COCKROACHES.

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I.

The Governess: And, perhaps, Mabel, as they are not black and they are not beetles, you will in future call them cockroaches.

Mabel: Certainly, Miss Smith, although they are not cocks and they are not roaches.

ALL this time we have been rather neglecting the navy, partly because it is less interfered with by insect pests than is the sister service, though the common pests of our

Fig. 1.—*Periplaneta orientalis*, male. $\times 2$. Dorsal view. (From Kükenthal.) 1, Antenna; 2, palp of first maxilla; 3, prothorax; 4, anterior wings; 5, femur of second leg; 6, tibia; 7, tarsus; 8, cerci anales; 9, styles.

poor humanity—the flea, the louse, the bug—are, like the poor, “always with us.” Like aeroplanes, insects have captured the air, like motors they have made a respectable show on land, but they have signally failed at sea. They have nothing corresponding to battleships or submarines, and a certain bug, called *Halsbates*, alone hoists the insect flag on the ocean, and that only in the warmest waters. But one insect at least causes more trouble to sailors than to soldiers, and that is the cockroach. Like the bed-bug, the cockroach came into England at the end of the sixteenth century, and, like the bed-bug, it came from the East. It seems to have been first introduced into England and Holland by the cross-sea traffic, and from about the end of the sixteenth century the cockroach began gradually to spread throughout the Western world. Like the rat, the bed-bug, and the domestic fly, it has become thoroughly acclimatized to human habitations, and is indeed an associate of man. It is very rarely found living apart from some form or other of human activity.

This insect seems to have been first described in England in Mufet's *Insectorum Theatrum*, 1634, and he speaks of it as living in flour-mills, wine-cellars, etc., in England, and he tells us how Sir Francis Drake took, in 1584, the *San Felipe*, a Spanish East Indiaman, laden with spices and burdened with a great multitude of flying cockroaches on board.

This species is *Periplaneta orientalis*, but there is

another and a larger species, which presumably came into England from the West later than its Eastern cousin—*P. americana*—which can frequently be seen in England running about in the cages in our Zoological Gardens; but it is not on exhibition, it is a by-product, and is not counted in the fee for admission to the Gardens.

Latter tells us there are ten species of Blattodea which occur in Britain, but only three of these are indigenous, and these three all belong to the genus *Ectobia*. *Ectobias* are smaller than cockroaches, and do not frequent human habitations, but live in shrubs, under rubbishy heaps, etc. Species of *Ectobia* have been known to destroy in one day the whole accumulation of dried, not properly salted, fish in a Lapland village. The remaining species of cockroach are mostly local, and occur sporadically in particular factories, or places where food is stored, but are not very widely spread.

As we have said above, *P. orientalis* is the common English cockroach, *P. americana* occurs especially in zoological gardens and menageries, but a third species, *P. germanica*, sometimes gets established. Mercifully, *P. germanica* does not seem to spread. Neither *P. germanica* nor *P. americana* seem to make much headway against *P. orientalis*, which appears to be predominant over both these other species.

P. germanica is probably most methodical, very thorough, very brave, very faithful—but stupid! If it has any association with its specific name, it illustrates the most striking example in the world's history of the divorce of wisdom from learning. “O Lord! give us understanding,” should be the prayer of *P. germanica*.

Miall and Denny tell us that from the first introduction of *P. orientalis* into England it took two centuries before it spread far beyond London. It 1790 Gilbert White speaks of it as “an unusual insect, which he had never observed in his house till lately,” and, indeed, at the present moment many English villages are still blissfully ignorant of this particular nuisance.

As Fig. 2 shows, the cockroach is a somewhat slackly put together insect. One might almost call it rather slatternly and loose-jointed—and the latter it certainly is. Its head moves freely on the thorax and the thorax on the abdomen. The successive segments of the latter move very freely on one another. The legs are long and mobile, and so are the antennae with which the animal is ceaselessly testing the ground over which it flits hither and thither in a restless activity.

