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THE STRUCTURE AND LIFE-HISTORY OF THE COCKROACH (PERIPLANETA ORIENTALIS)

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The Structure and Life-history of the Cockroach (Periplaneta orientalis)

An Introduction to the Study of Insects

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PREFACE.

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That the thorough study of concrete animal types is a necessary preliminary to good work in Zoology or Comparative Anatomy will now be granted by all competent judges. At a time when these subjects, though much lectured upon, were rarely taught, Döllinger, of Würzburg, found out the right way. He took young students, often singly, and made them master such animal types as came to hand, thereby teaching them how to work for themselves, and fixing in their minds a nucleus of real knowledge, around which more might crystallise. “What do you want lectures for? Bring any animal and dissect it here,” said he to Baer, then a young doctor longing to work at Comparative Anatomy.1 It was Döllinger who trained Purkinje, Pander, Baer, and Agassiz, and such fame cannot be heightened by words of praise. In our own time and country Döllinger’s methods have been practised by Professor Huxley, whose descriptive guides, such as the Elementary Biology and the delightful little book on the Crayfish, now make it easy for every teacher to work on the same lines. From the description of the Cockroach in Huxley’s Anatomy of Invertebrated Animals came the impulse which has encouraged us to treat that type at length. It may easily turn out that in adding some facts and a great many words to his account, we have diluted what was valuable for its concentration. But there are students—those, namely, who intend to give serious attention to Entomology—who will find our explanations deficient rather

than excessive in detail. It is our belief and hope that naturalists will some day recoil from their extravagant love of words and names, and turn to structure, development, life-history, and other aspects of the animal world which have points of contact with the life of man. We have written for such as desire to study Insects on this side.

Whoever attempts to tell all that is important about a very common animal will feel his dependence upon other workers. Much of what is here printed has been told before. The large number of new figures is, however, some proof that we have worked for ourselves.

It is a pleasant duty to offer our thanks for friendly help received. Professor Félix Plateau, of Ghent; Mr. Joseph Nusbaum, of Warsaw; and Mr. S.H. Scudder, of Cambridge, Massachusetts, have very kindly consented to treat here of those parts of the subject which they have specially illustrated by their own labours.2 Mr. E.T. Newton, of the Jermyn Street Museum, has lent us the wood blocks used to illustrate one of his papers on the Brain of the Cockroach. A number of the figures have been very carefully and faithfully drawn for us by Miss Beatrice Boyle, a student in the Yorkshire College. We are much indebted to Dr. Murie, the Librarian of the Linnean Society, for procuring us access to the extensive literature of Insect Anatomy, and for answering not a few troublesome questions.

Five articles on the Cockroach were contributed by us to Science Gossip in 1884, and some of the figures were then engraved and published.

In issuing a book which has been long in hand, but which can never hope to be complete, we venture to adopt the

words already used by Leydig concerning his Lehrbuch der Histologie:—“Die eigentlich nie fertig wird, die man aber für fertig erklären muss, wenn man nach Zeit und Umständen das Möglichste gethan hat.”

CHAPTER I.

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WRITINGS ON INSECT ANATOMY.

MARCELLO MALPIGHI. 1628–1694.
JAN SWAMMERDAM. 1637–1680.
PIERRE LYONNET. 1707–1789.
HERCULE STRAUS-DÜRCKHEIM. 1790–1865.

The lovers of minute anatomy have always been specially attracted to Insects; and it is not hard to tell why. No other animals, perhaps, exhibit so complex an organisation condensed into so small a body. We possess, accordingly, a remarkable succession of memoirs on the structure of single Insects, beginning with the revival of Anatomy in the 17th century and extending to our own times. The most memorable of these Insect-monographs bear the names of Malpighi, Swammerdam, Lyonnet, and Straus-Dürckheim.

Malpighi on the Silkworm.

