then, it must be allowed, by one who understands the subject, or, in other words, by an entomologist.

Their ravages on other vegetables afford many similar instances. The young shoots of the vine are gnawed off by the *Lethrus cephalotes*, which drags them to its burrows, and there feeds upon them. The Hungarians, as Reaumur informs us, wage war with this insect, and destroy a great number. As the bud is on the point of opening, it is attacked by the small caterpillars of the *Ino statices;* they eat, as we are told by Pallas, their way into the fruit-buds, and destroy the germe of the future grapes, thus damaging the trees for two or three years. Two coleopterous insects attack the young shoots, the leaves and footstalks of the fruit, so that the latter is prevented from bearing grapes: and other species also make the young vine its food. Besides these, two small lepidopterous insects feed on this plant; one makes the leaves its choice, while the other feasts on the delicious fruit itself. Our greenhouse and hothouse vines are sometimes attacked by a coccus (*C. vitis*), which is not sufficiently hardy to bear the common temperature of our climate. This pest is easily known by the curious appearance which it exhibits on the stem, caused by a filamentous secretion transpiring through the skin of the animals, with which they cover their eggs. When they abound they cause great injury, by extracting the sap from various parts of the plant.

But although many insects, such as those just mentioned, are destined to destroy various kinds of useful and beneficial things, the Creator has caused others to check their ravages when they become too obnoxious, so that " all things" are " taught to keep within their proper limits. Hence it becomes necessary that some should prey upon others, and a part be sacrificed for the good of the whole." Thus the most splendid of British coleopterous insects, the *Calosoma sycophanta*, is said to take possession of the nests of moths, which sometimes appear in such masses on the trees, and to feed upon the caterpillars contained within them. Another of the same kind, *Carabus auratus*, is supposed to kill the females of the common cockchafers, when about to lay their eggs, and thus preserve the farmer from some hundreds of destructive grubs, the ravages of which we have described in a former chapter. There are also many others equally valuable in the same point of view, as, for example, the ichneumon-fly, the ant-lion (noticed in the former volume), &c. &c. But, without a knowledge of the science of entomology, how would it be possible to distinguish between those which are serviceable and those which are injurious to man? Others are of use, as food and as medicine to man: some of the wood-feeding larvæ were considered both by the ancients and by some modern nations as great delicacies. Madame Merian informs us that the natives of Surinam roast and eat those of the *Curculio palmarum*, as something very exquisite. An Indian king, it is said, set before his Grecian guests a roasted worm taken from a plant, which was probably the same larva. Its taste is said to be similar to sugared cream or sweet almond paste. Dr. Darwin supposes that the larvæ of the cockchafers might prove, if properly cooked, a delicious meal, and several others are also edible. On this, however, little stress need be laid, as modern refinement appears to have greatly diminished, if not altogether to have abolished, the taste for such delicacies of the insect race.

But not only does the study of insects tend in various ways to the good of mankind, it is also a subject of great interest as an endless amusement to the mind. The habits and economy of each separate species differ so greatly, and each single species offers so much material for thought, that it has been said, were man's life even longer than it is, it would not be sufficient to attain a thorough knowledge of the peculiar mode of life even of one insect. The following considerations will, however, show the almost boundless extent of the subject, as affording the materials of observation and of thought.

The great Linnè records in his immortal work, the Systema Naturæ, about 3,000 species, as the entire number of insects with which he was acquainted; yet he afterward showed that Sweden alone produces about 1,700, thus leaving but a small number as inhabiting the other portions of the world. The great Ray, who wrote towards the end of the seventeenth century, believed that there might be 10,000 species of insects in the world; but he afterward increased this supposed number to 20,000. Now the elaborate catalogue of British insects by Mr. Stephens contains 10,000 named species, and in the brief space which has elapsed since its publication, about 2,000 have been added, making 12,000 at present known to inhabit this country alone. The rapid strides which this interesting science has made of late years, have given rise to various speculations as to the probable number of species existing in the world. Mr. MacLeay conjectures that there are about 100,000, while M. Decandolle estimates them in the proportion of six to each phanerogamous plant and fungus; and as the number of these plants is estimated at about 100,000, the number of insects would be carried to the enormous sum of 600,000. This estimate far exceeds the conjecture of Ray, then considered a magnificent, although in truth a very poor, idea of the host of creeping animals. Messrs. Kirby and Spence seem to consider Decandolle's supposition as somewhat exaggerated, and estimate the number at about 400,000. The number of species actually existing in cabinets would certainly exceed 100,000.

