1. The External and Internal Parasites of Man and Domestic Animals.
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THE

EXTERNAL AND INTERNAL PARASITES

OF

MAN AND DOMESTIC ANIMALS.

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The External Parasites of Domestic Animals,

THEIR EFFECTS AND REMEDIES.*

BY A. E. VERRILL.

The external parasites of our domestic animals nearly all belong to the great class of animals which we call Insects, but the internal parasites are, with few exceptions, representatives of the class of Worms. The division of the subjects of these lectures is, therefore, both convenient and natural.

The class of Insects includes a far greater number of species than any other class of animals, the number actually amounting to several hundred thousands, each country having a vast number peculiar to itself. They are also exceedingly diverse in habits, as well as in form and structure.

In order to show the affinities of the insect-parasites and their position among other insects, it will be necessary to give a brief sketch of the whole class, with a few remarks on the more important peculiarities of their anatomy.

All insects, like the other articulated animals (worms and crustacea), have a body composed of a series of segments or rings, placed one behind the other, and together forming a sort of irregular tube, which incloses in one cavity all the in-

* In the preparation of the reports of these lectures on the parasites of domestic animals, we are greatly indebted to Dr. A. S. Packard for the use of many cuts of insects from his excellent "Guide to the Study of Insects" and the "American Naturalist," published at Salem, Mass.; and to Donald G. Mitchell, Esq., editor of the "Hearth and Home," published by Pettingill, Bates & Co., New York, for the use of several excellent cuts of parasitic worms, prepared to illustrate a series of articles on parasites of man and domestic animals by the writer. Without this assistance the lectures could have been illustrated only imperfectly. In addition to these we have added, so far as the available funds would admit, figures of the more important parasitic insects and worms, copied from Cuvier, Guerin, Clark, Leuckart, Cobbold, and others.—*A. E. Verrill.*

Fig. 1.

ternal organs. The nervous system consists of a double nerve-centre or ganglion in the upper part of the head, connected with another below by nerves that pass around the gullet on each side, so as to enclose it as in a ring, and this lower double ganglion is connected by a double nervous cord with a series of similar ganglions or nerve-masses, which are arranged along the lower side of the body, below the intestine, each ganglion sending off small nerves to the adjacent organs (figure 2). The rings of the body are thickened in certain parts, and in the head and middle region of the body are more or less consolidated. They thus form a somewhat firm *external* skeleton, composed of a peculiar substance, called *chitin*. When the rings are movable this outer covering, where it connects the rings together, is thinner and flexible, and often folded inward so as to form peculiar joints. The legs, jaws, and other external organs, are merely hollow outfoldings of the outer covering, and contain, like the body, the muscles that move the various parts, while their cavities communicate freely with that of the body, and thus receive their supply of blood, nerves, etc. Each joint of the legs and other appendages is also formed by a thinner portion of the outer covering, which is folded in upon itself in various ways. The wings, when present, are also outfoldings of the integu-

Fig. 2.

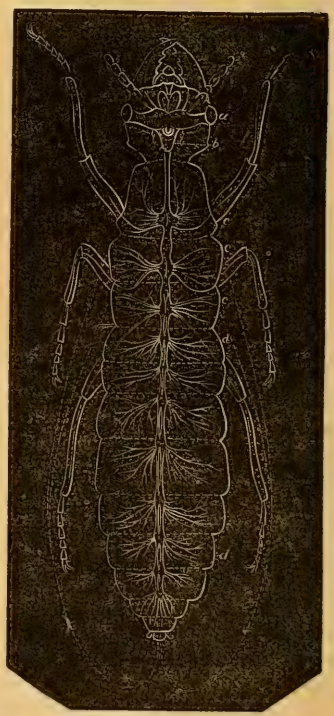

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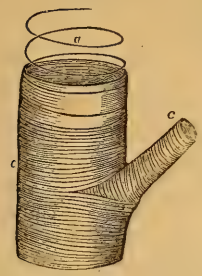
Fig. 3.



ment, which appear at first in the form of little sacks containing fluid, but finally expand into broad membranes and the sides of the sack unite so as to appear like a simple membrane, supported by little branching, hollow rods, or tubes, which communicate with the cavity of the body, and also form the joints of the wings. The legs and jaws originate from the lower part of the sides of each ring that bears such appendages, so that there must be as many rings or segments in any part of the body as there are pairs of such organs, but

Fig. 4.

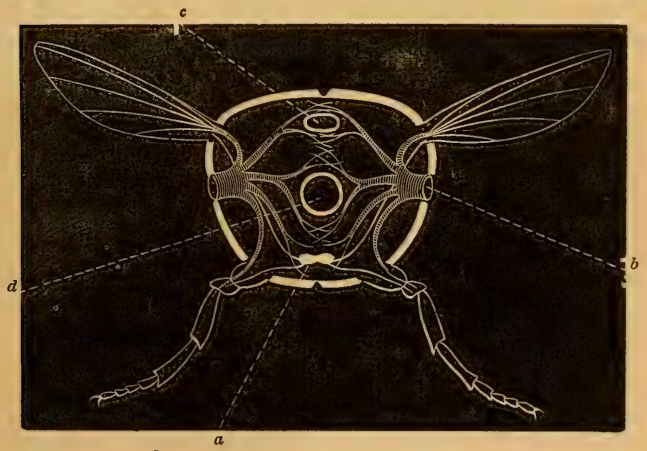


FIGURE 1.—"Hundred-legs," (*Scolopocryptops sexspinosa* Say), natural size; color deep orange, with yellow feet. From Packard's Guide.

FIGURE 2.—Nervous system of *Corydalus cornutas*, a large neuropterous insect; *a* and *b*, ganglions of the head; *c*, the three ganglions of the thorax, which send nerves to the three pairs of legs; *d*, *d*, the eight double ganglions of the abdomen. From Packard's Guide, after Leidy.

FIGURE 3.—Portion of one of the tracheæ or breathing tubes, prepared so as to show the spiral fibre *a*, a part of which has been unwound; *c*, a secondary branch. From Packard's Guide.

FIGURE 4.—Transverse section of the thorax of a bee; *a*, one of the nervous ganglions; *b*, breathing pore or spiracle, opening into the tracheæ, which branch in the interior, and send small tubes into the legs and wings; *c*, the dorsal vessel or pulsating organ, which circulates the blood; *d*, the intestine. From Packard's Guide.

the wings originate from the upper part of the same rings that bear legs below (fig. 4). Most insects breathe air by means of a complicated system of finely branched air tubes, having a sort of spiral spring to keep them open (fig. 3), which are connected with valvular openings, called spiracles, along each side of the body. Some species of spiders have respiratory cavities that somewhat resemble lungs, and contain numerous thin membranes, arranged like the leaves of a book. These are, however, connected with openings in the lower side of the body, and may be regarded as a peculiar modification of the air tubes or tracheæ found in other insects. In many flying insects the air tubes expand in certain parts into large hollow vesicles, which give greater lightness to their bodies. In all insects we can distinguish three regions of the body: the head, composed of several rings closely united together, and bearing the organs of the mouth and senses—as many pairs as there are rings; the thorax, composed of either three or four rings, which bear as many pairs of legs, and sometimes one or two pairs of wings above; the abdomen, composed of numerous rings, which are not consolidated, and generally bear only the external reproductive organs; but in the spiders they bear the spinnerets, in many larvæ several pairs of fleshy legs, in centipeds, etc., numerous legs, (figures 1 and 6), and in some insects long, slender, feeler-like organs (figure 5).

Insects are naturally divided into three great groups or sub-classes,* founded on important differences in their internal anatomy and the arrangement of their external parts.

Fig. 5.

I.—Hexapod Insects.

The highest sub-class contains the *Hexapod* or six-legged insects, including all the flying insects, and many that are destitute of wings. In these the head, thorax, and abdomen, are distinctly separated as three regions of the body.

* According to some writers these divisions are called *orders*.

Figure 5.—"Furniture-bug," or Shiner, *(Lepisma)*, natural size. A smooth, shining, neuropterous insect, covered with minute silvery scales, but destitute of wings. It lives in houses among books, papers, clothing, or in furniture, etc., eating them in various ways; it is very fond of the paste of books, and will often loosen wall-paper.

The head appears to be composed of seven rings, and there are three pairs of mouth organs. They all breathe by means of air tubes or tracheæ.

II.—Arachnids.

The next sub-division, called *Arachnida*, includes the spiders, scorpions, "daddy-long-legs," or harvest men, mites, etc. In these the head is generally more or less united to, or sunken in, the thorax, as in the spiders, which have the abdomen very distinct; or the abdomen may be closely united to the thorax, as in the mites (figure 48). When mature they have eight legs. The head bears but few organs. There are no antennæ. The eyes are simple, but often numerous. Many breathe by tracheæ, but some spiders by lung-like organs, and others by both combined.

Fig. 6.

III.—Myriapods.

The lowest sub-class, called *Myriapoda*, includes the centipeds, "thousand-legs," etc., (figures 1 and 6.) These have the rings of the thorax and abdomen all very similar, and the rings of the abdomen in some become very numerous, sometimes amounting to several hundred. Each ring usually bears a pair of legs, and contains a nerve ganglion. The head is similar to that of the six-legged insects, and bears antennæ, and sometimes compound eyes. They breathe by air tubes or tracheæ. This last sub-class contains no parasites, but in both the others there are numerous examples. Yet in those they are confined to particular orders and families.

Among the Arachnids we find parasites only in the lowest order, which includes the mites, the true ticks, the itch-insect, etc., but among the Hexapod insects we find that the parasites belong mostly to two of the seven orders into which they are naturally divided.

The seven orders of six-legged insects are based on many anatomical differences, but they are characterized, also, by

Figure 6.—*Lithobius Americanus* Newport, natural size; color yellowish brown. From Packard's Guide.

differences in their transformations, and peculiarities in their habits. The most obvious distinctions are found in the structure of the organs composing the mouth, and in the wings, when these exist. Their names are derived from the character of their wings. The orders are as follows:

I. *Hymenoptera*, (membrane-winged). This order includes the bees, wasps, ichneumon-flies, saw-flies (figures 7, 7*a*), etc.

Fig. 7.

Fig. 7 *a*.

They have four small but strong membranous wings, the front pair largest. The body is compact, the head large, and the three regions of the body very distinct. The head (figure 8) usually has three simple eyes in front, forming a triangle; a pair of slender antennæ or feelers, and a pair of very large compound eyes; connected with the mouth we find a pair of powerful, often toothed, *mandibles* or jaws; a pair of orceps-like *maxillæ*, bearing near the base a jointed palpus or small feeler; and finally the *labium* or lower-lip, which bears a pair of *palpi* or feelers, and the *ligula* or tongue, which is long and highly developed and covered with hairs in the bees. They have, therefore, all the parts of the mouth symmetri-

Fig. 8.

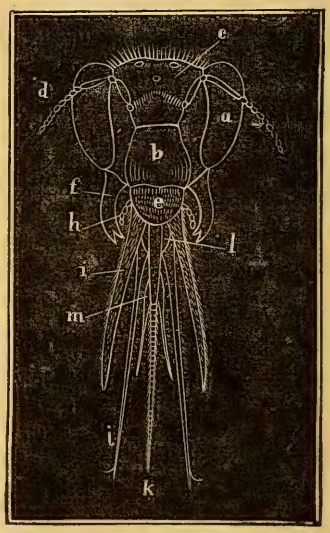


FIGURE 7.—The Pear-slug or Saw-fly (*Selandria cerasi* Peck), enlarged. Color black, with white spots on four anterior legs and feet.

FIGURE 7*a*.—Larvæ of the same on leaf of pear, natural size; and *a*, enlarged. It is covered with sticky slime. Both from Packard's Guide.

FIGURE 8.—Head of wild Bee (*Anthophora*), much enlarged; *a*, compound

cally developed. The jaws are used for biting and cutting the materials used in constructing their nests; the maxillæ are used in manipulating and arranging; the tongue is used for lapping up honey and other liquid food. The larvæ are generally soft, footless, and white, but those of the saw flies resemble caterpillars, and have numerous abdominal legs.

II. *Diptera* (two-winged). Insects belonging to this order have but one pair of wings. The three regions of the body are very distinct. The common house-fly, meat-flies, mosquito, Hessian-fly, wheat-midge, onion-fly (figure 9), bot-fly, horse-fly, and the fleas are examples. The mouth organs correspond in number with those of the *Hymenoptera*, but the *mandibles* and *maxillæ* are usually formed like long sharp lancets, as in the horse-fly (fig. 10), or have the shape of slender and sharp piercing organs, as in the mosquito. The labium and tongue together generally form a long proboscis, often with the tongue curiously bilobed and expanded at the end as in the horse-fly and house-fly. The sharp mandibles and maxillæ are used to penetrate the skin of animals, or the bark of plants, and rind of fruits, and the fleshy tongue is used to suck up the blood or other liquid food. The larvæ

Fig. 9.

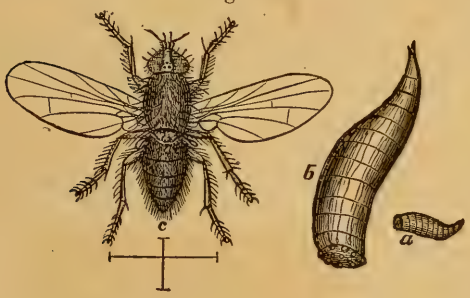
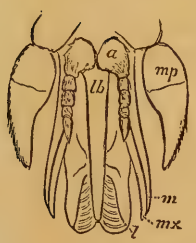


Fig. 10.



eyes; *b*, clypeus; *c*, the three simple eyes or ocelli; *d*, the antennæ; *e*, labrum or upper lip; *f*, mandibles; *h*, maxillary palpi, borne upon the base of the maxillæ *i*, which are slender and hairy; *j*, labial palpi; *k*, ligula or tongue; *l*, palpifer; *m*, paraglossæ or lateral lobes of the ligula. From Packard's Guide, after Newport.

FIGURE 9.—Onion-fly (*Anthomyia ceparum*), considerably enlarged, with larvæ, *a* and *b*. From Packard's Guide.

FIGURE 10.—Head of Green-head fly or Horse-fly (*Tabanus lineola* Fabr.), much enlarged; *a*, antennæ; *m*, mandibles; *mx*, maxillæ; *mp*, the large, two-jointed maxillary palpi; *l*, the ligula or tongue; *lb*, the labrum. From Packard's Guide.

are usually soft, white, and footless, and generally pass under the name of maggots. In this order we find many parasites, of which the fleas, sheep-tick, bat-ticks, horse-tick, forest-flies, bot-flies, etc., are examples. This order contains some beneficial and very many injurious insects.

III. *Lepidoptera* (scaly wings). This order includes the butterflies, moths, millers, army worm (figure 11), canker-worms, cut-worms, silk-worms, etc. The wings are four in number, usually broad, and covered with minute scales, looking somewhat like beautiful feathers under the microscope, but appearing like fine dust to the naked eye. The mandibles are nearly abortive, but the maxillæ are usually very long, slender, and hollowed out on the inside, so that when fitted together they form a long hollow tube or proboscis, through which they suck up their liquid food. The proboscis can be rolled up beneath the head when not in use. The larvæ mostly feed upon plants, and are generally known as caterpillars. They are often bright colored, sometimes hairy, and usually have, in addition to three pair of small true legs, two or more pairs of fleshy legs under the abdomen. Most of the insects of this order are injurious to vegetation.

Fig. 11.

IV. *Coleoptera* (shield-wings). Insects of this order are known as beetles, weevils, etc. The front wings are thickened and stiff, not used in flight, but serve to protect the hinder wings, which are larger and thin, and can be folded up and tucked away under them. The mandibles and maxillæ are both used as jaws for biting and chewing. The larvæ have usually three pair of legs, and many are well known as grubs and borers in wood. The apple-tree borer (figure 12), is an example. This great order includes many beneficial carnivorous insects, as well as many that are injurious to vegetation.

V. *Hemiptera* (half-wings). This order embraces those

FIGURE 11.—Southern Army-worm (*Leucania*) imago; and larva, *a*, natural size. From Packard's Guide, after Glover.

insects properly called bugs, such as the squash-bug (figure 13), strawberry-bug, bed-bug, and also the cicada or "seven-

Fig. 12.

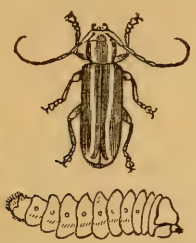


Fig. 13

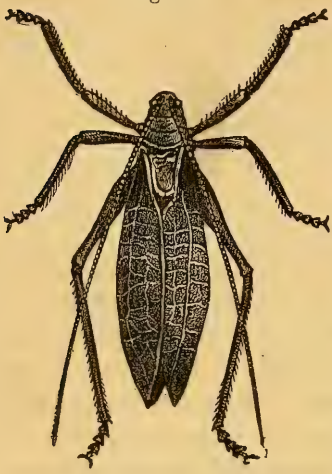
teen-year locust," the plant-lice, bark-lice, cuckoo-spits, the true lice, bird-lice, etc. In this order we find, therefore, the greatest number of external parasites: The wings, when present, are often crossed upon the back, and the front wings are often thickened toward the base, but in other cases, as in the cicada and plant-lice, the wings are transparent and not crossed. The mouth organs form a sharp hollow proboscis, for piercing the bark of plants or skin of animals, in order to suck up the blood or sap. When not in use the proboscis can be folded down upon the breast, by means of three joints. The mandibles and maxillæ are four, long, slender, very sharp, piercing organs, often barbed near the points. These are enclosed in the jointed proboscis, as in a sheath, but can be thrust out through the opening in the end. The proboscis is formed mostly by the lower lip or labium, but the opening in the upper side is covered by the shorter upper lip. The larvæ of many Hemiptera resemble the adults from the first, except that they lack wings; the pupæ are also active and have the same habits. They therefore undergo less remarkable transformations than those of the preceding orders. Many of these insects are beneficial by destroying other insects, but most are injurious to vegetation by sucking sap.