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Malpighi's treatise on the Silkworm (1669) is an almost faultless essay in a new field. No Insect—hardly, indeed, any animal—had then been carefully described, and all the methods of work had to be discovered. "This research," says Malpighi, "was extremely laborious and tedious" (it occupied

about a year) “on account of its novelty, as well as the minuteness, fragility, and intricacy of the parts, which required a special manipulation; so that when I had toiled for many months at this incessant and fatiguing task, I was plagued next autumn with fevers and inflammation of the eyes. Nevertheless, such was my delight in the work, so many unsuspected wonders of nature revealing themselves to me, that I cannot tell it in words.” We must recall the complete ignorance of Insect-anatomy which then prevailed, and remember that now for the first time the dorsal vessel, the tracheal system, the tubular appendages of the stomach, the reproductive organs, and the structural changes which accompany transformation were observed, to give any adequate credit to the writer of this masterly study. Treading a new path, he walks steadily forward, trusting to his own sure eyes and cautious judgment. The descriptions are brief and simple, the figures clear, but not rich in detail. There would now be much to add to Malpighi’s account, but hardly anything to correct. The only positive mistakes which meet the eye relate to the number of spiracles and nervous ganglia—mistakes promptly corrected by Swammerdam. Had the tract De Bombycibus been the one work of its author, this would have kept his memory bright, but it hardly adds to the fame of the anatomist who discovered the cellular structure of the lung, the glandular structure of the liver and kidney, and the sensory papillæ of the skin, who first saw the blood-corpuscles stream along a vessel, who studied very early and very completely the minute structure of plants and the development of the chick, and whose name is rightfully associated with the

mucous layer of the epidermis, the vascular tufts of the kidney, and the follicles of the spleen, as well as with the urinary tubules of Insects.

All that we know of Malpighi commands our respect. Precise and rapid in his work, keen to discover points of real interest, never losing himself in details, but knowing when he had done enough, he stands pre-eminent in the crowd of minute anatomists, who are generally faithful in a few things, but very unfit to be made rulers over many things. The last distinct glimpse which we get of him is interesting. Dr. Tancred Robinson, writing to John Ray, from Geneva, April 18th, 1684, tells how he met Malpighi at Bologna. They talked of the origin of fossils, and Malpighi could not contain himself about Martin Lister's foolish hypothesis that fossils were sports of nature. "Just as I left Bononia," he continues, "I had a lamentable spectacle of Malpighi's house all in flames, occasioned by the negligence of his old wife. All his pictures, furniture, books, and manuscripts were burnt. I saw him in the very heat of the calamity, and methought I never beheld so much Christian patience and philosophy in any man before; for he comforted his wife, and condoled nothing but the loss of his papers, which are more lamented than the Alexandrian Library, or Bartholine's Bibliothece, at Copenhagen."3

Swammerdam on the Honey Bee.

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Swammerdam's great posthumous work, the Biblia Naturæ, contains about a dozen life-histories of Insects worked out in more or less detail. Of these the May-fly

(published during the author’s life-time, in 1675) is the most famous; that on the Honey Bee the most elaborate. Swammerdam was ten years younger than Malpighi, and knew Malpighi’s treatise on the Silkworm—a not inconsiderable advantage. His working-life as a naturalist comes within the ten years between 1663 and 1673; and this short space of time was darkened by anxiety about money, as well as by the religious fanaticism, which in the end completely extinguished his activity. The vast amount of highly-finished work which he accomplished in these ten years justifies Boerhaave’s rather rhetorical account of his industry. Unfortunately, Boerhaave, whom we have to thank not only for a useful sketch of Swammerdam’s life, but also for the preservation of most of his writings, was only twelve years old when the great naturalist died, and his account cannot be taken as personal testimony. Swammerdam, he tells us, worked with a simple microscope and several powers. His great skill lay in his dexterous use of scissors. Sometimes he employed tools so fine as to require whetting under the microscope. He was famous for inflated and injected preparations. As to his patience, it is enough to say that he would spend whole days in clearing a single caterpillar. Boerhaave gives us a picture of Swammerdam at work which the reader does not soon forget. “His labours were superhuman. Through the day he observed incessantly, and at night he described and drew what he had seen. By six o’clock in the morning in summer he began to find enough light to enable him to trace the minutiæ of natural objects. He was hard at work till noon, in full sunlight, and bareheaded, so as not to obstruct the light;

and his head streamed with profuse sweat. His eyes, by reason of the blaze of light and microscopic toil, became so weakened that he could not observe minute objects in the afternoon, though the light was not less bright than in the morning, for his eyes were weary, and could no longer perceive readily.”