To prove the rapid increase of the science, it may be worth while to state the difference which exists between the number of species in a few genera known to Linnæus, and that known to modern entomologists. Thus, of the two genera, cicindela and carabus, Linnæus enumerated fifty-nine species, while Count Dejean has described, from his own collection, nearly 2,500. The genus staphylinus contains, in the Systema Naturæ, twenty-six species. Mr. Stephens mentions, in his catalogue, 750 as inhabiting this country alone, and Count Dejean 789, from various parts of the world. Linnæus, again, mentions only seventy-seven species as forming his genus ichneumon; while the number now known far exceeds 3,000.

The best means for the young student to obtain an idea of classification is by studying a series of plates illustrative of the Linnæan genera, such as those given by Rœmer (Genera Insectorum Linnæi et Fabricii Iconibus illustrata), and also in Mr. Samouelle's Compendium of Entomology. If each figure is attentively examined, as regards its general form and appearance, at the same time impressing the name on the memory, the student cannot fail in his object. When he considers himself somewhat familiarized with the subject, he may next peruse a well-arranged cabinet, so as to make himself master of the modern system. For this purpose a cabinet of British insects, arranged on the system laid down by Mr. Stephens, would furnish an excellent study, as being the one generally adopted by British collectors. If he should be further desirous of extending his knowledge to exotic forms, he will find the system of Latreille the most simple and practical, while in the maze of many of those systems which are usually termed natural, the beginner, at least, would find himself inextricably involved, and would almost be induced to abandon the subject in despair.

The young student very generally, and very naturally, supposes that insects are arranged in too many divisions and subdivisions, and thinks that a smaller number of genera might be sufficient. But when we consider that the knowledge of species has been so greatly increased since the time of Linnæus, who was in many cases acquainted with only one in fifty of the number at present known, it becomes obviously necessary for entomologists to subdivide the groups which were then genera of Linnæus, into many sub-genera. By this means we are enabled to name specimens with greater ease, and thus save ourselves the trouble of running over a hundred, or perhaps a thousand descriptions, that would now be placed in one of the Linnæan genera, whereas in his time only twenty, or at the utmost fifty, of these species were described.

The terms which are the most generally employed are those indicated by Messrs. Kirby and Spence, whose work is indispensable to an entomologist. Although, on turning over the leaves of that portion of the work which contains the terminology, some students may be frightened with the mass of names set before them, it is well to bear in mind that only a certain portion of these is required by the beginner.

The most generally useful and simple instrument for capturing insects is the bag-net. It consists of a stout hoop of brass wire, the diameter of which extends to nine or twelve inches; to the hoop is sewed a bag of fine gauze; and this, fixed to a common walking-stick, not only serves for flying insects, but also enables the collector to sweep the grass, nettles, &c. This stick is also useful in beating the hedges, trees, &c., and thus disturbing the insects, which may then be caught by means of the net. Some entomologists, in fact, use only this apparatus, which has been found sufficient for all purposes. There is another net, which is termed a fly-net; but it requires considerable dexterity to use it to advantage. This net is about four or five feet long, and two or three feet broad; when laid open it is extended by means of two rods, one of which is held in each hand, and when the object is captured the two sticks are brought together. A third instrument is the forceps, which is made of two octagonal rings of five or six inches in diameter, closing upon each other by means of a hinge like that of a pair of curling-tongs, and furnished with handles like those of a pair of scissors. The rings are covered with gauze, or strong open net, so as to allow the pins' heads to pass through, which is very essential in capturing stinging insects especially. The object of its being made in an octagonal form is, that it may be used when insects are stationary on palings and walls, &c., where it would not be equally serviceable if made round. For the water, a net may be employed consisting of a strong ring of brass or iron, five or six inches in diameter, fixed to the end of a stick. To this ring a piece of canvass, of at least three inches in depth, should be attached; and a piece of strong net sewn round the edge of the canvass completes the bag. This last is not in fact really wanted; the net may be made entirely of canvass, which would no doubt be better for very minute insects, many of which inhabit the water.