FIGURE 12.—Apple-tree Borer (*Saperda candida* Fabr.), natural size. Color light brown with two white stripes; the lower figure represents the larvæ. From Packard's Guide.

FIGURE 13.—Squash-bug (*Coreus tristis* DeGeer.), natural size. Color dark brown. From Packard's Guide.

VI. *Orthoptera* (straight-wings). This order includes the grasshoppers, true locusts, katydid, crickets, cockroaches, etc.

Fig. 14.



The front wings are generally long and straight, somewhat thickened, and in the male often have some sort of musical apparatus, as in crickets, katydids, etc. The hind wings are broad, fan shaped, and can be folded up like a fan beneath the front wings, which when folded generally lie lengthwise of the body, forming a sort of roof.

The mandibles and maxillæ are chewing organs. The larvæ have nearly the same form as the adults, but lack wings; they have similar habits; the pupæ are also active. Most of these insects, except the *Mantis*, are injurious to vegetation by eating the leaves.

VII. *Neuroptera* (nerve-winged). The dragon-flies, lace-winged flies (Figure 15), May flies, Lepisma (Figure 3), and white ants, belong to this order. The wings, when present, are thin, membranous, and subdivided by very numerous rods or nervures into small spaces, which are often squarish. The mandibles and maxillæ are chewing organs. The abdomen is generally long. The larvæ are of many forms, often aquatic, generally carnivorous and predacious in habits, and usually undergo a complete metamorphosis; the pupæ are mostly inactive. Most insects of this order, excepting the

Fig. 15.

Figure 14.—Katydid (*Cyrtophyllum concavum* Say), male, natural size. Color bright green. From Packard's Guide.

Figure 15.—The Lace-wing Fly (*Chrysopa oculata* Say), natural size, with the eggs attached to the tips of slender pedicels. Body light green. This insect lays its eggs among plant-lice (*Aphis*), which the larvæ, when hatched, destroy. From Packard's Guide.

white ants and Lepisma, are beneficial by destroying noxious insects.

To those who desire more information upon the structure, habits, and classification of insects generally, we would especially recommend Packard's Guide to the Study of Insects, Salem, Mass., 1869, and Harris' Treatise on Insects Injurious to Vegetation (illustrated edition), Boston, 1862.

Parasites belonging to the Diptera.

The Fleas.

Pulicidæ.

It is somewhat singular that parasites are almost always degraded species of the orders and families to which they belong. This is very evident in the case of parasitic insects, for they are mostly destitute of wings, and are imperfectly organized in other respects when contrasted with their self-supporting allies. The fleas furnish us with examples of degraded diptera, and the sheep-tick is even more degraded than the fleas. Of fleas there are several species that attack man and domestic animals; but the species do not appear to be so strictly limited to particular animals as are the lice and some other parasites; for the common dog-flea and cat-flea will attack man without hesitation, and in New England appear to be far more troublesome to the human race than is the species commonly regarded as the real human flea (*Pulex irritans*), which so far as I have observed, is comparatively rare, though in some localities it may be sufficiently common, as it is in parts of Europe.

In the genus *Pulex*, which includes the common species of fleas, the body is compressed and the integument is very firm, so that they are well adapted for gliding among hairs or feathers, and are not liable to be injured by any ordinary pressure. The wings are represented only by two pairs of short, stiff scales, which have little or no power of motion. The posterior legs are large and powerful, enabling them to leap with remarkable agility. The head is small; the eyes

are simple, in some species very minute; the antennæ are curiously constructed with three broad, flat, singularly lobed joints, and are, in nearly all species, closely folded away out of sight, in a socket or cavity behind the eyes; though in the males of the mouse-flea and pigeon-flea they are exposed and carried erect. The mouth organs are peculiarly constructed and well adapted for piercing the skin and sucking the blood. The maxillæ (Figure 16, *a*), are a pair of broad, flat, thin, somewhat lance-shaped organs, bearing at base the long, four-jointed feelers or palpi (*b*). The mandibles (*c*) are slender, flattened, sharp, piercing organs, finely serrated along their sides, like a minute saw. The labium (*d*) is a round, slender, piercing organ, forming the central lancet. The lower lip and labial palpi (*e*) form together a sort of sheath, with a groove on the inside, which receives the mandibles and labium, when in their natural position; the labial palpi are four-jointed in the cat and dog fleas, if not in all, though some writers say they are three-jointed. The mandibles (*c*) and labium (*d*) form together three slender lancets, and it is by means of these that the flea perforates the skin. The blood is then drawn up through the channels or spaces between these organs and the labial palpi and lower lip, by means of a sucking stomach.

Figure 16.

The Cat-flea (*Pulex felis* Bouché). Figures 17, 18.

This species of flea is perhaps the best known and most common kind in New England. It not only infests nearly all cats and the places where they sleep, but is also more or less common in dwellings of all classes, especially when cats are allowed to roam about over the carpets. It often becomes exceedingly troublesome in sleeping rooms, for it prefers to spend the day about the floor, in and beneath the carpet, or in some similar place of concealment; but when oppor-

Figure 16.—Head of the dog-flea (*Pulex canis* Curtis), highly magnified; *a*, the broad, thin maxillæ; *b*, their four-jointed palpi; *c*, the mandibles; *d*, the labrum or central seta of the proboscis; *e*, the labium and labial palpi. From Duges.

tunities offer it is always ready to jump upon the naked feet or ankles, and may thus gain entrance to the bed. Many persons, especially ladies and children, are badly poisoned by

Figure 17.

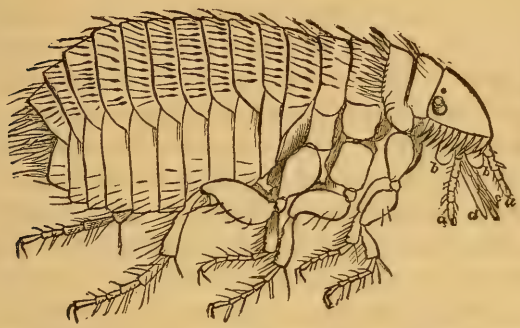
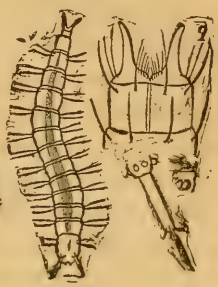


Figure 18.



them, and may suffer severely for several days from the bite of a single flea; for, unlike the mosquito and other blood-sucking insects, they are never satisfied with a single bite, or with one spot, but must travel about and bite as they go, literally "biting on the run." In these respects, however, it agrees closely with the so-called human flea (*Pulex irritans*).

The cat-flea (Figure 17) is dark chestnut-brown in color, and is stouter and thicker in the thoracic region than *Pulex irritans*, which has a rather slender waist and darker color. There is a row of sharp spines along the lower side of the head on each side, and another row of similar spines on the posterior edge of the first segment of the thorax; but the human flea lacks both these sets of spines. Other good distinctions are found in the joints of the feet or tarsi, and in the mouth organs. In all fleas the males and females differ considerably in form and size, the males being smaller and shorter.

The female cat-flea lays her eggs among the fur of the cat, to which they are but slightly attached; these eggs are very small, white, and long-oval. As the cat walks or runs about, the eggs are constantly being scattered around, often in great numbers. On one occasion I was able to collect fully a teaspoonful of these eggs from the dress of a lady in whose lap a half-grown kitten had been held for a short time. The places

where cats sleep become well filled with the eggs. These hatch in about two weeks into little, white, footless, maggot-like larvæ (Figure 18), which have small tufts of hairs along the sides. They are at first about one-sixteenth of an inch long. The head is pale yellow, and the posterior end of the body bears two spines. These larvæ feed upon the decaying particles of animal and vegetable matter always to be found in the dirt in which they live. They move about by means of their hairs and spines. They grow rapidly in warm weather, and in about twelve days, when they mature, spin a slight silken cocoon and change to a pupa, which is inactive. This looks more like the mature flea and has the legs free. In a short time, varying from ten to sixteen days or more, according to temperature, the pupa matures, and the full formed flea comes forth from the cocoon, ready and willing to take care of itself. This it does by leaping upon the first living creature that comes within range; but no doubt it is better suited with the cat than with other animals. This mode of increase and the habits of the young will explain the reason why fleas are often obtained out of doors, especially in gardens frequented by cats or dogs. Such fleas are often called "sand-fleas," but they are simply the progeny from eggs of cat or dog fleas that have been hatched and lived in the dirt or soil. They pass the winter both in the mature and larval states, and perhaps also as eggs and pupæ. There are several broods each season.

The Dog-Flea (*Pulex canis* Curtis). Figure 19.

This species is very similar to the last, and is considered the same by several writers. It has the same form and color, and the same rows of spines below the sides of the head and on the thorax. But there appears to be some difference in the mouth organs. The posterior tarsi in this species are

Figure 17.—Cat-flea (*Pulex felis* Bouché), much enlarged; *a*, the maxillary palpi arising from the bases of the maxillæ, *b*; *c*, the labial palpi; *d*, the slender mandibles. The labrum is not shown. From Packard's Guide.

Figure 18.—Larva of Cat-flea (*Pulex felis* Bouché), much enlarged; *a*, one of the antennæ more highly magnified; *b*, posterior end of the body, showing the two spines. From Packard's Guide.

said to have the fifth joint longer than the second, while in the cat-flea the second is longer than the fifth. The habits are essentially the same, except that this one seems to prefer the dog's blood. It will also attack human beings when opportunities offer.

Figure 19.

The *Hen-Flea* (*Pulex gallinæ* Schank) lives upon the hen and about poultry-houses and yards.

The *Pigeon-Flea* (*Pulex columbæ* Gervais) lives upon domestic pigeons and in pigeon-houses.

Other species infest rats, mice, bats, rabbits, swallows, and various other wild animals and birds.

Remedies for Fleas.

From the description of the habits of the larvæ given above, it is evident that dirt and filth of all kinds afford facilities for the increase of fleas, and that dogs and cats are the means of diffusing their own peculiar species, and also, no doubt, the true human flea. The first care, therefore, should be to see that the dogs and cats, if such are kept, are freed from their parasites. To this end they should be made to sleep on some material like shavings or chips, that can be easily burned, and their sleeping places should be often cleaned and their beds renewed. To remove the fleas themselves from the animals a wash of water containing 6 to 10 per cent. of petroleum, naphtha, or benzine, well shaken together, may be used. A weak solution of carbolic acid in water, about 2 or 3 parts of the acid to 100 of water, will also be efficacious for fleas and other parasites. Decoctions of tobacco and strong soap suds are also recommended.

When fleas are troublesome in dwelling houses, a thorough cleaning of the floors and an equally thorough beating and cleaning of the carpets, rugs, etc., will generally be effectual. When cracks or crevices exist in the floors, a thorough washing with the petroleum, naphtha, or carbolic acid water, will be useful to destroy the eggs and young. Persian Insect

Figure 19.—Head of Dog-flea (*Pulex canis* Curtis), much enlarged. The parts are the same as in Figure 16. From Duges.

Powder, which is a preparation from the flowers of a plant, is often used to expel fleas both from carpets and the fur or hair of animals. It appears to be particularly obnoxious to them. But after applying the powder to an animal it should soon after be thoroughly washed off.

It often happens that there are really but few fleas, perhaps less than a half dozen, in a room that is supposed to be overrun by them; for owing to their habit of biting repeatedly, a single one may do the mischief attributed to a large number. In such cases a careful search for and capture of the offenders will soon remedy the evil. When caught, a drop or two of benzine will kill them instantly.

The Sheep-Tick, Forest-Flies or Horse-Ticks, etc.

Hippoboscidæ.

These are degraded Dipterous parasites, and must not be confounded with the true ticks, which have eight legs. Some of them are destitute of wings, like the sheep-tick; others have long, narrow, simple wings, like the species infesting the horse, and those of the swallow and other birds, bats, etc. The body is flattened from above, and is hard and firm, with a horn-like or leathery texture. The head is somewhat sunken into the front edge of the thorax, without a distinct neck. The antennæ or feelers are very small and near together. The eyes are large and often occupy most of the sides of the head. The proboscis consists of two lateral, narrow, elongated, bristly plates (regarded as maxillæ by some authors), which project in front of the head. Below and between the bases of these there is a small orifice from which, when about to draw blood, three, long, slender, piercing organs are protruded; but these can be withdrawn when not in use. These are unequal in size, but equal in length. The lower one, which is largest and channeled along the upper side and dilated at base, receives the two smaller ones into its groove. These organs penetrate deeply into the skin, and through the channel formed by the setæ the blood is sucked up.

They live like lice among the feathers of birds or hairs of

animals, and run with agility either forward, sideways, or backward, somewhat like a crab. Their feet or tarsi are furnished with powerful denticulated claws, with which they cling securely. Their most remarkable peculiarity is their mode of reproduction. Each female produces but one or two young at a time, but these are born as living, fully developed larvæ, which are enclosed in a smooth oval skin, notched at one end, within which they change to pupæ immediately after birth, the enclosing case becoming dark colored. The female has an uterus-like enlargement of the oviduct, in which the eggs hatch, and this organ has the power of secreting a milk-like substance for the nourishment of the larvæ until full grown.

The Horse-tick or Forest-fly (*Hippobosca equina*). Figure 20.

This species is almost as large as the house-fly, nearly black, with conspicuous yellow markings on the thorax. It sometimes infests the horse to such an extent as to be very troublesome. It attacks by preference those parts where the hair is thinnest and the skin softest, especially under the belly and between the hind-legs. Their bites cause severe pain, and will irritate the gentlest horses, often rendering them almost unmanageable, and causing them to kick dangerously. When found they cling so firmly as to be removed with some difficulty, and they are so tough as not to be readily crushed. If one escapes when captured, it will instantly return to the horse, or perchance to the head of its captor, where it is an undesirable guest. Another species sometimes infests the ox.

Figure 20.

Figure 20. — The Horse-tick (*Hippobosca equina* Linn.), enlarged. From Cuvier.

The Sheep-tick (Melophagus ovinus Linnæus). Figure 21.

This insect never acquires wings. It has a broad head, wider than the thorax. The abdomen is roundish and hairy, not showing distinct rings, and in the gravid female becomes much enlarged. The legs are short and stout, and the claws very strong. The proboscis is as long as the head. Like the horse-tick, it is viviparous, producing a full-grown larva, enclosed in an oval case, as shown in Figure 21.

It is often very troublesome to sheep, especially lambs. There have been numerous remedies proposed. In general, when there are but few, they can easily be removed by hand when the sheep are sheared; but when numerous on lambs, they may be destroyed by various washes or baths. Snuff, or sulphur in powder, rubbed thoroughly into the wool, is sometimes used with good results. A bath made by steeping tobacco in water, about 2 pounds to 10 gallons of water, in which the lambs are entirely immersed, with the exception of the face, is said to be effectual, but in some cases, has proved injurious to the health of the lambs. Probably the same solutions recommended for fleas would be equally effectual for these; but the strength of petroleum water, or naphtha water, or carbolic acid water, ought to be adapted to the age and strength of the animals to which it is applied, young lambs having a much more tender skin than dogs or old sheep.

Figure 21.

The Bot-flies of Horses, Cattle, and Sheep.

ŒSTRIDÆ.

The insects belonging to this family are much less degraded than the other parasitic Diptera. But in reality these are not parasites, except in the larval state. They pass the pupa state in the soil, and in the winged state are powerful fliers, seeking the quadrupeds only for the purpose of depositing their

Figure 21.—Sheep-tick (*Melophagus ovinus* Linnæus), enlarged. The figure on the left represents the puparium when first born. From Packard's Guide.

eggs. There are numerous genera and species, each of which lives, in the larval state, upon some particular species of mammalia, and usually in some particular part of the animal. In the tropical parts of America there are species which live beneath the human skin, in tumors that they cause. The larvæ are usually thick, fleshy grubs, destitute of feet, but generally provided with rows of hooks or spines, by means of which they move about in their burrows. The breathing pores are in one or two scaly plates at the thick posterior end of the body. In those that are parasitic in the stomach, the mouth has horny hooks by means of which they cling to the lining membrane; but in those that live in tumors under the skin, there are no hooks to the mouth, but only fleshy tubercles. They live on the matter, or *pus*, which is caused by the irritation that they produce.

The flies generally have a stout, hairy body, sometimes looking somewhat like humble-bees. The female has a more pointed abdomen, with an extensible ovipositor. The antennæ are very small, and placed in little pits. The mouth organs are almost abortive, and the mouth very small, for these flies take little or no food in their winged state, this period of their lives being wholly devoted to the reproduction of their kind. The species that infest cattle, sheep, and horses have been transported to nearly all parts of the world where these animals are reared; but there are many native species that are found only in the wild animals.*

The Bot-fly of Cattle (*Hypoderma bovis* Latr). Figures 22, 23.

This fly is densely covered with hairs, except upon the thorax, which is partially naked and black, broadly banded with white and yellow. The abdomen is banded alternately with yellowish white and black, and with reddish orange at the end. The front of the head is dirty ashen, with yellowish white hairs. They appear from June to September, and the females lay their eggs on the backs of cattle. According to

* One species, *Cuterebra emasculator*, described by Fitch, lives in the scrotum of squirrels, and destroys one or both testicles. In some parts of the country it is often quite common, and doubtless greatly diminishes the number of squirrels.

some writers, they pierce the skin, by means of their peculiar gimlet-like ovipositor; but others deny this, and say that the eggs are merely attached to the skin, and that the young larvæ, which very soon hatch, eat their way in. At any rate

Figure 22.