Comparing Swammerdam’s account of the Bee with the useful and amply illustrated memoir of Girdwoyn (Paris, 1876), it is plain that two centuries have added little to our knowledge of the structure of this type. Much has been made out since 1675 concerning the life-history of Bees, but of what was to be discovered by lens and scalpel, Swammerdam left little indeed to others. It is needless to dwell upon the omissions of so early an explorer. Swammerdam proved by dissection that the queen is the mother of the colony, that the drones are males, and the working-bees neuters; but he did not find out that the neuters are only imperfect females. In this instance, as in some others, Swammerdam’s authority served, long after his death, to delay acceptance of the truth. It is far from a reproach to him that in the Honey Bee he lit upon an almost inexhaustible subject. In the 17th century no one suspected that the sexual economy of any animal could be so complicated as that which has been demonstrated, step by step, in the Honey Bee.

Lyonnet on the Goat Moth.

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In Lyonnet’s memoir on the larva of the Goat Moth (Traité Anatomique de la Chenille qui ronge le bois de Saule,

17604) we must not look for the originality of Malpighi, nor for the wide range of Swammerdam. One small thing is attempted, and this is accomplished with unerring fidelity and skill. There is something of display in the delineation of the four thousand and forty-one muscles of the Caterpillar, and the author's skill as a dissector is far beyond his knowledge of animals, whether live or dead. The dissections of the head are perhaps the most extraordinary feat, and will never be surpassed. Modern treatises on Comparative Anatomy continue to reproduce some of these figures, such as the general view of the viscera, the structure of the leg, and the digestive tract. Nearly the whole interest of the volume lies in the plates, for the text is little more than a voluminous explanation of the figures.

It is not without surprise that we find that Lyonnet was an amateur, who had received no regular training either in anatomy or engraving, and that he had many pursuits besides the delineation of natural objects. He was brought up for the Protestant ministry, turned to the bar, and finally became cipher-secretary and confidential translator to the United Provinces of Holland. He is said to have been skilled in eight languages. His first published work in Natural History consisted of remarks and drawings contributed to Lesser's Insect Theology (1742). About the same time, Trembley was prosecuting at the Hague his studies on the freshwater Polyp, and Lyonnet gave him some friendly help in the work. Those who care to turn to the preface of Trembley's famous treatise (Mémoires pour servir à l'histoire des Polypes d'eau douce, 1744) will see how warmly Lyonnet's services are acknowledged. He made all the

drawings, and engraved eight of them himself, while Trembley is careful to note that he was not only a skilful draughtsman, but an acute and experienced observer. When the work was begun, Lyonnet had never even seen the operation of engraving a plate. Wandelaar, struck by the beauty of his drawings, persuaded him to try what he could do with a burin. His first essay was made upon the figure of a Dragon-fly, next he engraved three Butterflies, and then, without longer apprenticeship, he proceeded to engrave the plates still required to complete the memoir on Hydra.

Lyonnet tells us that the larva of the Goat Moth was not quite his earliest attempt in Insect Anatomy. He began with the Sheep Tick, but suspecting that the subject would not be popular, he made a fresh choice for his first memoir. Enough interest was excited by the Traité Anatomique to call for the fulfilment of a promise made in the preface that the description of the pupa and imago should follow. But though Lyonnet continued for some time to fill his portfolio with drawings and notes, he never published again. Failing eyesight was one ground of his retirement from work. What he had been able to finish, together with a considerable mass of miscellaneous notes, illustrated by fifty-four plates from his own hand, was published, long after his death, in the Mémoires du Muséum (XVIII.–XX.).

Straus-Dürckheim on the Cockchafer.

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In beauty and exact fidelity Straus-Dürckheim’s memoir on the Cockchafer (Considérations Générales sur l’Anatomie Comparée des Animaux Articulés, auxquelles on a joint

l’Anatomie Descriptive du Melolontha vulgaris, 1828) rivals the work of Lyonnet. Insect Anatomy was no longer a novel subject in 1828, but Straus-Dürckheim was able to treat it in a new way. Writing under the immediate influence of Cuvier, he sought to apply that comparative method, which had proved so fertile in the hands of the master, to the Articulate sub-kingdom. This conception was realised as fully as the state of zoology at that time allowed, and the Considérations Générales count as an important step towards a complete comparative anatomy of Arthropoda. Straus-Dürckheim had at command a great mass of anatomical facts, much of which had been accumulated by his own observations. He systematically compares Insects with other Articulata, Coleoptera with other Insects, and the Cockchafer with other Coleoptera. Perhaps no one before him had been perfectly clear as to the morphological equivalence of the appendages in all parts of the body of Arthropods, and here he was able to extend the teaching of Savigny. His limitations are those of his time. If in certain sections we find his collection of facts to be meagre, and his generalisations nugatory, we must allow for the progress of the last sixty years—a progress in which Straus-Dürckheim has his share. It is the work of science continually to remake its syntheses, and no work becomes antiquated sooner than morphological generalisation.