Cockroaches are very difficult to catch. They practically never walk, but run with a hardly believable rapidity, darting hither and thither in an apparently erratic mode of progression. When caught they are not easily retained, for they have all the slipperiness of a highly-polished billiard-ball. They have great powers of flattening their bodies, and they slip out of one's hand with an amazing

Fig. 2.—*Periplaneta orientalis*, male. $\times 2$. Side view. (From Kükenthal.) 1, Antenna; 2, head; 3, prothorax; 4, anterior wing; 5, soft skin between terga and sterna; 6, sixth abdominal tergum; 7, split portion of tenth abdominal tergum; 8, cerci anales; 9, styles; 10, coxa of third leg; 11, trochanter; 12, femur; 13, tibia; 14, tarsus; 15, claws.

dexterity. Besides their slipperiness they have another weapon, and that is a wholly unpleasant and most intolerable odour, which is due to the secretion of a couple of glands situate on the back of the abdomen. The glands which produce this repellent odour are sunk in the soft membrane which unites the fifth and sixth abdominal segments, and the moment a cockroach is attacked it exudes a sticky, glue-like fluid, which gives out this most unpleasant smell. The fluid is extraordinarily tenacious and difficult to remove from the hand of those who have

touched them. No doubt the cockroach finds safety in this from the attacks of insectivorous animals.

Cockroaches, as has been said, very rarely walk, they nearly always run, and they advance the first and third leg of one side at the same time as the middle leg of the other, pulling themselves forward with their front legs and pushing themselves forward with the hindmost. They are thus constantly poised on a tripod. They occasionally, but not very often, use their wings for flight. When they do so, their anterior wings are stretched out at right angles to the body, and take no active share in beating the air. They act in effect as monoplanes. It is the hinder wings which really do the active flying. After a flight, the hinder wing is shut up something in the manner of a fan.

The flattened-shaped coxae, or thighs, of the leg are adapted for shovelling back debris from beneath the body when the insect is enlarging its habitation. When the cockroach gets into a dusty "milieu" the dust is immediately removed, the hairs on the legs act as clothes brushes and brush every part of the body, whilst the antennae, which attract any dust in the neighbourhood, are repeatedly drawn through the closed mandibles. A cockroach is able to walk on smooth surfaces because it possesses between the joints of the tarsus certain soft, white patches, very velvety, and these give the creature a good hold, and prevent slipping, even on glass.

Cockroaches will eat pretty well everything. They are a great nuisance on board ship, where they are said to gnaw the skin and nibble the toe-nails of sailors. Hardly any animal or vegetable substance is absent from their menu. It is said also that they devour bed-bugs, and that natives on the African shores, troubled by these semi-parasites, will beg cockroaches as a favour from sailors in passing ships.

The mandible (Fig. 3), with its strongly toothed surface, is capable of biting and grinding into fragments a very varied diet. The food is moistened by the secretion of the salivary gland, which is capable of converting starch into the more soluble sugar. The food is further ground up by a series of hard ridges projecting into the inner face of the gizzard (Fig. 4, 7). The secretion of the so-called hepatic caecums is capable of emulsifying fat and rendering proteins soluble. Thus the ordinary food substances are reduced to a condition in which they are capable of diffusing from the lumen of the alimentary canal into the blood which floods the body cavity.

The external movement—one might almost say "the panting"—which is very obvious in the abdomen, the alternately flattening and deepening of this part of the body, is a movement of inspiration and expiration, the air

are smelling out the external circumstances which environ them. The 39,000 sensory "nerve-endings" which are found in the antennae of the male cockroach are almost certainly olfactory in function. At the hinder end of the body the two "cerci" are also sensitive to tactile

Fig. 4.—A female cockroach, *Periplaneta*, with the dorsal exoskeleton removed, dissected to show the viscera. Magnified about 2. 1, Head; 2, labrum; 3, antenna, cut short; 4, eye; 5, crop; 6, nervous system of crop; 7, gizzard; 8, hepatic caeca; 9, mid-gut or mesenteron; 10, Malpighian tubules; 11, colon; 12, rectum; 13, salivary glands; 14, salivary receptacle; 15, brain; 16, ventral nerve cord with ganglia; 17, ovary; 18, spermatheca; 19, oviduct; 20, genital pouch, in which the egg cocoon is found; 21, collateral glands; 22, anal cercus.

impressions, and probably act at the hinder end of the cockroach as the antennae act at the forward end. Cockroaches are certainly keenly sensitive to light, and, as every one knows, they shun the light, and when detected in daylight or candle light they make as quickly as they can for some dark hole or crevice in which to hide.