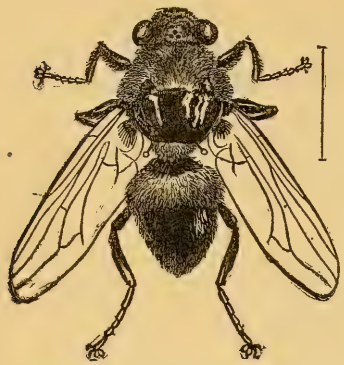
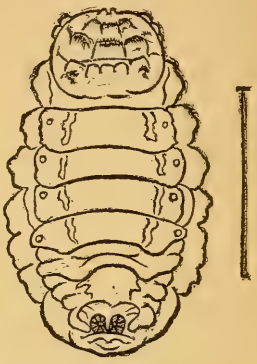


Figure 23.



the cattle are often greatly alarmed by their attacks, and run frantically about, sometimes even taking to the water for safety, which would hardly be the case unless they had suffered pain from their attacks. Working oxen, when thus attacked, sometimes cause serious trouble.

The larvæ having entered the skin increase the size and depth of their burrows as they grow larger, but always keep up an opening with the exterior, and keep the posterior end of the body, in which the breathing pores are situated, near this opening to get air. In this way they cause, by the irritation and inflammation that they produce, tumors or abscesses of considerable size beneath the skin, and live upon the matter formed by the inflammatory action. When young, they are white, but afterwards become brownish; when mature, deep brown.

They have transverse rows of minute hooks; the narrower rows are on the posterior part of each segment, and the hooks point backward; those of the wider rows, point forward. These

Figure 22.—The Bot-fly of Cattle (*Hypoderma bovis* Latreille), considerably enlarged.

Figure 23.—The full grown larva, enlarged. Both from Packard's Guide.

hooks are used in moving about, and no doubt cause considerable irritation. The mouth is small and inconspicuous, with small papillæ. The posterior end of the body bears two small plates in which the spiracles or breathing pores are situated; and this end of the body is kept next to the external orifice of the tumor. When the larva is mature, which happens from May to July, it is about an inch long (Figure 23). It then works its way out of the opening backward, and falls to the earth, where, in a day or two, it changes to a pupa, the dried-up skin of the larva serving as a covering for the pupa. They remain in the pupa state from four to six weeks during summer, when the end of the pupa-case comes off, like a lid or cap, and the mature fly comes forth. The sores caused by them heal very soon after the larvæ leave.

Although these insects probably cause some pain, especially at first, they do not appear to cause any permanent injury, and but little inconvenience, unless in large numbers. They can usually be pressed out of their burrows with the thumb; but care should be taken not to crush or burst them in the burrows. Or the openings of the tumors may be enlarged with a sharp knife or lancet, and then they can be easily removed and the wounds will soon heal. They attack by preference young and healthy or fat animals, perhaps because the skin is softer and thinner in these. They frequent chiefly the uplands, and especially the vicinity of trees, and seem to particularly avoid water or damp localities — a fact that cattle seem to learn by experience. Owing to this habit, cattle that graze upon meadows are generally free from them, or nearly so, although those upon the neighboring hills may be attacked. The eggs are laid soon after the flies emerge from the pupa; but as there is considerable variation in the time when the larvæ mature, the flies may occur from June to September. The larvæ live during the entire winter in the tumors, and perhaps some of the pupæ remain over winter.

The Sheep Bot-fly (*Œstrus ovis* Linn.). Figure 24.

This species somewhat resembles the preceding in form, but is considerably smaller, with a rounder abdomen in the

male, and the color is lighter. The thorax is ash-colored, with four black lines and small black spots. The abdomen is light ash, more or less spotted with blackish. The female has a tapering abdomen, with a long ovipositor, which is curved forward when about to deposit the eggs.

The flies appear during the whole summer, and according to Mr. Riley, deposit the young larvæ previously hatched in the oviduct, on the margins of the nostrils of sheep. "The moment the fly touches this part of the sheep, they shake their heads and strike the ground violently with their fore-feet; at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues. They also "smell to the grass" as they go, lest one should be lying in wait for them. If they observe one, they gallop back, or take some other direction. As they cannot, like the horses, take refuge in the water, they have recourse to a rut or dry, dusty road, or gravel pits, where they crowd close together during the heat of the day, with their noses close to the ground, which renders it difficult for the fly conveniently to get at the nostril." (Clark, 1796). This description, although written long ago, applies equally well to the habits both of the fly and sheep, as observed at the present day. The young larvæ at once proceed to ascend into the nostrils by means of their hooks and writhing motions, thus causing great irritation and an increased secretion of mucus, upon which they feed. They finally reach the frontal and maxillary sinuses and other cavities, connected with the nose, and attach themselves securely to the mucus membranes by means of the two sharp hooks upon their heads. They thus cause great inflammation, if in considerable numbers, and severe illness, or even at times convulsions and death result. This disease is often known as "grub in the head" among farmers. The disease is indicated by loss of appetite, frequent coughing or sneezing, unusual discharge of matter from the nose, slow and weak gait, dullness, inability to stand, tossing

Fig. 24.

Figure 24.—Larva of the Sheep-bot (*Œstrus ovis*), natural size. From Clark.

or turning of the head, inclination to butt and push with the head, fits of frenzy, and general appearance of suffering and weakness, which sometimes goes so far as to render the animal unable to rise, when death generally results. The gums, back part of mouth, and lining of the nasal cavities are often red and inflamed. Sometimes the larvæ even force their way, by the openings through which the nerves pass, into the brain, when death quickly follows.

These larvæ, when full grown (Figure 24) are about an inch long, and have lost more or less of the white color which they had when younger, and each ring is crossed above by two dark brown bands; there are also small, round, raised brown spots on the sides of each segment. The small end, or head, has two sharp hooks and two papillæ; but the posterior segment bears two small brown plates, in which the spiracles are placed, and this segment can be drawn into and concealed by the next, which give a truncated appearance to the posterior end. The under side is flattish, and each segment has a median row of minute brown spines, which are directed backward.

When full grown, they descend from the nostrils and fall to the earth, where, in the soil or among the roots of grass, they change to pupæ in about two days. They remain in this state from six weeks to two months, when a sort of lid is forced off from one end of the pupæ cases, and the mature flies come forth, pair, and immediately proceed with the work of perpetuating the race, for in the winged state they seem to have no other instinct; and not having any mouth, they take no food. When not engaged in depositing the eggs, they seem sluggish and lazy. The flies appear irregularly in June, July, and August, and larvæ of all sizes may be found at one time in the same sheep. Each female produces several hundreds of young. According to Mr. Riley,* over 300 living larvæ have been taken from one female fly, by Mr. Cockrill.

The amount of injury which these insects do to the sheep has long been a matter of discussion among veterinary surgeons and others; but it appears to be the universal testi-

*First Annual Report on the Noxious Insects of Missouri, p. 164, in Report of Board of Agriculture, 1868.

mony of those who are most immediately interested — the breeders of sheep — that their effects are evil, and evil only, and that the amount of injury is in direct proportion to their numbers, as is the case with all other parasites. That, when as abundant as they often are, they are capable of causing death, seems to be well established. As a preventive, it has been recommended to move the sheep to distant pastures after most of the grubs or larvæ have left the sheep and are in the earth in the pupæ state, which happens during June or July, according to locality. In this State probably the latter half of June would be the best time for this. Others smear the noses of the sheep with tar, or make them do so themselves by boring large augur holes in logs to contain salt, and frequently smearing the adjacent wood with tar. Many provide spots of light, dry soil into which the sheep may thrust their noses when pursued by the fly. When the larvæ have actually entered the nostrils in large numbers, they may be removed to a considerable extent by a feather wet with oil of turpentine, camphor, or a weak solution of carbolic acid, or of creosote. Lime, in fine powder, is sometimes used; for by sniffing it, they sneeze, and thus expel the larvæ. Salt water or diluted carbolic acid solution may also be injected into the nose with a syringe. It is doubtful, however, whether any remedies will reach the larvæ which have taken up their abode in the more remote cavities in the bones of the forehead and beneath the bases of the horns. Therefore it is better to apply these remedies early and often, if necessary.

Another species of bot-fly (*Hypoderma lineata* Brauer), lays its eggs upon the backs of sheep and cattle, and the larvæ live in tumors beneath the skin, like the more common *Hypoderma bovis* of cattle. It appears to be rare in this country, but has been observed in Kentucky. This fly may be known by three, longitudinal, naked, black stripes on the thorax. The abdomen is very hairy, blackish, with three bands, the base whitish or yellowish, the middle black, the apex orange-red. The wings are transparent, somewhat brownish, unspotted. In New Grenada another species, the *Dermatobia noxialis* Goud., has the same habits, and also at-

tacks men in the same way, forming painful tumors beneath the skin. The same or a similar species also infests the dogs in the tropical parts of America.

Several peculiar species of *Hypoderma* live beneath the skin of the moose, elk, and other species of the deer family. These animals are also infested by several species of the genus *Cephenomya*, which live in the larval state in the throat, or at the root of the tongue.

The goat is attacked by a species of *Hypoderma*, which makes tumors under the skin, and by a species of *Œstrus*, that enters the frontal sinuses, and has the same habits as the common species of the sheep; but these two species have not been determined and are little known. The camel is infested by the larvæ of *Cephalomya maculata* Wd., which lives in the nasal cavities, like the larvæ of the sheep-bot. Even the elephant and rhinoceros have their peculiar parasites of this kind. The latter is attacked by a bot-fly, allied to that of the horse, which lives in the stomach in its larval state.

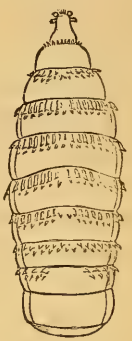
Bot-fly of the Horse (*Gastrophilus equi*). Figures 25, 26.

The "bots" of horses are the larvæ of several species of flies, belonging to the genus called *Gastrophilus*. The largest and most common kind is *G. equi*, the female of which is represented in Figure 25. This species is very hairy, and has dark spots on the wings. The eyes are black and distant; the top of the head is brown, the front whitish; the thorax is brown, with a darker brown or blackish central spot; the abdomen is brown with the transverse divisions and spots blackish. The male has a rounder or broad-oval abdomen, which is browner. This fly lays its eggs by preference upon the hairs about the knees of horses, especially on the inside; it also frequently attaches them to the hairs of the side and back part of the shoulder, and occasionally to the tips of the hairs of the mane. These eggs are of considerable size, of a long oval form, pointed at one end and blunt at the other, and adhere firmly by one side. They may easily be seen and can be removed either by thorough washing and brushing, or by cutting the hairs off with scissors. A wash of carbolic acid soap has been recommended to destroy them. Sometimes 500 or more may

be found on one horse. In depositing the eggs, the female fly hovers around the horse, and as each egg is ready to be deposited, she quickly advances and bends the abdomen forward, with the egg at the end, and applies it to the hair, to

Figure 25.

Figure 26.



which it instantly adheres by the glutinous secretion which covers it. She then retreats and prepares another egg for the same operation. This does not disturb the horse, unless by a tickling sensation, causing the muscles of the skin to contract with a tremulous motion. The eggs contain more or less perfectly developed larvæ when laid; and when they are mature, or have been a few days attached to the hair, they burst open and allow the young to escape almost instantaneously, when moistened. Thus, when the horse licks itself or its companions, the moisture hatches the eggs, and the young larvæ are transferred to the mouth by the tongue or lips, and thence to the stomach, where they fasten themselves to the lining membrane by their two hooks. They generally occur in clusters, and are most common in the vicinity of the pylorus, but are found attached to all parts of the stomach. In this situation they slowly grow to be large fleshy larvæ, with a round body, about an inch long (Figure 25). The segments of the body are provided with double rows of spines, pointing backward. These are reddish with black tips. The

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Figure 25. — Bot-fly of the horse (*Gastrophilus equi* Leach), female, natural size.

Figure 26.—Larva of the same, enlarged. From Packard's Guide.

two last segments do not show the spines, and the posterior end of the body is rather truncate, with two fleshy lobes, which cover, more or less completely, a chitinous plate, in which the spiracles are situated. The mouth is at the small end, between the hooks, which represent the maxillæ; the mandibles, above and between these, are small and slender. At the places where they attach themselves there are found small pits or depressions; but they do not appear to cause ordinarily much irritation or inflammation, unless in great numbers, as they sometimes are. They have been accused of perforating the walls of the stomach, and this may possibly be the case in very rare instances; but the perforations of the stomach, so often found in post-mortem examinations, are generally caused by the digestive action of the gastric juice after the death of the animal; for after death this fluid will attack the stomach as quickly as any other flesh.

When full grown they loosen their hold, and passing through the intestine, fall to the earth. But they often fix themselves for a few days upon the lining of the intestine, and then cause considerable irritation and pain. Probably most of the acute symptoms of "bots" in horses are caused in this way. They often attach themselves in and about the anal orifice, and in that situation cause much suffering and trouble to the horses, which under these circumstances, refuse to travel rapidly, and even after whipping, soon relapse into a slow walk, as if lazy. But the bots can be easily removed from this location, much to the relief of the horse. The bot-larvæ get their growth and leave the horses from the latter part of May to July, or even later. They enter the surface of the soil and change to pupæ within the shrunken skins of the larvæ. They remain in the pupa state forty or fifty days, and emerge in the same way as the preceding species; consequently the flies may occur from the last of June till September, or later.

The amount of injury caused by the bots of horses has long been a matter of dispute, many writers claiming that they are very injurious, and even at times, fatal; while others deny this, and consider them as harmless, or even beneficial. This can

be definitely settled only by experiment; but most reasonable men would be content to forego any possible benefit, and be satisfied with a healthy horse destitute of bots. No doubt many diseases due to other causes are commonly attributed to these insects, but that they are frequently the cause of serious trouble is generally believed and admitted. In this instance prevention is comparatively easy, while all writers admit that there is no reliable cure, no mattter how much they may differ in other respects. The means of prevention consist chiefly in frequently removing or destroying the eggs, as mentioned above, and also in removing and destroying the full-grown larvæ when observed attached to the rectum. In some countries the grooms frequently wash out the mouths of the horses with a suitable brush in order to remove the young larvæ. Many drugs have been recommended to remove bots from the stomach, but none that do not endanger the life of the horse can be relied upon; and in cases where they bring away the larvæ, it is possible that those that are already in the intestines are the only ones affected. Spirits (or oil) of turpentine is a remedy in common use, but should be used with caution, if at all. A better plan, under ordinary circumstances, is to keep the horses in good health in other respects, so that they can the better sustain the attacks of the larvæ until they naturally pass away, which will usually take place without serious injury. In exceptional and severe cases only, resort should be had to special medicines of a dangerous or doubtful character; and then they should be given, if possible, in accordance with the advice of a competent physician. There are several other species of bot-flies of the horse, which are less known, however, in this country.

The *Gastrophilus nasalis* is a smaller species, densely hairy, with the thorax yellowish red or rust-colored. The abdomen is either whitish at base, with the middle black and the apex yellowish-brown and hairy; or the base is whitish and all the rest brown; or the middle is black, with the base and apex whitish, with grayish hairs. The wings are unspotted. The larvæ are much like those of the preceding, except that they are smaller, and also live in the stomach of

horses. They change to pupæ beneath the manure, and the flies appear from June to September. It also infests the ass and mule, and some authors say that it lives even in cattle.

The *Gastrophilus pecorum* is densely covered with yellow hairs, with a band of black hairs on the thorax behind the suture, in the male. The female is yellowish brown, the abdomen black, with yellowish hairs at its base, as well as on the thorax. The wings are grayish or light brownish, clouded with yellowish brown. The larvæ are similar to those of the more common *G. equi*, and have similar habits. The flies appear at the same time.

The *Gastrophilus hæmorrhoidalis*, or red-tailed bot-fly, is a small species, easily distinguished by the bright orange-red tip of the abdomen. The thorax above is olive-gray and hairy, with a black band behind the suture. The base of the abdomen is whitish and the middle blackish, in strange contrast with the orange-red of the end. The larvæ have the same habits and are found in the same situations with those of the common bot-fly, which they much resemble, except that they are whiter and smaller, their length not exceeding one-half or five-eighths of an inch. They change to pupæ within two days after leaving the horse, and the pupæ are deep red. They remain in the pupa state about two months, and the flies appear from the last of June till the cool weather of autumn. In depositing the eggs, the female fly differs in habit from the common bot-fly, for she selects the lips and nose of the horse as the most suitable place for this purpose. In depositing her eggs she therefore causes the horse much trouble and uneasiness. Mr. Clark described the operation as follows: "At the sight of this fly the horse appears much agitated, and moves his head backwards and forwards in the air to baulk its touch and prevent its darting on the lips; but the fly, waiting for a favorable opportunity, continues to repeat the operation from time to time; till at length, finding this mode of defence insufficient, the enraged animal endeavors to avoid it by galloping away to a distant part of the field. If it still continues to follow and tease him, his last resource is in the water, where the *Œstrus* is never observed to follow

him. At other times, this *Œstrus* gets between the fore-legs of the horse whilst he is grazing, and thus makes its attack on the lower lip. The titillation occasions the horse to stamp violently with his fore-foot against the ground, and often strike with his foot, as if aiming a blow at the fly. They also sometimes hide themselves in the grass, and as the horse stoops to graze, they dart on the mouth or lips, and are always observed to poise themselves during a few seconds in the air, while the egg is preparing on the point of the abdomen." The eggs are darker colored than those of the common bot-fly, and contain a nearly developed embryo, so that they very soon hatch, and the young larvæ are transferred to the mouth by the tongue, and thence get into the stomach.