It is therefore no reproach to Straus-Dürckheim that his treatise should now be chiefly valuable, not as “Considérations Générales,” but as the anatomy of the Cockchafer. Long after his theories and explanations have ceased to be instructive, when the morphology and

physiology of 1828 have become as obsolete as the Ptolemaic astronomy, the naturalist will study these exquisite delineations of Insect-structure with something of the pleasure to be found in examining for the hundredth time a delicate organism familiar to many generations of microscopic observers.

The fidelity and love of anatomical detail which characterise the description of the Cockchafer are not less conspicuous in Straus-Dürckheim's Anatomie Descriptive du Chat (1846). Both treatises have become classical.

We have seen how, in Straus-Dürckheim's hands, Insect anatomy became comparative. New studies—histology, embryonic development, and palæontology—have since arisen to complicate the task of the descriptive anatomist, and it appears to be no longer possible for one man to complete the history of any animal of elaborate structure and ancient pedigree. As a method of research the monograph has had its day. The path of biological discovery now follows an organ or a function across all zoological boundaries, and it is in the humbler office of biological teaching that the monograph finds its proper use.

Later Insect Anatomists.

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It is impossible even to glance at the many anatomists who have illustrated the structure of Insects by studies, less simple in plan, but not less profitable to science, than those of the monographers. If we attempt to select two or three names for express mention, it is with a conviction that

others are left whom the student is bound to hold in equal honour.

Dufour[5] laboured, not unsuccessfully, to construct a General Anatomy of Insects, which should combine into one view a crowd of particular facts. The modern reader will gratefully acknowledge his industry and the beauty of his drawings, but will now and then complain that his sagacity does not do justice to his diligence.

Newport,[6] a naturalist of greater weight and interest, is memorable for his skill in minute dissection, for his many curious observations upon the life-history of Insects (see, for example, his memoir on the Oil-beetle), and especially for his early appreciation of the value of embryological study.

Leydig[7] was the first to occupy fully the new field of Insect histology, and point out its resources to the physiologist. In all his works the student finds beauty and exactness of delineation, suggestiveness in explanation. Leydig's contributions to Insect anatomy and physiology, valuable as they are to the specialist, are not isolated researches, but form part of a new comparative anatomy, based upon histology. Incomplete so vast a work must necessarily remain, but it already extends over considerable sections of the animal kingdom.

CHAPTER II.

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THE ZOOLOGICAL POSITION OF THE COCKROACH.

Sub-kingdom ARTHROPODA.	
Class I.	Crustacea.
" II.	Arachnida.
" III.	Myriopoda.
" IV.	Insecta.
Order 1.	Thysanura.
" 2.	Orthoptera.
" 3.	Neuroptera.
" 4.	Hemiptera.
" 5.	Coleoptera.
" 6.	Diptera.
" 7.	Lepidoptera.
" 8.	Hymenoptera.

The place of the Cockroach in the Animal Kingdom is illustrated by the above table. It belongs to the sub-kingdom Arthropoda, to the class Insecta, and to the order Orthoptera.

Characters of Arthropoda.

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Arthropoda are in general readily distinguished from other animals by their jointed body and limbs. In many Annelids the body is ringed, and each segment bears a pair of appendages, but these appendages are soft, and never articulated. The integument of an Arthropod is stiffened by a deposit of the tough, elastic substance known as Chitin, which resembles horn in appearance, though very different in its chemical composition. In marine Arthropoda, as well as in many Myriopoda and Insects, additional firmness may be gained by the incorporation of carbonate and phosphate of lime with the chitin. However rigid the integument may be, it is rendered compatible with energetic movements by its unequal thickening. Along defined, usually transverse lines it remains thin, the chitinous layer, though perfectly continuous, becoming extremely flexible, and allowing a certain amount of deflection or retraction (fig.1). The joints of the trunk and limbs may thus resemble stiff tubes. Muscles are attached to their inner surface, and are therefore enclosed by the system of levers upon which they act (fig.2B). In Vertebrate animals, on the contrary, which possess a true internal skeleton, the muscles clothe the levers (bones) to which they are attached (fig.2A). The whole outer surface of an Arthropod, including the eyes, auditory membrane (if there is one), and surface-hairs, is chitinised. Chitin may also stiffen the larger tendons, internal ridges and partitions, and the lining membrane of extensive internal cavities, such as the alimentary canal, and the air-tubes of Insects.