Cockroaches breed during the summer, and their eggs are laid in packets of sixteen in an oval capsule with rounded ends, and with an upper corrugated edge. This cocoon is very like the hand-bag ladies now carry since the dressmakers denied them pockets. There are sixteen ovarian tubes in the female, and each of these deposits one egg in each capsule. The ventral portion of the seventh segment in the female is shaped like the prow of a boat, and it is in this structure that the cocoon, or egg-case, is built up. Each egg is fertilized by a spermatozoon which has been deposited by the male in the spermatheca of the female. The eggs are placed in a double row, eight in each row, facing each other, and as they gradually develop it becomes apparent that the ventral face of one row faces the ventral face of the other row, and that their heads are all directed towards the corrugated ridge. The ripe embryos secrete some fluid, probably saliva, which dissolves the ridge, and it is through this dissolved or softened ridge that they make their way into the outer world.

After birth they are at first quite white but with black eyes, and it has often struck me how surprised they must be when they awake to consciousness and find themselves staring at their brother or sister just opposite, of which they have had hitherto no consciousness.

Young cockroaches are very active, running about and seeking everywhere for any food of a starchy nature. They are, in fact, miniatures of their parents, for a cockroach, like many of the primitive insects, has a direct development, and there are no such stages as caterpillar and pupa in their life-history.

But, like other insects, cockroaches change their skin from time to time, and they lose little time over this ecdysis, for they change it immediately they escape from the cocoon. The second ecdysis is four weeks later, and the third at the end of the first year, and after this time they moult annually. At the seventh moult, when the

Fig. 3.—Mouth appendages of *Periplaneta*, magnified. A, mandible. B, first maxilla: 1, cardo; 2, stipes; 3, lacinia; 4, galea; 5, palp. C, right and left second maxillae fused to form the labium: 1, submentum; 2, mentum; 3, ligula, corresponding to the lacinia; 4, paraglossa, corresponding to the galea; 5, palp.

being driven into the stigmata and so into the trachea. There is a considerable variation in the number of these pulsations, but the cockroach's heart beats at an average rate of 70 to 80 contractions per minute.

Although cockroaches have fairly developed eyes, they seem to trust more largely to tactile impressions in appreciating their relations to the surrounding world. Their antennae and the palps of their first and second maxillae are constantly touching the surface on which they are resting or moving, and from time to time their antennae wildly wave in the air in a manner which suggests they

animal is now 4 years old, it assumes the form of the perfect insect, and is capable of reproduction. The later moulting falls in the summer time, and so does fertilization and oviposition.

Male cockroaches may be distinguished from the females by their well-developed wings and wing covers. They stand higher on their legs than do the female, whose abdomen often trails upon the ground. In spite of the noxious secretion of their abdominal glands there are creatures who habitually feed on cockroaches—hedgehogs, for instance, are frequently imported into our houses to check these pests. Rats, cats, polecats, frogs, and wasps have been known to eat them, and some few of the digging wasps lay them down in their larders for the use of their progeny. Some birds will also tackle them. But even the most devoted friend of the cockroach can find little to say in its favour, except that it is currently reported to form the basis of the flavouring of a very popular sauce, but even wild cockroaches will not drag from me which particular sauce that is.

THE INCIPIENT PULMONARY PHTHISIS OF SCHOOL CHILDREN.

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I.

INTRODUCTION.

In the present communication the discussion will be mainly limited to the ages between 5 and 15, when the tuberculous process tends to become localized within the ducts and glands of the lymphatic system of the respiratory organs. This is practically the time of school life. During the earlier period of childhood, and particularly the first and second years—that of the first dentition—the conditions differ; the lymphatic system remains embryonic; its channels appear wider, and less able to prevent dissemination into the blood and distant areas.

Fig. 1.—Diagram of the lymphatic glands concerned, modified from Sukienikow. T.Br., Tracheo-bronchial. B., Bifurcation. H., Hilum, and P., pulmonary glands. Above the tracheo-bronchial group is a tracheo-bronchial chain of glands on each side of the trachea, reaching as high as the thyroid gland.

In other words, children of this age are practically defenceless, and the little resistance they may possess must be ascribed to increased efficiency of the leucocytes, since the opsonic indices are negligible.