In other countries there are still other species of bot-flies that infest the horse, ass, and mule; among them *Gastrophilus inermis* Br., which lives in the horse; *G. flavipes* Oliv., which inhabits the stomach of the ass and mule; and a species of *Hypoderma*, which lives beneath the skin of all three. But I am not aware that either of these has been observed in this country.

The Meat-fly, Blowflies, etc. Figure 27.

These flies are not true parasites, but naturally feed, while in the larval state, upon decaying flesh and other animal matter. Their larvæ are, however, frequently found in wounds and sores, both of animals and men, feeding upon the purulent matter, and when allowed to live undisturbed, not ununfrequently attack the living flesh, when their food becomes exhausted; and in this wa, if they gain access to wounds in large numbers, they will not only greatly aggravate and enlarge them, but in many cases, when neglected for a short time, they have caused the death of men and animals by actually eating away living tissues. The females in this group of flies are viviparous, the eggs being retained in capa-

Fig. 27.

Figure 27.—Larva or maggot of the Blue-bottle fly (*Musca Cæsar* Linn.), enlarged. From Packard's Guide.

cious spiral dilations of the oviducts, until hatched into small larvæ or maggots, when they are deposited by the mother, with almost unerring instinct, upon or near decaying flesh. The female flesh-fly (*Sarcophaga carnaria* Linn.), is said to deposit at least 20,000 of these young larvæ. They are ready to commence feeding at once, and grow with remarkable rapidity, often becoming half an inch long in two or three days. When mature, they crawl out of the flesh and change to long-oval, brown pupæ, in the earth or any other convenient place, and the mature flies come forth in a few days. By this rapid increase the progeny of a few pairs would in a short time devour the carcass of a large animal. The blue-bottle fly (*Musca Cæsar* Linn.), the meat-fly (*Musca vomitoria* Linn.), and others allied to them, are common and well known species, having similar habits. The larvæ of all these are long, soft-bodied, footless maggots, smaller toward the head, thicker and blunt behind. The larva of the blue-bottle fly is represented in Figure 27. The eggs or larvæ and those of other similar flies are not rarely swallowed with food by men and animals, and are capable of living, for a time at least, in the stomach and intestine, sometimes giving serious trouble. To keep them out of wounds or sores, the old females should be kept away. If this cannot be done by bandages, frequently washing the wounds with a weak solution of carbolic acid will be an effectual remedy and preventive.

PARASITES BELONGING TO THE HEMIPTERA.

The parasitic *Hemiptera* are all degraded, and mostly wingless forms, belonging to three very different families: the *Cimicidæ*, including the bed-bug; *Pediculidæ*, including the true lice; and the *Mallophagidæ*, including bird-lice, etc.

CIMICIDÆ.

This family, as restricted by Westwood, includes only the genus *Cimex*, or the bed-bug and its allies. These have a smoothish, oval, flat body, with a broad metathorax; a small head; a slender, three-jointed proboscis or beak, which reaches as far as the front legs when folded down, and slender, four-

jointed antennæ, the last joint not enlarged or clavate. They seldom, if ever, have wings. In addition to the common bed-bug, there are species infesting pigeons (*C. columbarius* Jenyns); swallows (*C. hirundinis* J.); and bats (*C. pipistrelli* J.). It is doubtful, however, whether all these be not identical with the common species. At any rate, it appears that the common bed-bug will attach itself to bats and various birds, when opportunities occur.

The Bed-Bug, (*Cimex lectularius* Linn.). Figure 28.

This species has long been notorious. It was mentioned by Pliny, Aristophanes, Aristotle, Dioscorides, and other ancient writers. Yet English writers have argued that it was first carried to that country from America, and thence to the continent of Europe. Moffitt mentions it, however, as having been seen in England as early as 1503, though it does not appear to have been common there until a century later. Its early English name was "wall louse"; the term "bug" was applied to it much later, its original meaning having been nearly synonymous with "bug-bear."

At the present day this insect is sufficiently common throughout the civilized world, if not among the barbarians also. Its form and general appearance are well shown in Figure 28, which represents it considerably larger than ordinary specimens. Its size varies greatly, however, according to its locality and the amount of blood it has been able to imbibe. Its color, when young, is pale yellowish, the blood in the intestine showing through; as it grows older it becomes darker, until, when full grown, it is reddish brown, the color being darker when filled with blood. The eyes are small and bright red; the proboscis is much like that of the ordinary blood-sucking Hemiptera, which prey on other insects; the labium forms a three-jointed sheath or tube, the middle joint being broadest, the last one sharply pointed; the labrum is broader than the basal joint, which it overlaps. According to Dr. Packard, the internal structure is as follows: "The mandibles and maxillæ arise near each other, in the middle of the head, opposite the eyes, their bases slightly diverging. Thence they converge to the mouth, over which they meet, and beyond are

free, being hollow, thin bands of chitine, meeting like the maxillæ, or tongue, of butterflies, to form a hollow tube for suction. The mandibles each suddenly end in a curved, slender filament, which is probably used as a tactile organ to explore the best sites in the flesh of their victim for drawing blood. On the other hand, the maxillæ, which are much narrower than the mandibles, become rounded toward the end, bristle-like, and tipped with numerous exceedingly fine barbs, by which the bug anchors itself in the flesh, while the blood is pumped through the mandibles. The base of the large, tubular labium, or beak, which ensheathes the mandibles and maxillæ, is opposite the end of the clypeus, or front edge of the upper side of the head, and at a distance beyond the mouth equal to the breadth of the labium itself. The labium, which is divided into three joints, becomes flattened toward the tip, which is square, and ends in two thin membranous lobes, probably endowed with a slight sense of touch." At the same time that the blood is sucked up, some poisonous secretion or saliva is introduced into the wound, perhaps to render the blood more liquid. To some persons these bites are extremely poisonous and cause large inflamed swellings and violent itching, while in other persons no such effects occur, and the bites are scarcely noticed.

Figure 28.

These insects are inclined to be gregarious in their habits, and are fond of herding together, a dozen or more in a place, whether in a crack, knot-hole, chink in the walls of houses, or any snug corners about a bedstead. They are also fond of returning constantly to the same hiding-place, morning after morning, after their nocturnal raids, just as many birds return regularly to their roosts. On this account their retreats become discolored by dark spots of excrement. When much disturbed, or when food fails, they will disperse, however, and each one will migrate on its own account. In the night they are quite lively and nimble, and run about with

Figure 28.—Bed-bug (*Cimex lectularius* Linn.), enlarged. The straight line shows the ordinary length. From Packard's Guide.

great rapidity, and can then evidently see better than by day. They are capable of making long journeys even during the day, and may thus migrate from house to house. They are, however, not restricted to human dwellings or to human blood, for they often take up their residences in poultry houses and yards, at times completely swarming in such places. They will also attack dogs and cats, and may live about the places where those animals sleep. They have even been found in the woods under the bark of dead trees. The same species, apparently, also attacks bats, and may thus enter houses. In fact, there are a great many ways in which they may get into the best of houses, besides the well known method of adhering to clothing, etc. It is, therefore, no disgrace to any housekeeper that a bug should now and then be detected in the house; but the disgrace consists in allowing them to remain undisturbed until their numbers increase to a great extent, as they will most surely do if neglected. Many kinds of Hemiptera, like the squash-bug, etc., have the power of forming a peculiar odorous secretion, which, from the similarity of the odor, probably consists in part of formate of amylic ether; but in the bed-bug this odor is combined with others that are far more disagreeable.

The eggs are long-oval and white, and are laid in clusters in the cracks, etc., about bedsteads and other places that they frequent. The young hatch by forcing off one end of the egg-shell like a lid. The young, when first hatched, are whitish and translucent, and although having three legs and the general features and habits of the old ones, they differ considerably in form, being more louse-shaped. They have a broader and more triangular head, and shorter and thicker antennæ. They cast their skins several times during growth, each time looking a little more like the adult than before. It is said that they require eleven weeks to mature, but this probably differs according to the temperature and food. They are, however, lively and blood-thirsty from the first, and are well able to look out for themselves. Their skill in finding a sleeping person and reaching him is marvelous indeed.

In ordinary cases there is no great difficulty in eradicating

these insects completely, if a proper amount of care is bestowed in the way of keeping the house and beds clean and neat. The principal trouble arises from neglect on the part of housekeepers to examine the beds frequently, for, as already intimated, no bed is sure to escape their attentions for any great length of time, especially in cities, where they may at any time walk in from some neighbor's house for a friendly visit or morning call.

When they are merely located in bedsteads, or bedding, there is no better way than to make a careful and thorough examination of all cracks and corners, and when any are seen, a little benzine poured upon them will kill them instantly, and the benzine should be poured into all suspicious cracks, which cannot otherwise be reached. Scalding hot water thoroughly applied is also effectual, but is liable to injure the varnish of furniture. One examination of a bed is seldom sufficient, for eggs that have escaped observation, may subsequently hatch. Therefore two or three searches, with benzine in hand, should be made at intervals of a week or ten days. The use of corrosive sublimate and similar poisons is unnecessary and objectionable, for such preparations are not more dangerous to the bugs than to the persons who occupy the beds, and are less fatal, even when applied directly to the bugs, than benzine. When the bugs have also taken up their residence in the cracks and crevices in the walls of old houses, it is much more difficult to destroy them. If very bad, the house, when empty, may receive a thorough fumigation with burning sulphur, which will generally prove very effectual. Hen-houses and other out-buildings may be thoroughly drenched with a mixture of crude petroleum and water, or with the solution of carbolic acid.

Bed-bugs are extremely tenacious of life and have wonderful powers of fasting. They have been kept hermetically sealed in glass bottles for more than a year without any food, and were still lively and had a good appetite.

PEDICULIDÆ.

This family includes the ordinary lice of man and quadrupeds, which are furnished with a sucking mouth. They are

very low, degraded Hemiptera, destitute of wings. The head is small, conical, and narrow; the thorax is small and indistinctly separated into segments; the abdomen is large, flattish, rounded or oval, with nine segments. The antennæ are very slender and five-jointed. The eyes are simple and very minute. The feet, or tarsi, have two joints, the last joint forming a strong hook for grasping the hairs firmly while crawling and climbing among it. The mouth-parts form a long and extremely slender fleshy tube, which is retracted when not in use, and is capable of being introduced into the skin, for the purpose of sucking blood. The structure of the mouth is as follows, according to Schiödte: "The peculiar attenuation of the head in front of the antennæ at once suggests to the practised eye the existence of a mouth adapted for suction. This mouth differs from that of Rhynchota [Hemiptera, bed-bug, etc.] generally, in the circumstance that the labium is capable of being retracted into the upper part of the head, which therefore presents a little fold, which is extended when the labium is protruded. In order to strengthen this part, a flat band of chitine is placed on the under surface, just as the shoemaker puts a

Figure 29.

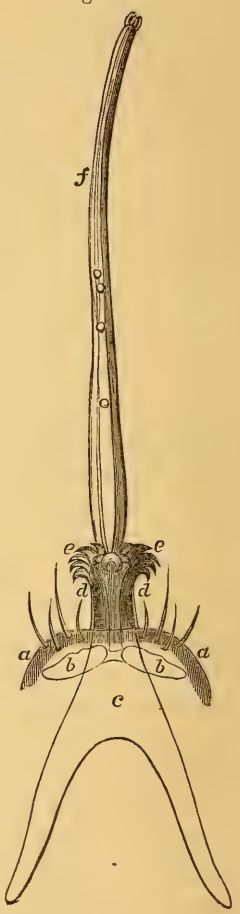


Figure 29.—Proboscis of body-louse (*Pediculus corporis* DeGéer), entirely protruded and seen from above, magnified one hundred and sixty times; *aa*, the summit of the head, with four bristles on each side; *bb*, the chitinous band, and *c*, the hind part of the lower lip—such as they appear through the skin by strong transmitted light; *dd*, the foremost protruding part of the lower lip (the haustellum); *ee*, the hooks turned outwards; *f*, the inner tube of suction, slightly bent and twisted; the two pairs of jaws are perceived on the outside as thin lines; a few blood globules are seen in the interior of the tube.—*From American Naturalist.*

small piece of gutta-percha into the back of an India-rubber shoe; as, however, the chitine is not very elastic, this band is rather thinner in the middle, in order that it may bend and fold a little when the skin is not extended by the lower lip. The latter consists, as usual, of two hard lateral pieces, of which the fore ends are united by a membrane so that they form a tube, of which the interior covering is a continuation of the elastic membrane in the top of the head; inside its orifice there are a number of small hooks, which assume different positions according to the degree of protrusion; if this is at its highest point the orifice is turned inside out, like a collar, whereby the small hooks are directed backward, so that they can serve as barbs. These are the movements which the animal executes after having first inserted the labium through a sweat-pore. When the hooks have got a firm hold, the first pair of setæ (the real mandibles transformed) are protruded; these are, towards their points, united by a membrane so as to form a closed tube, from which, again, is exserted the second pair of setæ, or maxillæ, which in the same manner are transformed into a tube ending in four small lobes placed crosswise. It follows that when the whole instrument is exserted, we perceive a long membranous flexible tube hanging down from the labium, and along the walls of this tube the setiform mandibles and maxillæ in the shape of long narrow bands of chitine. In this way the tube of suction can be made longer or shorter as required, and easily adjusted to the thickness of the skin in the particular place where the animal is sucking, whereby access to the capillary system is secured at any part of the body. It is apparent, from the whole structure of the instrument, that it is by no means calculated for being used as a sting, but is rather to be compared to a delicate elastic probe, in the use of which the terminal lobes probably serve as feelers. As soon as the capillary system is reached, the blood will at once ascend into the narrow tube, after which the current is continued with increasing rapidity by means of the pulsation of the pumping ventricle and the powerful peristaltic movement of the digestive tube."

The various species of these lice have similar habits, and all are blood suckers, but each species inhabits only certain kinds of animals, and some are restricted to particular parts of the skin. Many animals have two or more species of these parasites. Five species have been described as parasitic upon man, though but three are common.

When they become very abundant, as they soon will if the animals upon which they once get well established be neglected, they cause great irritation of the skin and nervous system, and the itching that they produce causes the animals to rub themselves against buildings, fences, etc., and thus the hair is often worn off and the skin abraded. Such animals generally soon become weak and emaciated, and are, therefore, more liable to be attacked by other diseases.

There are various washes which, if properly applied, will very rapidly destroy all species of lice, without much trouble. The use of preparations of mercury and arsenic, and all similar poisons, should be avoided, for they often poison the animals, as well as the persons who use them, and thus the remedy may be worse than the disease.

A strong solution of tobacco, made by boiling cheap tobacco in water, is an effectual remedy, in common use. Snuff rubbed into the hair is also used. Ordinary whale-oil, such as was formerly used in lamps, poured upon the skin along the back of an ox, cow, calf, or sheep, will diffuse itself over the skin and kill the lice. Weak petroleum water, or carbolic acid solution, or carbolic soap, may be used as a wash, or small animals may be immersed in a bath, taking care to keep the nose, mouth, and eyes out of it. But perhaps one of the best and simplest, as well as safest, washes for this purpose, as well as to destroy fleas, mites, itch-insects, mange-acari, and all other external parasites of man and animals, is a solution of *sulphuret of potassium* in water,—two to four ounces to the gallon of cold water, varying the strength according to the age and tenderness of the skin of the animal, for the solution will contain some free potash, which, if too strong, might irritate a delicate skin. There is otherwise no danger from its use, though its odor, like sulphuretted hydro-

gen, is disagreeable, and it should be used, therefore, where there is plenty of ventilation. This is an exceedingly valuable remedy, also, for the itch of man, as well as the "mange" of animals. The sulphuret of potassium comes in the form of grayish or greenish lumps, put up in tight bottles. It is used in photography and can usually be bought at the principal drug stores.

An equally useful preparation, having the same properties, may be easily made by taking fresh quick-lime, slacking it gradually with water, and forming a milky solution by the addition of more water, as in the preparation of white-wash. Into this put as much flowers of sulphur as will dissolve by boiling for some time. This will produce a deep yellow solution like that of the sulphuret of potassium in odor and effects. It may be diluted if too strong. It contains *sulphuret of calcium*, upon which its usefulness depends. Sulphur may also be boiled in potash lye, to produce a similar preparation, and to this, while boiling, tobacco is sometimes added, but the sulphur is, no doubt, sufficient for all practical purposes. But in no case can we be certain of destroying all the eggs of these parasites by any wash whatever, that would not be dangerous to the animal. Therefore the treatment should be repeated two or three times, at intervals of ten or twelve days, in order to destroy any young that may have hatched in the meantime.

The Head-louse of man (*Pediculus capitis* DeGéer). Fig. 30.

This is, probably, the best known species of the genus *Pediculus*. It is still sufficiently common among persons who neglect personal cleanliness, though much less so than it is said to have been formerly, when it was thought no disgrace in some parts of the old world, but was regarded as fashionable, rather than otherwise. This insect is almost exclusively confined to the human head. It attaches its eggs firmly to the hair, near the roots. These eggs are long-oval, with several little conical prominences at the large end,

Figure 30.

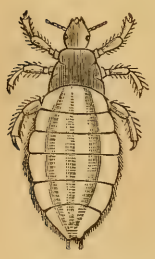


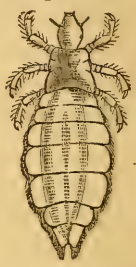
Figure 30.—Head-louse (*Pediculus capitis* DeGéer), greatly magnified. From Packard's Guide.

which are open at the top, while the small end bears a cluster of bristles. The habits and treatment are too well known to need further description.

The Body-louse of Man (*Pediculus corporis* DeGéer). Figure 31.