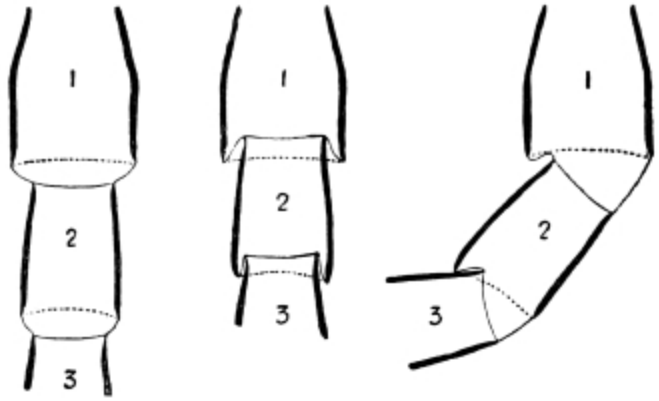

Fig. 1.—Diagram of Arthropod limb extended, retracted, and flexed. Graber has given a similar figure (Insekten, fig.8*).

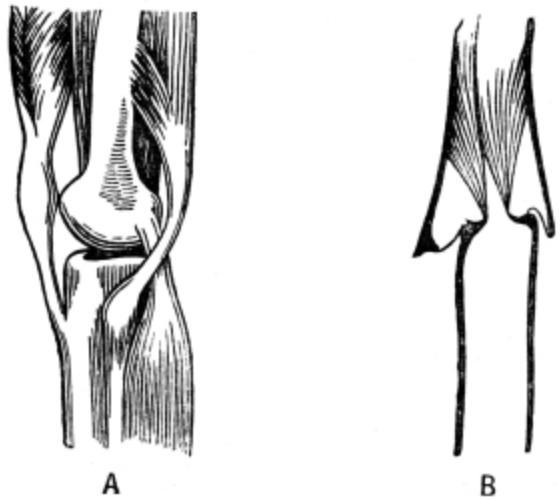

Fig. 2.—Vertebrate and Arthropod joints. A, Vertebrate joint, the skeleton clothed with muscles. B, Arthropod joint, the skeleton enclosing the muscles.

In most Arthropoda the body is provided with many appendages. In Crustacea there are often twenty pairs, but some Myriopoda have not far from two hundred pairs. Some of these may be converted to very peculiar functions; in particular, several pairs adjacent to the mouth are usually appropriated to mastication. One or more pairs of appendages are often transformed into antennæ.

The relative position of the chief organs of the body, viz.:—heart, nerve-cord, and alimentary canal, is constant in Arthropoda. The heart is dorsal, the nerve-cord ventral, the alimentary canal intermediate. (See fig.3.) The œsophagus passes between the connectives of the nerve-cord. Not a few other animals, such as Annelids and Mollusca, exhibit the same arrangement.

Arthropoda are not known to be ciliated in any part of the body, or in any stage of growth. Another histological peculiarity, not quite so universal, is the striation of the muscular fibres throughout the body. In many Invertebrates there are no striated muscles at all, while in Vertebrates only voluntary muscles, as a rule, are striated.

The circulatory organs of Arthropoda vary greatly in plan and degree of complication, but there is never a completely closed circulation.

The development of Arthropoda may be accompanied by striking metamorphosis, *e.g.*, in many marine Crustacea, but, as in other animals, the terrestrial and fluviatile forms usually develop directly. Even in Insects, which appear to contradict this rule flatly, the exception is more apparent than real. The Insect emerges from the egg as a fully formed larva, and so far its development is direct. It is the full-grown larva, however, which corresponds most nearly to the adult Myriopod, while the pupa and imago are stages peculiar to the Insect. It is not by any process of embryonic development, but by a secondary metamorphosis of the adult that the Insect acquires the power of flight necessary for the deposit of eggs in a new site.