The next object is to know how to put the insects captured to speedy death, as many are very tenacious of life. The hard-winged tribes, as beetles and field-bugs, are placed, when collected, in a bottle of spirit of wine, which usually destroys their vitality almost immediately, or in a tin collecting-box, which is peculiarly constructed for the purpose. It is about three inches in length and one and a half in diameter, and rather flattened; from the centre of the lid there projects inwards a small spout of tin, which is made fast by a tin cover. But the collector must not forget that many insects are cannibals, and eat one another without any sort of discrimination. Several boxes are therefore generally carried, in which the different kinds are placed. On returning home, the insects thus collected are turned into a vessel of boiling water, which kills those which had not been previously put to death by the spirit of wine, and relaxes their limbs so that they can after-wards be pinned and set at leisure. The softer-winged insects, such as butterflies, moths, flies, &c., must be pinned as soon as taken; the two former are disabled by pressing the trunk under the fore wings between the finger and thumb. They are placed, as collected, in a chip or mahogany box, about seven inches long and four or five broad, but the former generally requires the sides to be cut down so as to allow about two inches clear in the inside. The top and bottom of this box are corked with close-grained cork. The entomologist must be provided with a series of small pill-boxes, in each of which he can place separately any very small and tender insects. The inside of the hat, well corked, has become a fashionable repository for the impaled insects.

Thus provided, the entomological collector sallies forth in quest of his game. Each variety of situation furnishes its peculiar kind. It is indispensable that he should examine the forests and woods, especially their borders and vicinity, which generally contain numerous species of all the orders, and more particularly *Lepidopterous* insects. On the mountains and hills on which certain plants are found, and also in the valleys and plains, he will obtain numerous kinds, especially if the latter have a sunny exposure. Heaths are not very prolific in minute insects, but still they have their own peculiar inhabitants; some prefer those situations where the turf has been peeled, and others the sunny banks of sand-pits. Cultivated lands afford the entomologist as well as the agriculturist a rich harvest. He must not pass over meadows and pastures, as many insects lie hidden in the grass. Numerous species feed on certain wild plants, some of which are rarely met with; the insect-hunter should therefore be particular in examining them, in the hope of discovering some scarce insect. Different kind of soils have also their peculiar species; of these, the lighter appear to be the most prolific; but much time will be lost in searching a clay-pit, as only very few insects are found in such a locality. Old trees afford a nidus for various insects, as well as timber and planks which have not been disturbed for a considerable time. On palings, post and rails, &c., are found lepidopterous species, and also others in a state of repose. The sea itself has its particular species, especially under stones, after the water has left the shore. The running streams are the element of some throughout their metamorphoses, of others only through their larval stages. The collector must also look under stones on the bank, as well as in the mud. Aquatic plants afford food for many, and even their roots require examination. Stagnant water contains its peculiar kinds, especially under the duckweed, and brackish must not be neglected. Even carrion and dung form the habitation of a great variety of species.

Scarcely any situation, indeed, is without its peculiar races of insects; and the poet, Thomson, seems to have been well acquainted with their various haunts:—

> "Ten thousand forms! ten thousand different tribes!
> People the blaze. To sunny waters some
> By fatal instinct fly; where on the pool
> They, sportive, wheel; or, sailing down the stream,
> Are snatch'd immediate by the quick-eyed trout
> Or darting salmon. Through the greenwood glade
> Some love to stray; there lodged, amused, and fed
> In the fresh leaf. Luxurious, others make
> The meads their choice, and visit every flower
> And every latent herb: for the sweet task,
> To propagate their kinds, and where to wrap,
> In what soft beds, their young yet undisclosed,
> Employs their tender care. Some to the house,
> The fold, and dairy, hungry, bend their flight;
> Sip at the pail, or taste the curding cheese;
> Oft, inadvertent, from the milky stream
> They meet their fate; or, weltering in the bowl,
> With powerless wings around them wrapped, expire."

We recommend the beginner to use store-boxes for the purpose of arranging his collections, as it is easy to place them in a cabinet after obtaining a knowledge of the subject, and when the collection has attained some degree of magnitude. These boxes should be made about eighteen inches square, and two and a half deep; the lids should be fitted very closely to keep out the acari, and the boxes should be corked both above and below. The great advantage resulting from this plan is, that additions can be made to the number of the boxes from time to time, without much displacement of the specimens, and they may, consequently, be made use of until the entomologist has obtained some tolerable idea of the space which is likely to be required for the final arrangement of his specimens in a proper cabinet.

END OF VOL. II.

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