This species very closely resembles the last, but is usually larger. It attaches itself especially to the clothing, and attacks various parts of the body. It attaches its eggs chiefly to the clothing which it frequents, especially along the seams, and when the clothing is seldom changed, as often necessarily happens in time of war, it increases rapidly and becomes a great source of annoyance. Many unfortunate soldiers, who were confined in the southern prisons and prison-pens during the late war, can testify to the abundance of this parasite under such circumstances. Nor were the ordinary camps free from them, especially during active campaigns.

Figure 31.



The Crab-louse (*Phthirius pubis* Leach). Figure 32.

In the genus *Phthirius* the thorax is broad and not distinct from the abdomen, which is flat and has eight segments, the first one being composed of two united. The first pair of legs are terminated by slender tarsi, not changed to grasping claws, but the claws of the other two pairs are large and strong.

Figure 32.

This species lives among the hairs of the pubic regions of man, and also, though much less commonly, upon the breast, arm-pits, in the beard, eye-brows, and also upon the head. It sometimes also clings to linen and clothing, and, not unfrequently, may be found in the beds of those persons harboring them. They may be destroyed by simple ointments and unguents, or by the sulphuret washes described above.

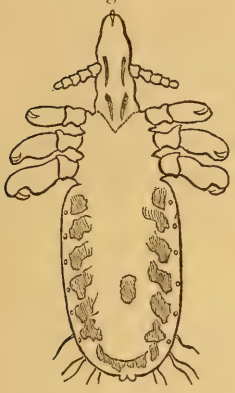
Figure 31.—Body-louse (*Pediculus corporis* DeGé), greatly magnified. From Packard's Guide.

Figure 32.—Crab-louse (*Phthirius pubis* Leach), much enlarged. From Packard's Guide.

The Cattle-louse (*Hæmatopinus vituli* Denny). Figure 33.

In the genus *Hæmatopinus*, which includes a large number of species, the head is obtuse or truncated in front, the middle segments of the abdomen well separated, and the posterior legs much the longest. The eyes are very minute. They are all small and some are minute species.

Figure 33.

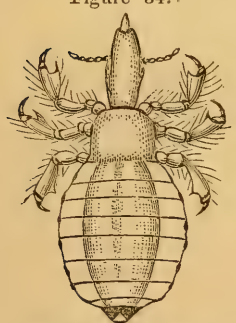


H. vituli is brownish, with a pale abdomen, the abdominal segments bearing lateral chitinous pieces, in which the spiracles are situated. The head is elongated with a constriction behind the antennæ. It is about $\frac{1}{12}$ of an inch in length, or a little more. It is parasitic both on cattle and horses, and sometimes becomes very abundant.

Another species (*H. eurysternus* Denny), also infests both cattle and horses. In this the head, thorax, and feet are horn-colored. The thorax is very broad. The length is about $\frac{1}{18}$ of an inch.

The Hog-louse (*Hæmatopinus suis* Leach). Figure 34.

Figure 34.



This species is brown, with a white abdomen. The spiracles are placed in blackish, horny plates along each side of the abdomen. Length $\frac{1}{8}$ of an inch.

H. stenopsis infests the goat. It is a horn-colored species, with a long oval hairy abdomen.

H. asini Denny is parasitic on the ass.

H. piliferus Denny lives upon the dog. It is uniformly horn-colored. The body is slender and covered with pale hairs. Length $\frac{1}{12}$ of an inch.

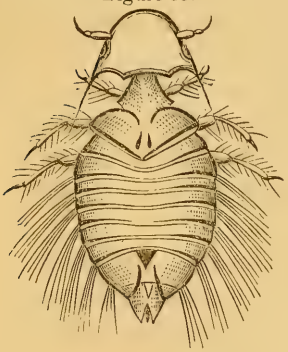
Figure 33.—Cattle-louse (*Hæmatopinus vituli* Denny), much enlarged. From American Naturalist.

Figure 34.—Hog-louse (*H. suis* Leach), much enlarged. From Cuvier.

MALLOPHAGA (Bird-lice).

These insects live both among the feathers of birds and hair of mammals. They are peculiar in having distinct jaws (Figure 36), instead of a sucking tube. The body is flat, corneous, and firm above. The head is horizontal and generally broad. The antennæ have three to five joints. The mandibles are small and hook-like. The maxillary palpi, when present, are four-jointed; and the labial palpi two-jointed. The legs are short and stout, with one or two strong claws. There are several hundreds of species already described, nearly every bird having one or several peculiar species. They produce nearly the same effects as the true lice, and may be destroyed by the same remedies.

Figure 35.



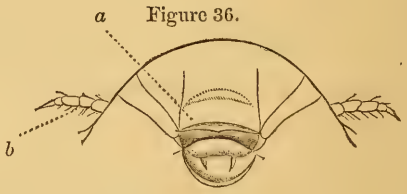


Figure 36.

The Turkey-louse (*Goniodes stylifer* Denny).

This is a large species, conspicuously marked with transverse black bands. It is very common both on the domestic and wild turkey, together with three or more other species, one of which is much longer and nearly black. Some of the other species parasitic on the turkey are *Liotheum stramineum* Nitzsch, *Philopterus polytrapezius* Nitzsch.

The Hen-lice (*Liotheum pallidum* Nitzsch, *Philopterus variabilis* N., *P. heterographus* N., *P. dissimilis* N., and *P.*

Figure 35.—Turkey-louse (*Goniodes stylifer* Denny), much enlarged.

Figure 36.—Head of same, seen from below, more magnified; *a*, mouth organs; *b*, antenna. Both from Cuvier.

hologaster N., *Goniocotes Burnettii* Packard, Figure 37) are common enemies of domestic fowls.

Figure 37.

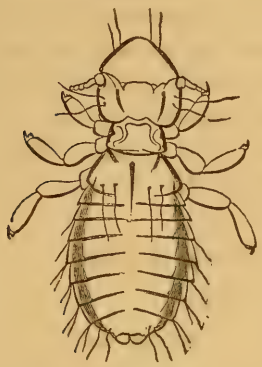
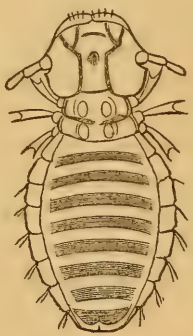


Figure 38.

The Pigeon-lice (*Liotheum giganteum* Denny, *Philopterus baculus* Nitzsch, *Nirmus clavicornis*, *Goniodes compar* N.) infest domestic pigeons.

Figure 39.

Figure 40.



The Goose-louse (*Trinotum squalidum* Denny) is found with other species on the goose.

The Duck-lice (*Philopterus squalidus* Nitzsch), Figure 38, with other species, inhabit the common duck.

Figure 37.—Hen-louse (*Goniocotes Burnettii* Pack.). American Naturalist.
Figure 38.—Duck-louse (*Philopterus squalidus* N.) From Gervais.
Figure 39.—Cat-louse (*Trichodectes subrostratus* N.) From American Naturalist.
Figure 40.—Goat-louse (*T. caprœ* Packard). From American Naturalist

The Peacock-lice (*Philopterus falcicornis* N., *P. rectangulatus* N.) are very common on the peacock.

The Cat-louse (*Trichodectes subrostratus* Nitzsch), Figure 39, is one of the parasites of the house cat. This species is whitish, with the head and thorax pale honey-yellow.

The Goat-louse (*Trichodectes caprœ* Packard, probably the same as *T. limbatus* Gervais), Figure 40, lives with other species upon the domestic goat. It is reddish yellow, transversely barred with reddish brown, the abdomen edged with red.

SUB-CLASS, ARACHNIDA.

ACARINA (Mites).

These are characterized by their simple, usually rounded or oval bodies, in which there is no distinct separation into thorax and abdomen. They have eight legs, which are generally short, but when young many of them are six-legged. The species are numerous. Their habits are very diverse; many are parasitic upon man, various quadrupeds, birds, reptiles, insects, etc., some externally and others internally. Species have even been found within the abdominal cavity and skull. Other species live under the water, and are parasitic on mollusca. Many attack plants and prove very injurious. Others are carnivorous and prey on small insects. Some, like the meal-mite, sugar-mite, cheese-mite, fig-mite, and many others attack and greatly injure articles of food. Many lead a solitary, wandering life, others occur together in vast numbers at certain times.

DERMANYSSUS Dugès.

The insects of this genus are small, soft-bodied parasites, which infest various birds, bats, insects, and some of them are at times parasitic upon man.

The fifth joint of the palpi is smallest. The lip is sharp. The mandibles of the male are forceps-like, with long hooks; those of the female ensiform. The anterior feet are the longest. Young with six legs.

Dermanyssus gallinæ is found among the feathers of the domestic fowl, and lives by sucking the blood.

D. Gallopavonis infests the turkey. The body is marked by peculiar, delicate, transverse striæ, and with numerous small circular impressions on the back.

D. avium torments small cage birds, like the canary. It often takes refuge in cracks about the perches, which should therefore be kept clean.

ARGAS Latreille.

This genus includes the famous *Argas Persicus*, which infests old dwellings in Persia, especially at Miana, and is said to be so poisonous that its bite produces convulsions and speedy death; or even its juices, if crushed upon the skin, may produce the same results.

These are larger than most of the mites, and somewhat resemble the ticks. The body is broad-oval or roundish. The upper side of the head so projects as to conceal the mouth parts. The jaws are suctorial. The lower side of the body is granulous, not scaly, and covered by a single piece.

Argas reflexus Latreille lives upon pigeons and sucks their blood. It especially infests the young, upon which there are sometimes great numbers. The body is marked with curious tortuous grooves and pits. The color is yellowish, but when filled with blood violaceous.

IXODES Latreille. (Ticks).

These are the largest of the Acarians, and all are parasitic, chiefly upon quadrupeds and reptiles, but sometimes on birds. The body is broad-oval or round, and when not swollen with blood is flatish, and the integument is firm and tough. Their mandibles (Figure 43, b,) are covered with teeth and have terminal hooks; their maxillæ are small, not reaching beyond the beak, but bear a peculiar organ called the glossoid (Figure 43, a,) also covered with hook-like teeth. The legs are slender and have two claws, and in the young have pads or suckers (d). The young are six-legged (Figure 42). The ovarial opening is near the mouth, between the first pair of legs. These parasites, when young, cling in large clusters to the tips of leaves and twigs of herbs and shrubs, with part of their six slender legs extended. When brushed by a passing

animal, they instantly leave the plant and quickly disperse over their host. They insert their glossoids and mandibles into the skin, where they cling firmly by means of the numerous hooks, and live by sucking the blood. The abdomen soon becomes very much swollen, and sometimes grows so large as to resemble a tumor. They attack various animals and even man, indiscriminately. In many parts of the Southern States the "wood ticks" are extremely troublesome to persons who have occasion to go into the forests, as well as to animals. The eggs of *Ixodes albipictus* are laid in large masses, from the first of May until the last of June. Early in July the eggs hatch out simultaneously, "the shell opening like a clam." The young when first hatched have six slender legs.

Figure 41.

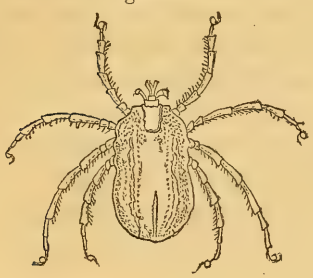


Figure 42.

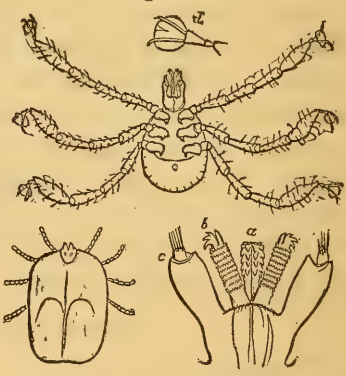


Figure 44.

Figure 43.

The Cattle-tick (*Ixodes bovis*). Figure 41.

This is a flattened, leathery, reddish, seed-like species, with an oblong-oval body. It sometimes grows to be nearly half an inch long. It infests cattle, and is very troublesome in the Western and Southern States, but is far less common in the North. It also attacks the horse and many other quadrupeds, as well as reptiles, including the rattle-snake.

Figure 41.—Cattle-tick (*Ixodes bovis* Riley), enlarged.

Figure 42.—*Ixodes albiptctus* Packard; six-legged young, much enlarged; *d*, foot with sucker.

Figure 43.—Head of the same, more enlarged; *a*, glossoid; *b*, mandibles; *c* maxillary palpi.

Figure 44.—Adult of the same, gorged with blood, natural size. All from Packard's Guide.

Ixodes albipictus Packard. Figures 42, 43, 44.

This was originally found upon a tame moose by Mr. W. G. Hays, but doubtless infests other animals.

Ixodes unipictus Packard.

This is about a quarter of an inch long and has an oval form. Is is reddish brown, or mahogany-color, with a central silvery spot upon the back. It often attacks men and various animals. It has been found in New England, but is more common southward.

In Europe, numerous species have been found.

Ixodes vicinus is very troublesome to dogs. It is of a brownish violet color, crenulated posteriorly. It has five radiating brown spots and some brown dots.

Ixodes reduvius infest sheep and dogs. It has a pale red or yellowish color, and becomes more than a quarter of an inch long. It must not be confounded with the ordinary "sheep-tick" (see page 89).

Mites, ACARUS Linn.

This genus, which originally included all the mites, is now restricted to those that are allied to the cheese-mite. The mouth parts are prolonged into a rostrum or beak. There is a constriction of the body between the second and third pair of legs, dividing it somewhat into two parts.

The Cheese-mite (*Acarus siro* Linn.).

This species ordinarily lives in cheese and other articles of food; but has sometimes been observed parasitic upon man, in certain diseased conditions.

The Meal-mite (*Acarus farinæ* De Géer).

This species, found in meal and flour that has been injured is sometimes accidentally swallowed while living.

Acarus dysenteriæ Linn. was found living in the excreta of a person attacked by violent dysentery. It also sometimes occurs in large numbers about wine and beer casks, and may therefore be swallowed accidentally.

Glyciphagus hippopodos has been found in the ulcerated feet of horses. A species of mite also occurs in the diseased feet of sheep.

Mange-insect of the Horse (*Psoroptes equi* Gervais).

This insect is readily visible to the naked eye and swarms on horses afflicted with the mange, which is a disease analagous to the itch in man. It has a soft, depressed body, spiny beneath at the base of the legs and on the thorax. One or both of the two posterior pairs of feet bear suckers, and all are more or less covered with long slender hairs.

Figure 45.

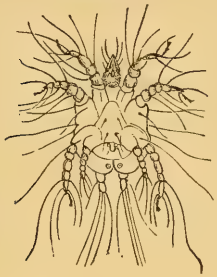
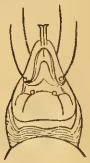


Fig. 46.



This insect may be destroyed by the same remedies used for lice and for the human itch. The best remedy is probably the solution of sulphuret of potassium, described on page 109.

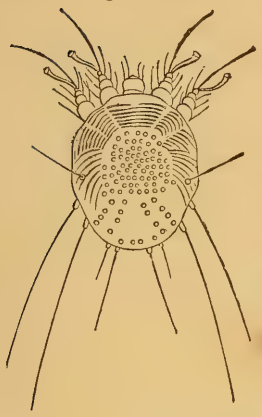
The Itch-insect (*Sarcoptes scabiei* Latr.). Figure 47.

This is a very minute, whitish species, barely visible to the naked eye, unless on a dark surface. It has been, in former times, the subject of many lengthy discussions, in reference to its causing the itch. It is, however, at the present time fully ascertained to be the sole cause of the ordinary itch, though other species of similar parasites may cause different varieties of itch. The body is rounded and soft, with small round pustules on the middle of the back, and with radiating lines or ridges, the sides of the body and legs bearing long bristle-like hairs. The mandibles are needle-like. The female is largest and has the two pairs of hind legs but little developed, ending a bristle; in the male they are well developed and terminate in a slender sucker. These creatures, as seen under the microscope, have something of the unwieldy

Figure 45.—*Psoroptes equi* Gervais, female; ventral side, much enlarged.
Figure 46.—Head of the same, more magnified. Both from Cuvier.

appearance of a tortoise, and are ordinarily sluggish, yet they are capable of leaping to a considerable distance. They bury themselves in the human skin, especially in the more delicate and less exposed parts, and excavate minute galleries for themselves, in a manner something like that in which moles excavate galleries in the soil. These galleries are at first perpendicular, and then go off horizontally to some distance. The females lay their eggs in these galleries as they progress.

Figure 47.



These mining and boring operations cause much irritation of the nerves of the skin and induce an intolerable itching, and the inflammation that they cause produces pustules, filled with a watery exudation. The insects themselves are not found in the pustules but in their minute galleries, off to one side, the pustule generally marking the place where they entered. The itch is contagious, simply because the insects, especially in their young and more active state, pass from one person to another, or are transmitted by clothing. They are most active at night and, therefore, sleeping with an infested person is pretty sure to be attended by the transfer of the insects. The longer the parasites are neglected, the more numerous they become. The increase is, however, quite slow at first, owing to the small number of eggs. There are various remedies for this disease, but the different preparation of sulphur are no doubt the best and safest. The solutions of sulphuret of potassium, described on page 109, is probably the simplest and most efficacious preparation for this purpose. Its use should be accompanied by a thorough change of garments and bedding, and it should be used by all the members of an infected family simultaneously. It should be appliedat

Figure 47.—Itch-insect (*Sarcoptes scabiei* Latreille), female, upper side, much enlarged. From Guerin.

least three times, at intervals of three or four days, to destroy the young as fast as they hatch.

Species of *Sarcoptes*, closely allied to the itch-insect, have been found on the domestic animals, causing diseases analogous to the itch in man. Such diseases, caused by quite a number of distinct parasites, are called "mange." They have been observed on the cat, dog, camel,* and hog.