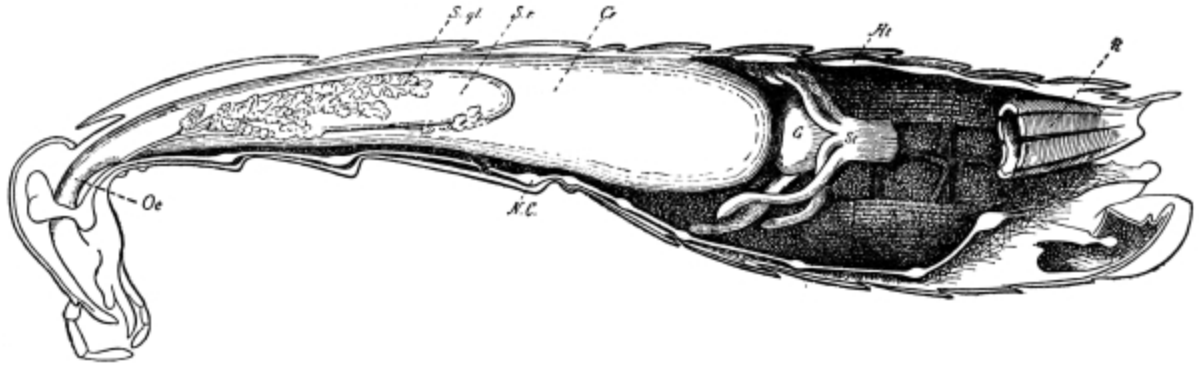

Fig. 3.—Longitudinal section of Female Cockroach, to show the position of the principal organs. *Oe*, œsophagus; *S.gl*, salivary gland; *S.r*, salivary reservoir; *Cr*, crop; *G*, gizzard; *St*, chylific stomach; *R*, rectum; *Ht*, heart; *N.C*, nerve-cord. ×7.

Characters of Insects.

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Insects are distinguished from other Arthropoda by the arrangement of the segments of the body into three plainly marked regions—head, thorax, and abdomen; by the three pairs of ambulatory legs carried upon the thorax; by the single pair of antennæ; and by the tracheal respiration. Myriopods and Arachnida have no distinct thorax. Most Crustacea have two pairs of antennæ, while in Arachnida antennæ are wanting altogether. Crustacea, if they possess special respiratory organs at all, have branchiæ (gills) in place of tracheæ (air-tubes). In Arachnida, Myriopoda, and Crustacea there are usually more than three pairs of ambulatory legs in the adult.

The appendages of an Insect’s head (antennæ, mandibles, maxillæ) are appropriated to special senses, or to the operations of feeding, and have lost that obvious

correspondence with walking legs which they still retain in some lower Arthropoda (*Peripatus*, *Limulus*, *Arachnida*). The thorax consists of three[8] segments, each of which carries a pair of ambulatory legs. No abdominal legs are found in any adult insect. The middle thoracic segment may carry a pair of wings or wing-covers, and the third segment a pair of wings.

The lower or less-specialised Insects, such as the Cockroach, have nearly as many nerve-ganglia as segments, and the longitudinal connectives of the nerve-cord are double. In the adult of certain higher Insects[9] (*e.g.*, many Coleoptera, and some Diptera) the nerve-ganglia are concentrated, reduced in number, and restricted to the head and thorax; while all the connectives, except those of the œsophageal ring, may be outwardly single.

The heart, or dorsal vessel, is subdivided by constrictions into a series of chambers, from which an aorta passes forwards to the head.

Air is usually taken into the body by stigmata or breathing-pores,[10] which lie along the sides of the thorax and abdomen. It circulates through repeatedly-branching tracheal tubes, whose lining is strengthened by a spiral coil. Air-sacs (dilated portions of the air-tubes) occur in Insects of powerful flight.

The generative organs are placed near the hinder end of the body.[11] Most Insects are oviparous.[12] The sexes are always distinct; but imperfect females (“neuters”) occur in some kinds of social Insects. Agamogenesis (reproduction by unfertilised eggs) is not uncommon.

Orders of Insects.