The radiological appearances of the healthy infant's chest consist of a few indistinct bronchial streaks, radiating from the hilum towards the periphery. The hilum opacity and its ramifications become more obvious as age advances. Constant irritation of the walls of the lymphatic vessels, by particles, organized or inanimate, leads to a small-cell infiltration and a thickening of perivascular and peribronchial trunks—a process which emphasizes the central and arborescent opacities of the radiogram.

II.

ANATOMICAL AND PATHOLOGICAL CONSIDERATIONS.

Bartels¹ divides the glands into four categories: (a) Tracheo-bronchial, (b) bifurcation, (c) hilum, and (d) pulmonary glands.

(a) *The tracheo-bronchial glands* lie on each side of the thoracic portion of the trachea and on the outside of the extrapulmonary bronchi. They number from five to nine on the right, and from three to four on the left. Normally each is about the size of a large pea. The right glands lie nearer to the margin of the sternum. They receive branches from (b) and (c), from the posterior mediastinal glands, and from the trachea and bronchi. They send efferents to the broncho-mediastinal trunk on the right, to the thoracic duct on the left, and to the deep cervical glands (supra-clavicular). Since they lie at and above the level of the bifurcation of the trachea, they are situated in the superior and just above the middle mediastinum. In front of the right tracheo-bronchial glands lies the superior vena cava; behind, the right vagus; internally, the trachea; externally, the internal surface of the right lung; below lies the right bronchus, the right pulmonary artery and the terminal bend of the azygos major. The left tracheo-bronchial glands lie behind the ascending arch in front of the left vagus; above is the horizontal arch and left recurrent nerve; externally is the internal surface of the left lung. This group of glands is connected with the lymphatics of the upper and middle lobes of the lung.

(b) *The bifurcation glands* are ten to twelve in number and more closely related to the right than to the left bronchus. They lie between the pericardium and left auricle on the one hand, and the oesophagus, aorta, posterior pulmonary plexus and posterior borders of both lungs on the other. They receive ducts from the hilum glands and send branches to the tracheo-bronchial. They are connected with the lymphatics of the middle and lower lobes.

(c) *The hilum glands* lie buried in the pulmonary parenchyma at the root of the lung and occupy the angles of the first four divisions of the bronchi. They are in intimate connexion with branches of the pulmonary artery and receive afferent vessels from the pulmonary glands.

(d) *The pulmonary glands* lie outside the hilum in the substance of the lung at the divisions of the bronchi. Minute glands are even found just beneath the visceral pleura.

Surface Anatomy.—The trachea bifurcates at the level of the upper border of the fifth dorsal vertebra posteriorly, and about the junction of the manubrium with the sternum anteriorly. The extrapulmonary right bronchus is nearly vertical and reaches to the level of the upper part of the sixth vertebra. It gives one cparterial branch close to the hilum. The left extrapulmonary bronchus ends at the same level as the right. Each hilum is about 1½ inches broad and extends on either side at the level of the vertebral ends of the fifth, sixth, and seventh ribs. Within it are the branches of the bronchi, pulmonary artery and veins, bronchial arteries and veins, lymphatics and lymph glands, nerves and connective tissue. Robinson² gives three excellent figures of the mesial surface of the lung with sections of each hilum, showing the arrangement of these structures. The pulmonary artery and veins possess branches corresponding with the bronchi. After the cparterial branch is given off on the right side, the stem sends a ventral branch to the middle lobe. The tracheo-bronchial glands lie at the level of the vertebral ends of the third, fourth, and fifth ribs; the bifurcation at the level of the sixth vertebral extremity, and the fifth spine is dull from this cause and from the proximity of the right pulmonary artery (Ewart³). The apices of the upper lobes reach the level of the first rib; the apices of the lower lobes that of the vertebral ends of the fourth rib, but the left lower apex is a little higher (Ewart⁴). In front the middle lobe of the right lung occupies the third and fourth intercostal spaces. In front of the root of the lung lie the anterior pulmonary plexus and the phrenic nerve.

The lymphatics commence in irregular lacunae situated just beneath the walls of the air sacs; and also below the surface of the pleura. They form fine networks around the lobules, the bronchi, and the blood vessels. Superficial collecting trunks arise from the subpleural lobules and deep collecting ducts from the veins, arteries, and bronchi.