The genus *Dermatodectes* is closely allied to *Sarcoptes*, and the species likewise live on animals, burrowing in the skin. *D. bovis* infests cattle, and *D. ovis* lives in the skin of sheep. The genus *Dermaleichus* infests birds in a similar manner.

All these parasites should be treated like the itch-insect of man. The sulphuret of potassium solution, applied with a brush that has long bristles, like a white-wash brush, is probably the best and simplest remedy.

The Face-mite (*Demodex folliculorum* Owen). Figure 48.

This singular but minute parasite lives in the diseased and enlarged follicles in the skin of the human face, especially in those about the nose and chin. The follicles, when thus diseased, are enlarged and filled with a thickened sebaceous matter, the orifice being usually obstructed by a hardened, blackish substance. If these be pressed, and the matter which is forced out be carefully examined with a microscope, it will often be found to contain numerous specimens of this minute creature, in all stages of development. A drop of oil or ether applied to the sebaceous matter, to dissolve the fatty parts, will render them more readily visible. The young ones have but six short legs; the adults have eight legs and a worm-like body, as represented in Figure 48. It has been thought that the "barber's itch" is caused by this parasite, but I do not know that this has been fully established.

Figure 48.

S. dromedarii, of the camel, is sometimes communicated to man, causing a form of itch worse than the ordinary, owing to its great size and numerous spines.

Figure 48.—Face-mite (*Demodex folliculorum* Owen, or *Simonea folliculorum* of some authors), much enlarged. From Packard's Guide.

The same species, or one very closely allied to it, occurs in the skin of the dog and other domestic animals, producing some forms of the "mange." These parasites will probably be destroyed by the same remedies that are effective against the itch-insect.

SECOND LECTURE.

The Internal Parasites of Domestic Animals;

THEIR EFFECTS AND REMEDIES.

The parasites of man are so intimately connected with those of his domesticated animals, that it is impossible to discuss them separately. Indeed, many of the human parasites inhabit also the hog, cattle, sheep, and the dog, in certain stages of their development, and nearly all the most dangerous kinds are derived, either directly or indirectly, from those animals. While in return mankind furnish to them the eggs of several

of their worst parasites. Thus some of these creatures are kept in existence solely by reason of the peculiar relations existing between man and his brute dependents. This is particularly the case in respect to the two most common tape-worms of man, derived respectively from the flesh of cattle and hogs, in which the young worms live. These two worms appear to be capable of coming to maturity only in the human intestine.

Most of these internal parasites belong to the great class of articulated animals known as Worms, constituting, however, several distinct orders, which are often collectively called Helminths. The orders of parasitic worms are much lower in rank than those that include the independent kinds, like the numerous species of free marine worms, or Annelids, many of which have beautiful gills and locomotive organs, a very complex circulation, red blood, and a well-organized head, eyes, mouth, and intestine; to such worms the common earth-worms, or angler-worms, are also allied, although destitute of gills. But the parasitic worms never have red blood nor special organs for breathing, and rarely for locomotion; most have no distinct organs of sense, and many have no head and no intestine. The reproductive system is, however, always very highly developed, and most of them are exceedingly prolific. This is essential to their existence, for it is often only by mere chance that any of the eggs or young reach the peculiar habitats in which alone they can grow to maturity.

The internal parasites of animals have long been the subject of laborious and careful research by many of the ablest naturalists and physiologists,* owing to the remarkable

*The following are some of the more important and useful of the recent general works on parasitic worms:

Félix Dujardin, Histoire naturelle des Helminthes au vers intestinaux, 8vo, with plates, Paris, 1845. (Suites a Buffon.)

C. M. Diesing, Systema Helminthum. Two volumes, 8vo. Vindobonæ, 1850.

J. Leidy. A Flora and Fauna within living animals. Smithsonian contribu tions, 1852.

C. Davaine, Traité des Entozoaires et des mala lies vermineuses de l'homme et des animaux domestiques, 8vo, 930 pages, with 88 figures. Paris, 1860.

D. F. Weinland. An Essay on the tape-worms of man; 8vo pamphlet, with figures. Cambridge, Mass., 1858.

T. S. Cobbold. Entozoa; an Introduction to the study of Helminthology, with

peculiarities of their structure, habits, andmodes of reproduction, as well as to their great practical importance with reference to human health and property.

The total number of species hitherto described, from all animals, is more than 2,000. Of these upwards of 100 species are found in domestic animals and man.

The parasitic worms of man and domestic animals are naturally divided into four principal orders, which are characterized by important anatomical and physiological peculiarities.

I. Cestodes. (Tape-worms).

This order includes the numerous kinds of tape-worms and their young, the "measles," hydatids, and bladder-worms, found in more or less abundance in all classes of vertebrate animals, as well as in insects, mollusca, etc. These tape-worms belong to three very distinct families and to numerous genera. About 250 species have been hitherto described.

These worms in the sexually mature condition have a more or less enlarged roundish, oval, angular, or lobed head, destitute of a mouth, but provided with two or four suckers, or pits, and often with one or four proboscis-like organs, surrounded by hooks, by means of which they fasten themselves securely to the mucous membrane of the intestine of the animal in which they live. There is no intestine or other digestive system. The head is followed by a series of many flattish joints or segments, those near the head being small and short, while those that are more distant are larger and usually oblong or squarish. These joints, as they mature, are spontaneously detached and may enjoy a short independent existence, and are then called proglottides. Each joint contains distinct male and female reproductive organs, and matures a vast number of eggs, which are generally liberated

reference more particularly to the internal parasites of man. Large 8vo, 480 pages, with numerous figures and 21 plates. London, 1864.

J. L. W. Thudichum. On the Parasitic Diseases of Quadrupeds used for food. In the Seventh Report of the medical officer of the Privy Council, p. 303. London, 1865.

T. S. Cobbold. Tape-worms (Human Entozoa), their sources, nature, and treatment; 12mo, 83 pages, with figures. London, 1866.

R. Leuckart, Die Menschlichen Parasiten, und die von ihnen herrührenden Krankheiten. Two volumes, 8vo, with numerous figures. Leipzig and Heidelberg, 1862 to 1868.

from the enclosing proglottid after the latter has been discharged from the animal that nourishes the parent tape-worm. The eggs usually escape by the bursting of the integument of the proglottid, owing to their increase in size, as the embryos develop within them. While attached to the tape-worm the successive joints are connected together by longitudinal tubes or ducts that pass through the entire length of the worm, generally one near each edge of the joints. These are connected together by transverse tubes in each end of the successive joints (Figure 54).

The reproductive organs occupy variously branched and ramified cavities in the interior of the joints, communicating by ducts with the external male and female organs, which are placed side by side, either on the edge of each joint, as in *Tænia*, or in the middle of one side, as in *Bothriocephalus*. The remainder of the joint is composed of a firm, more or less solid tissue.

All the species of this order undergo remarkable metamorphoses; the larva living in one animal must be swallowed by another before it can become mature.

II. Trematodes. (Flukes).

This order includes a great number of more or less flattened worms, of which the "fluke," frequently found in the liver of sheep, causing the "rot," is an example (Figure 73).

The body is generally broad and more or less oval, sometimes elongated, but never divided into distinct joints. On the lower side there is usually one or two prominent suckers, and sometimes several. There is a small mouth on the lower side, usually near one end, but no head. The mouth communicates with a small, dilated œsophagus or stomach, and this with a more or less branched and subdivided, sometimes arborescent, intestine, the branches ending in closed tubes or blind-sacs. Another system of branched and often much subdivided tubes arises in the more or less solid tissues of the body. These tubes are at first small, like rootlets, but gradually uniting into larger and larger branches, finally empty their contents into one or two main trunks, which open externally by one, or sometimes two orifices, near the posterior end of the body. This is called the water-vascular system,

and is supposed to perform the office of excretory organs, analogous to the kidneys and liver of vertebrate animals. In the central region of the body there is a well developed reproductive system, both male and female organs being generally contained in the same individual worm; but in some species the sexes are separate. All the rest of the body, around these organs, is composed of a rather firm and solid tissue, the organs not being contained in a distinct cavity.

The species constituting this order are very numerous, belonging to several distinct families and many genera. About 400 species have been described. They are found in all classes of vertebrate animals, and are numerous in their larval states in many invertebrates, especially in fresh-water snails. They particularly abound in fishes, frogs, and aquatic birds. Nearly all the species undergo very remarkable transformations, with alternate generations, some of them passing different stages of their lives free in water, and then in two or more distinct animals, as parasites. So that the adult forms, found in the higher animals, are generally derived from larvæ swallowed in small mollusks, like the river snails, and perhaps in insects.

III. Acanthocephala. (Thorn-headed worms.)

This order includes elongated, more or less cylindrical worms, usually with the body encircled by distinct transverse ridges and wrinkles, and which have at the anterior end a prominent, elongated or conical, retractile proboscis, covered with numerous recurved hooks, by means of which they attach themselves to the mucous membrane in the intestine of the animals that they inhabit. The body contains a large cavity, in which the reproductive organs are contained. The sexes are distinct. The ovary, situated in the anterior part of the body, sets free large roundish masses of cells from which the ova are afterward developed, while these masses, or "cocoons," are free in the abdominal cavity, each mass containing a large number of eggs, often several hundred. In the male the two testicles are attached to the lower closed end of the digestive sac, and are connected by ducts with the intromittent organ, which is a slender spiculum, enclosed in a sheath, situated at the posterior end of the body.

Many observers state that these worms have no mouth and no digestive organs whatever, but obtain their nutriment by absorbing the nutritive materials by which they are surrounded in the intestine of their host directly into their own tissues, after the manner of the tape-worms. M. Lespes* states, however, that *Echinorhynchus clavæceps*, found in the minnow, etc., has a *complete alimentary system*. The mouth is very small, in form of a pore, opening at the end of the proboscis and raised upon a small mobile papilla. This mouth communicates with a short digestive cavity, in the form of a blind sac. He states that he has seen the refuse of the food ejected from the mouth.

Upwards of 100 species of these worms have been described, nearly all of which are referred to the genus *Echinorhynchus*. They are especially abundant in birds and fishes.

Those species in which the development has been studied, have a kind of alternate generation, the young embryo being very different from the parent, and afterward developing in its interior another form, which in turn becomes like the grandparent. M. Lespes states that *E. clavæceps* produces "cocoons" containing 150 to 200 eggs. The embryos developed in the eggs are capable of moving while still in the shell, and remain alive for a year. On feeding a snail with food containing these eggs, they hatched in his intestine, and the free embryos were quite lively and active, and furnished with two pairs of hooks for boring purposes. They had considerable resemblance to the free embryos of tape-worms and no doubt have similar habits, but they failed to undergo their transformations in the snail.

Leuckart fed the eggs of *E. proteus*, found in the trout and other fishes, to a small crustacean, *Gammarus pulex*. The eggs hatched in a few days and the young embryos bored their way through the intestine into the general cavity of the body, some of them penetrating into the limbs. In the course of three weeks they grew larger and the granular mass still in the interior of the body of these embryos developed into a distinct organism, which afterwards developed a proboscis, muscles, and the other peculiar organs of an *Echinorhynchus*, becoming gradu-

*Journal de l' Anatomie, 1864, p. 683 ; Gunther's Zoological Record, 1865, p. 747.

ally more and more like its grandparent. It finally fills up the whole interior of the body of the enclosing embryo, sexual organs appear, and then the outer skin of the latter is cast off. Thus the young *Echinorhynchus* is formed, but in order to become mature it must be swallowed, with its crustacean host, by some fish. In the intestine of the fish it becomes sexually mature in about a week.

The giant *Echinorhynchus* of the hog (*E. gigas*), Figure 74, is the only species known to infest domestic quadrupeds.

IV. Nematodes. (Round-worms).

This order includes a great number of worms, which occur in all classes of animals, both vertebrates and invertebrates, together with some that are not parasitic, but live in water, moist earth, or decaying animal or vegetable matters. They are much more highly organized than those of the preceding orders. The pin-worms of children, the common round-worms of man and domestic animals, and the notorious *Trichina spiralis* are examples of this order. (See figures 76 to 83.)

These worms are almost without exception long, round, and rather slender, varying in length from a tenth of an inch or less to three feet, or even more, and usually tapering to one or both ends. The external surface of the body is generally smooth and uniform, without suckers or other appendages. In the interior of the body there is a continuous visceral cavity, containing a distinct digestive system, the intestine generally extending from one end of the body to the other, and well developed reproductive organs, the sexes being separated. The mouth is usually at the smaller end of the body and is often surrounded by papillæ or other organs. Some of the species are viviparous, like *Trichina*; others produce eggs, like the common round-worms and pin-worms. There is great diversity in their habits and modes of development. Some of them pass through alternate generations and remarkable transformations, living in some cases, like *Trichina*, in two different animals in the larval and adult states, in other cases passing the young states in the water, as free worms, and afterwards becoming parasitic, when swallowed by the proper animal, in which alone they develop their reproductive organs

and become mature. Some species seem to have a much more simple history during development. There are but few species, however, of which the complete history is known. The *Trichina spiralis* is, perhaps, better understood in all stages of its life than any other species. Important discoveries remain to be made, without doubt, concerning other species that infest our own bodies, as well as those of our domestic animals. At present the complete histories of the two commonest human parasites, the round-worm and pin-worm, are still unknown, although they have been most carefully investigated and experimented upon by many able naturalists.

Of this order about 1,000 species have been already described, but it is probable that a considerable number of these will eventually prove to be only the young of others. They particularly abound in mammals, birds, and fishes, inhabiting the intestine, stomach, windpipe, lungs, kidneys, muscles, brain, and various other parts of the body. Twelve species or more are liable to infest human beings.

Acarina.

In addition to the internal parasitic worms, there are certain parasites which belong to other groups. Among these are certain forms of acarina, or mites, some of which are, perhaps, only accidentally parasitic, like the *Acarus dysenteriæ* mentioned in our previous lecture. But the genus *Pentastoma* includes species which are true parasites and have nearly the same habits as some of the parasitic worms, which, indeed, they closely resemble in general appearance. Formerly these parasites were regarded as worms by all authors, but they are now generally referred to the *Acarina*, although they differ greatly from the more typical forms. One of these species is represented in Figure 84.

Protozoa.

Several genera and species of infusoria have been found living in the human body, or in the excreta, especially of patients attacked with certain contagious diseases. The effects of these parasites and their relations to diseases are not well understood.

Lists of the Parasites of Man and Domestic Animals.

The number of species of these internal parasites now known is upwards of 100. Therefore it will be impossible, at this time, to do more than enumerate the species, with their principal modes of occurrence, and then describe more fully some of the most important kinds, with their effects and remedies, so far as space will admit. It is hoped that the lists will serve as a key or index for those who wish to pursue the subject further, in the more extensive works upon this subject.

INTERNAL PARASITES OF MAN.

CESTODES.

Tænia solium Linnæus. Intestine, young in hog; common.

T. mediocanellata Kuch. Intestine, young in beef; common.

T. flavopunctata Weinland. Intestine; one case only, in the United States.

T. lophosoma Cobbold. Intestine, larva unknown; one case.

T. elliptica Batsch. Intestine; rare, common in cats.

T. nana Siebold. Intestine; only observed in Egypt.

Bothriocephalus latus Bremser. Intestine, larva in fish (?); Europe, rare in America.

B. cordatus Leuckart. Intestine; common in Greenland.

In the larval state.

Tænia solium Linn. In muscles, brain, eye, etc.; not rare.

T. marginata Batsch. Abdominal viscera; very rare.

T. acanthotrias Weinland. In muscles, mature worm unknown; observed once only, in Virginia.

T. echinococcus Siebold. Tumors in liver, brain, lungs, abdomen, muscles, etc., adult in dog; common.

TREMATODES.

Bilharzia hæmatobia Cobbold. Inhabits the blood-vessels, especially the portal veins and those of the kidneys and bladder; very common in Africa, producing a very serious disease.

Fasciola hepatica Linnæus. Gall-bladder and ducts, and sometimes beneath the skin; common in sheep, rare in man.

Distoma lanceolatum Mehlis. Gall-ducts; rare.

D. crassum Busk. Duodenum; one case.

D. heterophyes Siebold and Bilharz. Small intestine, in large numbers; two cases, in Egypt.

D. ophthalmobium Diesing, (perhaps young of *D. lanceolatum*). Eye, several together; two cases.

Tetrastoma renale Delle Chiage. Kidney; one case.

Hexanthyridium pinguicola Treutler. In an ovarian tumor; one case.

H. nenarium Treutler, (probably young). Veins; rare.

NEMATODES.

Trichina spiralis Owen. Adult in intestine, young in muscles; common.

Trichocephalus dispar Rudolphi. Small intestine.

Filaria trachealis Cobbold. Trachea and larynx; one case.

F. lentis Diesing, (larval form). Eye; very rare.

Dracunculus medinensis Gmelin, (Guinea-worm). In the connective tissue beneath the skin and among the muscles. Very common in Arabia, Guinea, Upper Egypt, and other parts of tropical Asia and Africa; also in some parts of the West Indies.

D. oculi Diesing, (loa). Orbit of the eye, in the conjunctiva, etc. Not uncommon in tropical Africa and America, chiefly in the African races.

Oxyuris vermicularis Bremser, (pin-worm). In the large intestine, chiefly in the rectum and near the anus, sometimes in the genital passage; very common, especially in children.

Ascaris lumbricoides Linn., (round-worm). Intestine, sometimes ascending into the stomach, rarely passing into the abdominal cavity by perforating the intestine; very common.

A. *mystax* Rud. (round-worm of cats). Intestine; rare in man, common in the cat.

Eustrongylus gigas Diesing, (kidney-worm). Kidney; rare in man.

Strongylus bronchialis Cobbold. Bronchial tubes; very rare.