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The orders of Insects are usually defined with reference to the degree of metamorphosis and the structure of the parts of the mouth. Five of the orders (3, 5–8) in the table on page9 undergo complete metamorphosis, and during the time of most rapid change the insect is motionless. In the remaining orders (1, 2, 4) there is either no metamorphosis (*Thysanura*), or it is incomplete—*i.e.*, the insect is active in all stages of growth. Among these three orders we readily distinguish the minute and wingless Thysanura. Two orders remain, in which the adult is commonly provided with wings; of these, the Orthoptera have biting jaws, the Hemiptera, jaws adapted for piercing and sucking.

The name of Black Beetle, often given to the Cockroach, is therefore technically wrong. True Beetles have a resting or chrysalis stage, and may further be recognised in the adult state by the dense wing-covers, meeting along a straight line down the middle of the back, and by the transversely folded wings. Cockroaches have no resting stage, the wing-covers overlap, and the wings fold up fan-wise.

Further Definition of Cockroaches.

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In the large order of Orthoptera, which includes Earwigs, Praying Insects, Walking Sticks, Grasshoppers, Locusts, Crickets, White Ants, Day-flies, and Dragon-flies, the family of Cockroaches is defined as follows:—

Family *Blattina*. Body usually depressed, oval. Pronotum shield-like. Legs adapted for running only. Wing-covers usually leathery, opaque, overlapping (if well developed) when at rest, anal area defined by a furrow (fig.4). Head declivent, or sloped backwards, retractile beneath the pronotum. Eyes large, ocelli rudimentary, usually two, antennæ long and slender.

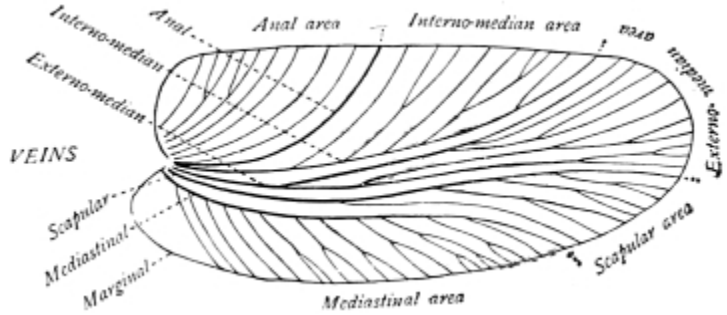

Fig. 4.—Generalised sketch of Cockroach wing-cover.

About eight hundred species of Cockroaches have been defined, and to facilitate their arrangement, three groups have been proposed, under which the different genera are ranked.13

Group 1. Both sexes wingless (*Polyzosteria*).

Group 2. Males winged, females wingless (*Perisphæria*, *Heterogamia*).

Group 3. Both sexes with more or less developed wings (about 7 genera).

In Group 3 occur the only two genera which we shall find it necessary to describe—viz., *Blatta*, which includes the European Cockroaches, and *Periplaneta*, to which belong the Cockroaches of tropical Asia and America.

Genus *Blatta*. A pulvillus between the claws of the feet. The seventh sternum of the abdomen entire in both sexes; sub-anal styles rudimentary in the male.

Genus *Periplaneta*. Readily distinguished from Blatta by the divided seventh abdominal sternum of the female, and the sub-anal styles of the male.

Two species of Periplaneta have been introduced into Europe. These are—

1. *P. orientalis* (Common Cockroach, Black Beetle). Wing-covers and wings not reaching the end of the abdomen in the male; rudimentary in the female.

2. *P. americana* (American Cockroach). Wing-covers and wings longer than the body in both sexes.

CHAPTER III.

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THE NATURAL HISTORY OF THE COCKROACH.

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Range.

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The common Cockroach is native to tropical Asia,14 and long ago made its way by the old trade-routes to the Mediterranean countries. At the end of the sixteenth century it appears to have got access to England and Holland, and has gradually spread thence to every part of the world.

Perhaps the first mention of this insect in zoological literature occurs in Moufet's Insectorum Theatrum (1634), where he speaks of the Blattæ as occurring in wine cellars, flour mills, &c., in England. It is hard to determine in all cases of what insects he is speaking, since one of his rude woodcuts of a "Blatta" is plainly *Blaps mortisaga*; another is, however, recognisable as the female of *P. orientalis*; a third, more doubtfully, as the male of the same species. He tells how Sir Francis Drake took the ship "Philip,"15 laden with