Dochmius duodenalis Leuckart. Small intestine; Italy, much more common in Egypt, causing very serious disease.

ACARINA.

Pentastoma denticulatum Rud. (Probably the young of *P. tænioides* of the dog.) In cysts on the liver, etc.; not very rare.

P. constrictum Siebold. Liver and lungs; common in Egypt.

PROTOZOA.

Paramecium coli Malmstein. Colon, excreta.

Cercomonas intestinalis Lambl. (*C. hominis* Davaine). Intestine; from a cholera patient.

Variety B. From a typhoid fever patient.

C. urinarius Hassal. In urine.

C. saltans Ehrenberg.

Trichomonas vaginalis Donné. Vagina, in mucus.

Psorosperms, (perhaps the eggs of Distoma).

In addition to the preceding species of true parasites, various kinds of insect larvæ have been known to live for a time in the human stomach and intestine, from which they have been discharged either by vomiting or purging.

Among the most common larvæ that may thus live in the human body are those of the various species of meat-flies, blue-bottle-flies, blow-flies, or flesh-flies (see page 101), and those of the house-fly. Several species of the genus *Homalomyia* have also been known to occur in this way, the eggs or larvæ having been swallowed with fruit, and more especially in decayed fruit, in which they naturally live.* Such larvæ often cause considerable irritation of the intestine, and diarrhœa, but as their life in the larval state is very short, they must soon pass from the intestine or perish in it.

INTERNAL PARASITES OF THE DOG.

CESTODES.

Tænia echinococcus Siebold. Intestine, many together; larvæ in sheep, cattle, and man; common.

*These insects are well described by Mr. B. D. Walsh in the American Entomologist, vol. II, page 137, 1870.

T. cœnurus Küch. Intestine, many together; not rare. Larvæ in sheep.

T. marginata Batsch. Intestine, few or singly; common. Larvæ in sheep and cattle.

T. serrata Goeze. Intestine; common. Larvæ in rabbits.

T. canis-lagopodis Rud. Intestine; in Iceland common. Larvæ unknown. Perhaps same as *T. litterata* Batsch.

T. cucumerina Bloch. Intestine; very common. Larvæ unknown.

T. solium Linn., (in *cysticercus* state). Muscles, brain, etc.

Bothriocephalus latus Bremser. Intestine; not common.

B. cordatus Leuckart. Intestine; very common in Greenland.

B. fuscus Krabbe. Intestine; not rare in Iceland.

" " *var. reticulatus* Kr. " " "

" " *var. dubius* Kr. " " "

Dibothrium serratum Diesing. Intestine; very rare.

TREMATODES.

Holostoma alatum Nitzsch. Intestine; less common than in the fox.

NEMATODES.

Trichina spiralis Owen. Intestine (mature); larvæ in muscles.

Spiroptera sanguinolenta Rudolphi. Œsophagus, stomach, and heart, larvæ in blood; very common in China.

Trichosoma plica Rudolphi. Bladder; rare.

Trichocephalus depressiusculus Rud. Cœcum; not common.

Ascaris marginata Rud. Small intestine; very common.

Pseudalius filum Duj.(?). Heart and pulmonary artery, recorded by Collas; originally from porpoise.

Eustrongylus gigas Diesing. Kidney; rare.

Dochmius trigonocephalus Duj. Intestine, larvæ in water; rare.

Filaria trispinulosa (larval form). Eye.

F. sanguinis (larval form). In blood.

F. immitis Leidy. Heart.

Dracunculus medinensis Cobbold. Sub-cutaneous tissues; in tropical Asia, Africa, and America.

ACARINA.

Pentastoma tænioides Rudolphi. Nostrils; not rare. Larvæ in man and cattle.

That thousands of lambs and sheep are annually killed by dogs that have a taste for mutton of their own procuring is unfortunately too well known to most of the farmers in this country, especially in those States where neither stringent laws nor severe taxes have diminished the numbers of these useless curs.

That the number of dogs in every part of the country is by far too great, and even dangerously so, is generally admitted, especially during the summer, when mad dogs and hydrophobia are the constant theme of conversation in our cities. That the laws of every State ought to impose restrictions, or, at least, very high taxes upon the owners of dogs is evident and advocated by many legislators. Yet it is not, by any means, generally known to what an alarming extent our flocks are injured in health and depreciated in value by the parasites derived directly from dogs. Still less is it known to what an extent *human lives and health* are sacrificed on account of these animals.

There are three principal and very important parasites of sheep derived from tape-worms of dogs. These are: 1. The "water-brain" of sheep, which is produced by the young or larvæ of a small tape-worm (*Tænia cœnurus*); 2. The echinococcus, or hydatid tumors of sheep, of cattle, and of man, found in various organs, but most commonly in the liver, brain, and kidneys, which are caused by the young of a very small dog tape-worm (*Tænia echinococcus*); 3. The diving bladder-worm, or "water-bladder," often found in the abdomen of sheep, cattle, and pigs, frequently forming tumors as large as a hen's-egg, or even a goose-egg, which is the young of a larger tape-worm of the dog (*Tænia marginata*). There are, also, others of less importance obtained by sheep from dogs, as indicated in the lists.

It is perfectly safe to say that at least twenty-five sheep are killed by parasites derived from dogs, for every one killed by the teeth of dogs! It is also safe to say that more than fifty persons die from the same parasites, for every one that dies of hydrophobia! And yet this work of destruction goes on silently and almost unobserved, except by professional men week after week and year after year. The loss of human life every year more than counterbalances all the good that all the dogs in the civilized world can possibly do. In Iceland it is stated that one-sixth of all the deaths are caused by one of the dog-parasites (*Echinococcus*). The same parasite occurs also, not unfrequently, in all other parts of the world where dogs are kept, and causes most horrible disease and death. To this we may add the *Pentastoma*, which man also derives from dogs, and in all probability several other parasites, internal and external.

INTERNAL PARASITES OF THE CAT.

CESTODES.

Tænia crassicollis Rud. Intestine, young in rats and mice.
T. elliptica Batsch. Small intestine; common.
T. canis-lagopodis Rud. Intestine; common in Iceland.
Dibothrium decipiens Diesing. Intestine, also in leopard, ounce, etc. Perhaps *Bothriocephalus felis* Creplin.

TREMATODES.

Amphistoma truncatum Rud.
Distoma lanceolatum Mehlis. Bile ducts; rare.

NEMATODES.

Trichina spiralis Owen. Intestine, young in muscles.
Dochmius tubæformis Dujadin. Duodenum.
Ollulanus tricuspis Leuck. Intestine, and young in muscles.
Ascaris mystax Rud. Small intestine; common.

ACARINA.

Pentastoma denticulatum Rud. Cysts on liver, etc.

This list includes all those that I have found recorded from the house cat, but doubtless many others may occur.

INTERNAL PARASITES OF SHEEP.

CESTODES.

Tænia expansa Rud. Mature, in small intestine.

Tænia. (Undetermined species with hooks.) In *cysticercus* state in muscles.

T. marginata Batsch. Young or cysticercus state in viscera, adult in dog; common.

T. cœnurus Kuch. Young or encysted state in large tumors in the brain, adult in dog; common.

T. echinococcus Siebold. Young or hydatid condition in liver, lungs, brain, and other organs, adult in dog; common.

TREMATODES.

Fasciola hepatica Linn. Liver and bile ducts.

Distoma lanceolatum Mehlis. Bile ducts.

Amphistoma conicum Rud. First stomach.

NEMATODES.

Ascaris ovis Rudolphi. Intestine; rare.

Trichocephalus ovis (*affinis ?*). Large intestine; common.

Sclerostoma hypostomum Dujadin. Intestine.

Strongylus contortus Rud. Small intestine.

S. filicollis Rud. Small intestine. Perhaps same as last.

S. filaria Rud. Trachea and bronchial tubes; common; also in the goat.

ACARINA.

Pentastoma tænioides Rud. Larynx, nostrils, etc.

The goat is infested by many of the parasites found in sheep. Besides these, there are a few peculiar species; among them are *Tænia capræ* and *Strongylus venulosus* Rudolphi, both found in the intestine.

INTERNAL PARASITES OF CATTLE.

CESTODES.

Tænia expansa Rudolphi. Intestine, mature; not common.

T. denticulata Rud. Intestine, mature; rare.

T. mediocanellata Küch. Young or *cysticercus* state in muscles, adult in man; common.

T. marginata Batsch. Young or *cysticercus* state in viscera, adult in dog; common.

T. echinococcus Siebold. Young or hydatid state in liver, brain, and various other organs, adult in dog; common.

T. *cœnurus* Küch. Young state in brain, adult in dog; rare.

TREMATODES.

Fasciola hepatica Linn. Liver, gall-ducts, etc.; not rare.

Distoma lanceolatum Mehlis. Liver; not uncommon.

Amphistoma conicum Rud. First stomach; common.

A. crumeniferum Creplin. Stomach.

A. explanatum Creplin. Bile ducts.

NEMATODES.

Trichina spiralis Owen. Observed only in experimental animals.

Trichocephalus affinis Rud. Large intestine; frequent.

Strongylus radiatus Rud. Duodenum, colon, small intestine.

S micrurus Mehlis. Trachea and bronchial tubes.

Eustrongylus gigas Diesing. Kidney; rare.

Filaria lachrymalis Gurlt. Lachrymal ducts, etc.

F. papillosa Rudolphi. Abdominal cavity, etc.; rare.

ACARINA.

Pentastoma tænioides Rud. Nasal cavaties, larynx, etc.

P. denticulatum Rud. (Young of preceding.) In cysts on liver, etc.

INTERNAL PARASITES OF THE HORSE.

CESTODES.

Tænia perfoliata Goeze. Swell intestine, colon, cœcum; common, and sometimes in vast numbers.

T. plicata Rud. Stomach and small intestine; common.

T. mamillana Mehlis. Large intestine; common.

Tænia, (species undetermined). Young state (*cysticercus fistularis*) in peritoneum.

T. cœnurus Kuch. Young or encysted state in brain; rare.

T. echinococcus Siebold. Hydatid state in liver, etc.; not common.

TEMATODES.

Fasciola hepatica Linn. Liver, gall-bladder, etc.

NEMATODES.

Ascaris megalocephala Cloquet. Small intestine; common.
Oxyuris curvula Rudolphi. Colon, cœcum, rectum; common.
Eustrongylus gigas Diesing. Kidney, etc.
Sclerostoma equinum Blainv. Duodenum, colon, cœcum, pancreas, sometimes very numerous, and in enlargements of the arteries; common.
S. tetracanthum Diesing. Duodenum, cœcum, colon.
Strongylus micrurus Mehlis. Trachea and bronchial tubes.
Filaria microstoma Schneider.
F. papillosa Rud. Abdomen, thorax, brain, eye, intestine.
F. lachrymalis Gurlt. About the eyes, in lachrymal ducts, etc.
Spiroptera megastoma Rud. Tubercles in stomach.
Dracunculus medinensis Cobbold. (Guinea-worm). Subcutaneous tissues; only in tropical parts of Africa, Asia, and America.

ACARINA.

Pentastoma tænioides Rud. Nasal cavities, larynx, etc.

The mule and ass are subject to the same parasites as the horse, but not to the same extent. The number of species hitherto observed is less, and they are far less common.

INTERNAL PARASITES OF THE HOG.

CESTODES.

Tænia solium Linn. In the larval or *cysticurcus* state in the abdominal viscera.
T. marginata Küch. *Cysticercus* state in the abdominal viscera.
T. echinococcus Siebold. Hydatid state in liver, etc.; not common.

TREMATODES.

Fasciola hepatica Linn. Liver and bile ducts.
Distoma lanceolatum Mehlis. Bile ducts.

ACANTHOCEPHALA.

Echinorhynchus gigas Goeze. Small intestine; common.

NEMATODES.

Trichina spiralis Owen. Mature in intestine, young in muscles; common.

Ascaris suilla Dujardin. Small intestine; common.
Spiroptera strongylina Rud. Stomach.
Simondsia paradoxa Cobbold. Stomach, in cysts; one case.
Trichocephalus crenatus Rud. Large intestine.
Strongylus dentatus Rud. Cœcum, colon.
S. elongatus Dujardin. Bronchial tubes.
S. paradoxus Mehlis. Trachea and bronchial tubes.
Eustrongylus gigas Diesing. Kidneys, etc.
Sclerostoma pinguicola Verrill. In fat about kidneys and "spare-ribs," in large numbers; probably common.

ACARINA.

Pentastoma denticulatum Rud. Cysts on liver, etc.

INTERNAL PARASITES OF POULTRY.

CESTODES.

Tœnia infundibuliformis Goeze. Intestine of hens, ducks, geese, etc.
T. proglottina Davaine. Duodenum of hens; common.
T. crassula Rud. Intestine of pigeons, hens, and geese.
T. malleus Goeze. Intestine of geese and ducks, etc.
T. lanceolata Goeze. Intestine of geese and ducks, etc.
T. setigera Fröh. Intestine of geese; common.
T. sinuosa Rud. Intestine of geese and ducks.
T. fasciata Rud. Intestine of geese; common.

TREMATODES.

Monostoma mutabile Zeder. Sub-orbital cavities of geese, etc.
M. variabile. Geese.
M. triseriale. Geese. Perhaps same as the next.
M. verrucosum Zeder. Ducks, in cœcum.
M. caryophyllinum Bremser. Ducks. Originally described from fish.
Distoma ovatum Rud. Oviducts, etc., of geese and ducks.
D. lineare Zeder. Large intestine of hens.
D. dilitatum Miram. With last.
D. echinatum Zeder. Intestine of ducks and geese.
D. oxycephalum Rud. Same habits as last.

ACANTHOCEPHALA.

Echinorhynchus polymorphus Bremser. Intestine of ducks.

NEMATODES.

Heterakis compressa Schneider. Intestine of chicken.
H. vesicularis Duj. Intestine of hens and turkeys.
H. dispar Duj. Intestine of geese.
Ascaris crassa Desl. Intestine of ducks.
A. inflexa Rud. Intestine of hens.
A. perspicillum Rud. Intestine of turkey.
A. maculosa Rud. Intestine of pigeon.
Spirotera hamulosa. Gizzard of hens.
S. uncinata Rud. Tubercles in œsophagus of geese.
Syngamus trachealis Siebold. Windpipe, causing "gapes."
Strongylus nodularis Rud. Gizzard and intestine of ducks and geese.

In the preceding lists we have brought together most of the parasites hitherto discovered in our more common domestic animals. There can be no doubt but that many more will hereafter be discovered. In the rabbit, Guinea-pig, parrots, singing birds, and other animals often domesticated, many additional species occur.

In the following pages only the more common and important species will be described.

The Armed Tape-worm or Pork Tape-worm of Man (Tœnia solium Linn.); *and its young, the "measles" of pork and human flesh.*

This is perhaps the best known of all the numerous kinds of tape-worms. Its young or larvæ are common in the muscles and other organs of hogs, and not very rare in man. (See Figures 49–51.) In the adult state it is, so far as known, peculiar to the human intestine, where it is unnecessarily common. It grows to a great length, frequently ten to fifteen feet, or even more, and is then composed of upwards of 800 joints, those that are sexually mature commencing at about the 450th segment. The head is small, about the size of a pin-head, roundish, with four prominent suckers on the sides, and a conical, proboscis-like top, around which there are two circles of sharp hooks, 22 to 28 in each circle (Figure 53). The neck portion is slender, crossed by fine lines, which are wider apart as they recede from the head, finally forming dis-

tinct joints. These are at first very small and short, gradually becoming broader and squarish, then oblong. The largest are about a third of an inch in breadth and quite thin and flat (Figure 52). The sexually mature joints or proglottides are twice as long as broad, and contain the ovaries and a long central egg cavity or uterus, with 7 to 12 lateral branches, which are irregularly lobed and divided (Figure 54); and also the male organ, or testicle, in the form of branched tubes, communicating with a penis, which is situated on one edge of the joint, in front of the female genital orifice, and has a curved or sickle-shaped form. The genital openings are either on the right or left edge indifferently, in the successive joints.

Figure 49.

Figure 52.

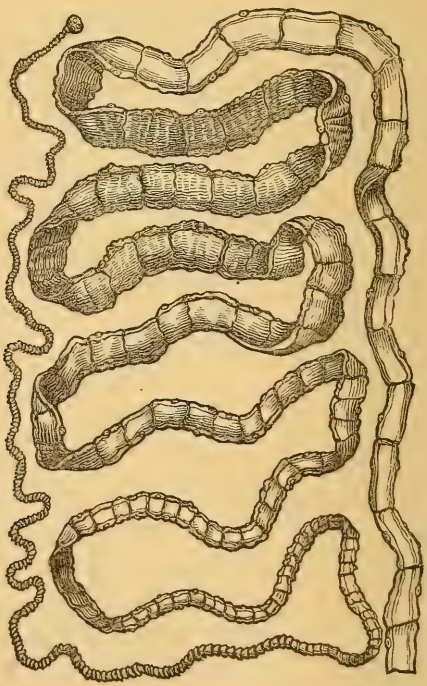
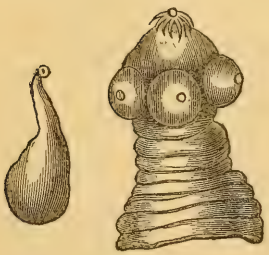


Fig. 50. Fig. 51.



The young or larval state produces the white spots known as

Figure 49.—Pork "measles"; natural size; Hearth and Home, after Owen.

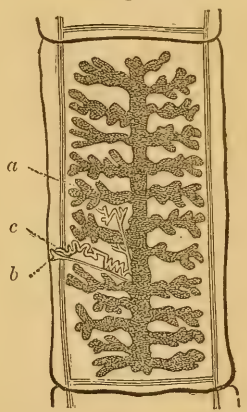
Figure 50.—Young tape worm from measles of pork; and Fig. 51, head of same, more enlarged; Hearth and Home, after Owen.

Figure 52.—Pork tape-worm (*Tænia solium*), less than natural size; Hearth and Home, after Owen.

,' measles " in pork (Figure 49). These are cavities or cysts produced by inflammation, containing whitish fluid and enclosing small, bladder-like, translucent, vesicles, filled with a watery fluid, and which contain the proper head and neck of the young worm coiled up spirally in the interior in an inverted position. By gentle pressure the head and neck may be made to protrude by inversion, like the finger of a glove, and will then present the appearance shown in figure 50, the vesicle of fluid now forming the flask-like caudal portion of the worm. The head may now be seen to have four suckers and a central prominence surrounded by two circles of hooks, as in the adult. In this condition, enclosed in the cysts, they will remain living

Figure 53.

Figure 54.



for a long time in the hog, even surviving the death of their host for a considerable period. If one or more of these young worms or measles be swallowed by a human being, the muscular fibres and the cysts will be digested, and each young worm thus liberated will evert its head, and losing its bladder-like portion, will pass into the intestine. There it will fasten itself to the inner membrane by its suckers and hooks, and grow rapidly by absorbing the digested food by which it is surrounded. New joints will be rapidly formed as the older ones grow larger, until it becomes a mature tape-worm, with joints ready to be cast off. There may be but one tape-worm in

Figure 53. Head of *Tænia solium*, magnified. From Cobbold.

Figure 54.—A joint or *proglottis* of *Tænia solium*, magnified; *a*, branches of the uterus; *b*, external orifice; *c*, male organ. From Cobbold.

the human intestine, or there may be several together, the number depending only upon the number of living young swallowed.

It is, therefore, obvious that this tape-worm can be acquired only by eating raw or under-done pork. In this country the principal kinds of food serving as sources of this tape-worm are raw smoked ham and raw sausages, but soldiers and others are often obliged to eat their pork-rations uncooked, and thus obtain the parasites. Our recent war was the means of greatly increasing the numbers of this and other parasites, both internal and external.

Persons harboring the mature tape-worms become in their turn the means of diffusing the race. Each mature joint cast off contains several thousands of eggs, each of which encloses an embryo, nearly ready to hatch, and as these joints are continually being discharged during the whole life of the worm, which may be ten or twelve years, it is evident that one person may thus be the means of diffusing many millions of eggs, most of which will no doubt perish, but the chances are good that some of them will find their way into the stomachs of hogs, either with their food or in water.

The free joints or proglottides have an independent life for a few days and are capable of moving and crawling about to a considerable extent. In a short time, however, the myriads of embryos in the interior so increase in size that the walls of the proglottis burst open and thus liberate the eggs. The eggs are globular and very small, their average diameter being about $\frac{1}{150}$ of an inch; the shell is comparatively thick; being $\frac{1}{4000}$ of an inch. They are so small that they may be blown about by the winds, carried on the feet of insects, or may be suspended in unfiltered waters. They may, therefore, also readily adhere to lettuce, celery, and other garden plants, or to fallen fruit, especially when night-soil is used as manure, and unless such food be carefully and thoroughly washed, there is always more or less danger of eating the eggs of this and other parasites. When these eggs are swallowed, either by hogs or human beings, they hatch as soon as acted upon by the gastric juice, and disclose their con-

tained embryos, which are very different from both the old worm and the measle-worm. They are provided with six hooks or spines, placed in three pairs upon the head. By means of these they quickly bore their way through the walls of the intestine into the blood-vessels, and are thus carried to all parts of the body. They finally lodge in various organs, but especially in the muscles, liver, brain, eyes, lungs, and heart. They then excavate galleries for themselves in these situations, causing, if in large numbers, a great amount of inflammation and disease, which in some cases proves fatal. The inflammation soon causes cysts to be formed around the intruders, by which they are enclosed and restricted in their motions. Thus the "measles" in the muscles of hogs and man are formed. After this the patient may recover, unless these parasites have lodged in the brain or other vital organs, so as to produce serious symptoms subsequently. In the human subject more than 100 cases have been recorded in which these parasites have taken up their abode in the brain, causing epilepsy, insanity, and sometimes sudden death. In such cases, which are probably more common than is generally imagined, there can be no relief. There have also been recorded quite as many instances in which these *cysticerci* or larval tape-worms have been situated within the ball of the eye, causing a partial or total loss of sight, and sometimes great inflammation. Many of these have been successfully removed. In other important organs they are liable to produce serious trouble. But when in the subcutaneous, areolar, or intermuscular tissues, they may often be easily removed by the surgeon. In hogs they are much more liable to produce these results, because hogs are likely to swallow whole joints, or even entire tape-worms, while human beings seldom swallow more than a few dozens of eggs.

The effects and symptoms caused by the adult tape-worms are discussed under the next species, together with the remedies.

As means of prevention every one should avoid eating pork, in any form, that has not been thoroughly cooked. In this way it is easy to avoid the mature tape-worm of this species.

To prevent measles in hogs they should not be allowed to have access to human excrement, the reverse of which is too often specially provided for by farmers. To avoid the same parasites in our own flesh we must take care to have all fruit and other uncooked vegetable food well washed and our drinking water pure.

The Beef Tape-worm of Man (Tænia mediocanellata Kuch.); *and its young, the "measles" of veal and beef.*

This is a very large species, which was formerly generally known as the unarmed variety of the human tape-worm. It is known to occur among all beef-eating people, and is the common species in Africa, Western Asia, and several European countries, especially in Austria, Turkey, and certain parts of Russia.

It has long been known that Jews, Mohammedans, and other people who never eat pork, are nevertheless liable to be infested by tape-worms. It was also observed, many years ago, that infants fed upon dried beef—a custom much practised at St. Petersburg—were liable to have the same parasites; and these facts were formerly brought forward as arguments against the doctrine that the common tape-worm is derived from eating the larval form contained in measly pork. But it was soon discovered that nearly all the tape-worms obtained from patients in Mohammedan countries, as well as in Austria, and some other parts of Europe where pork is little used, were destitute of the two circles of peculiar hooks around the central, proboscis-like prominence of the head, as well as the prominence itself, which are very conspicuous features in the common tape-worm of pork-eating people. Owing to these peculiarities, naturalists began to consider the two forms either as different varieties or different species. The source of the unarmed tape-worm remained uncertain, however, until direct experiments were undertaken by Leuckart, Mosler, and others to settle this question. Thus it was discovered that when the joints or eggs of the unarmed tape-worm (*Tænia mediocanellata*) were given to calves, the eggs hatched in the stomach, and the young embryos worked their way, by means

of their six boring hooks, through the intestine into the circulation and, lodging in the muscles, caused serious disease or death, if in too large numbers, and after a time became enclosed in little capsules, producing, in fact, "measly" veal or beef, as shown in Figure 55, which represents part of a muscle of the hind leg from a calf that had been fed by Drs. Cobbold and Simonds upon the eggs of this tape-worm, and killed three months afterward. The flesh of this calf was estimated to contain over eight thousand measles, and yet, although at first it had been seriously ill from the effects of the parasites, it was at the time when slaughtered perfectly

Figure 55.

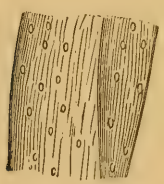
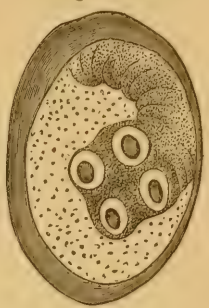


Figure 56.



healthy and fat. The measles of veal or beef are much smaller than those of pork, and if they existed only in moderate numbers, would scarcely be detected either by the butchers or consumers. They are seldom larger than a small pea. One of these "measles," when examined with the microscope, is found to consist of an outer oval cyst or membranous sac, enclosing loosely in its cavity a more delicate vesicle filled with fluid and containing the inverted head of the young tape-worm, as represented in Figure 56. The head has four well-marked suckers, but has no central proboscis and no circle of hooks—differing therefore from the pork-measle, or *cysticercus*, in just the same way that the heads of the mature tape-worms differ from each other. Thus it was definitely settled that the unarmed or hookless tape-worm of

Figure 55.—Measles in veal, reduced. Hearth and Home, after Cobbold.
Figure 56.—One of the measles magnified. Hearth and Home, after Cobbold.

man (*Tænia mediocanellata*) is obtained by eating the young, in the shape of "measles," in raw or slightly cooked beef and

Figure 57.

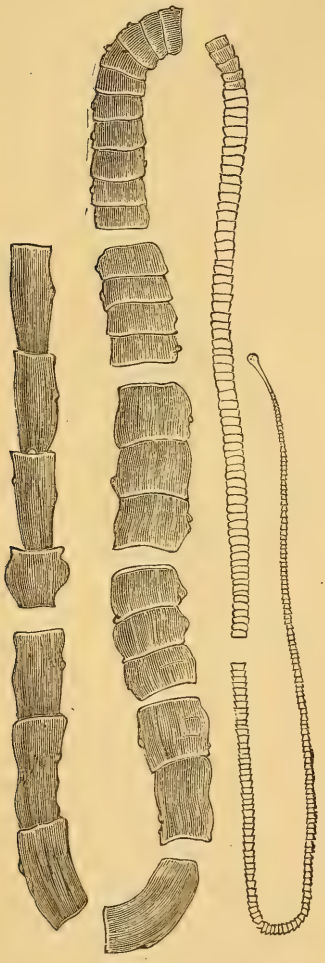


Figure 58.

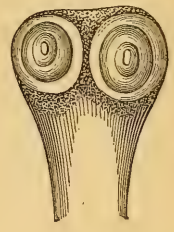


Figure 59.

veal. And thus the presence of tape-worms in infants fed on dried beef, as well as in Jews and others not guilty of eating

Figure 57.—*Tænia mediocanellata*, natural size. Hearth and Home, after Leuckart.

Figure 58.—Head of beef tape-worm, magnified. Hearth and Home, after Leuckart.

Figure 59.—A joint of the beef tape-worm, showing the ovaries, enlarged. Hearth and Home, after Leuckart.

pork, is fully explained. Since these facts have been ascertained, search has been made for "measles" in beef from animals not experimented upon, and they have been found in several instances.

When such beef is swallowed by man, without cooking, the young tape-worms are liberated from their capsules or cysts by the process of digestion; the head becomes protruded, and, passing into the intestine, it fastens upon the lining membrane by its suckers. There it rapidly grows larger, new joints are developed, and the body grows longer and longer, the form of the joints changing as they grow, until those that are most mature become square, and finally oblong, as shown in Figure 57, which represents a beef tape-worm, of natural size, in several sections, the intermediate joints being omitted. When full grown, which requires three or four months, one of these tape-worms may contain over 800 joints, of which 360 to 400 of the last ones will be sexually mature, each one containing 5000 or more eggs. This species is much larger than the pork tape-worm (*T. solium*), as well as longer, its length being sometimes twenty feet, and its greatest breadth half an inch, while the joints are thicker and stouter, or have a plump look, instead of being thin and flat, as in the other. The head, as already intimated, is quite different in the two species —that of the beef-worm being larger and flat, or even concave, at the end, with four large suckers on the sides, as shown, greatly magnified, in Figure 58. The joints themselves are very different internally, the egg-masses or uteri being very numerous, and crowded together in a more parallel manner (Figure 59) in this than in the pork tape-worm, in which they are fewer and more aborescently branched. The mature joints, filled with eggs, are cast off, as in other tape-worms, and leaving the intestine, have an independent existence for a few days, when they burst by the enlargement of the embryos in the eggs. The eggs are thus scattered about in manure, in water, in the drainage of cess-pools and sewers, by the winds, and by insects. It is not strange, therefore, that cattle should occasionally swallow such eggs with their food and drink, especially if we reflect that one man, harboring only one of

these worms, may thus scatter about, during a single year, more than a thousand joints, and if each of these contains but 5000 eggs, he would thus diffuse 5,000,000 eggs, each containing an active embryo, ready to leave its shell the moment that it enters the stomach of a calf, cow, or ox. Young animals seem to be more liable to be infected by them than old ones. Fortunately these young worms retain their vitality for but one year when enclosed in the flesh, and after that die and, withering away, leave only a very small yellowish spot, containing calcareous particles. The adult worm, if left undisturbed, will live in a person ten or twelve years, constantly dropping its joints. Among the Burätes, or Cossacks of the Baikal region, this species is very abundant. Their habits of eating chiefly the raw or slightly cooked flesh of cattle, sheep, camels, horses, and goats, while they devour the liver, kidneys, and fat quite raw, would lead us to expect that this and other parasites might abound in their bodies, which proves to be the case. According to Dr. Kaschin in 130 post mortem examinations only two bodies were found without this tape-worm, and among 500 hospital patients every one had it. Sometimes as many as fifteen specimens were found in one person.

It has been supposed until within a short time that the beef tape-worm (*Tænia mediocanellata*) was very rare in Great Britain and the United States, where the pork tape-worm was thought to be the only one that was at all common in man. Dr. Cobbold has shown, however, in his late works on parasitic worms, that the beef tape-worm is really quite as common in England as the pork tape worm, the wealthier classes generally harboring the former, and the poorer people the latter. I am convinced that, even if not so common as the pork tape-worm, the beef tape-worm is by no means so rare in America as is generally supposed. The Museum of Yale College possesses one large specimen, raised by a citizen of New Haven, and many other museums in the United States no doubt contain them, labelled, however, "*Tænia solium*." In fact, probably not one physician in a thousand, in the country at large, possesses the knowledge of the subject requisite for

distinguishing the two species and, therefore, both are confounded together as "the common tape-worm."

In this country persons generally obtain this parasite by eating dried beef and Bologna sausages uncooked. In the latter, there may be not only the young of this tape-worm, but also those of the pork tape-worm and *Trichina*, since there is also an admixture of pork. It is therefore evident that it is unsafe for the individual, and even a wrong to the community for persons to indulge in eating raw meats of any kind, for we find that pork, beef, and mutton may each contain the young of different tape-worms and other parasites, and persons who harbor these worms in their own bodies become, in one sense, a nuisance, since they thus serve as the propagators and disseminators of parasites. And although one or two of these tape-worms may not cause any serious trouble in the bowels of one man, in another they may produce very grave consequences, and still more so, if, as often happens, several live together in one person.

Symptoms.

The symptoms and treatment are the same for both species of human tape-worms, but the species now under consideration is said to be more easily destroyed than *T. solium*, perhaps because it does not have so secure an anchorage as the latter has, with its hooks well imbedded in the membranes.

The symptoms vary greatly, according to the temperament and other peculiarities of the person affected. Sometimes it causes little or no marked disturbance of the health, though causing perhaps more or less weakness, lassitude, and sense of weariness, often accompanied by restlessness, nervous irritability, and headache, which are nearly always attributed to other causes. In more severe cases, these symptoms become much increased, the headache especially, which is often accompanied by giddiness. "The sight and hearing may be affected; noises in the head, itchings at the nose and anus, obscure pains about the body and limbs, loss of appetite, and other dyspeptic symptoms, show themselves in greater or less degree in different cases. One of the most common symptoms, however, which I have noticed, is the tendency to faintness. This is sometimes so marked as to create much alarm, and a

person uninformed as to the true cause of the disorder might be led to treat the symptom as arising from a totally different source. In female patients the nervous symptoms display features more or less peculiar to the sex. The restlessness and anxiety are excessive, and at times accompanied by chorea and fits of hysteria. In the worst cases, in both sexes, the cerebral disturbance may show itself in convulsions and epileptiform seizures. I regret to have to add that in not a few instances even mania itself has been entirely attributable to the presence of tape-worms in the intestinal canal." Such are the usual symptoms, according to Dr. Cobbold. Many unusual and remarkable cases are on record. In one instance, mania of eight years duration was completely cured by the removal of the parasite. In another, hysteria was caused by eighteen tape-worms in one patient. Many cases of insanity, due to this cause, are also on record. The best and perhaps only sure evidence of tape-worms is the passage of the joints from the intestine.

Remedies.

The remedies for tape-worms are numerous and, if fresh and pure drugs be used, there are several that appear to be perfectly reliable in most cases. These remedies should, however, be administered with proper precautions. Therefore, patients afflicted in this way should immediately place themselves under the care of a reliable and competent physician.

The remedies chiefly used are the oil or root of male-fern, kousso, kamala, oil of turpentine, panna, pumpkin-seeds, and pomegranate-root bark. These are generally administered while the patient fasts. The pumpkin-seeds are perhaps the most domestic remedy, as well as one of the best, and safest in the hands of inexperienced persons. The fresh seeds may be bruised or pounded in a mortar, and mixed with water into a paste, of which the patient may eat freely, morning and evening, at the same time fasting, or eating sparingly soups or similar food. The root of the male-fern (*Aspidium filix mas*) is generally regarded as the most certain remedy, if fresh and pure. The dose for an adult is ten to fifteen grammes of the powder, morning and evening, followed by a purgative. The etherial

extract is generally more effectual, however. The patient should have a sparing diet of soup, etc., for twelve or fifteen hours before taking the medicine, and the second dose should be followed, after an hour or two, by a purgative like castor-oil. These remedies are mentioned here not to encourage self-treatment, but for the benefit of those who may not be within reach of a reliable physician.

The margined Tape-worm of the Dog (Tœnia marginata Batsch); *and its young, the "diving bladder-worm" of Sheep and Cattle.*

The young of this parasite are very frequently found in the abdominal cavity of sheep, either attached to various parts of the viscera, especially the liver and mesentery, or else nearly or quite free among the organs, so that when the sheep are opened, the bladder-like sacs fall out, of their own accord. These are usually known to butchers as "water-bladders." When attached to the organs, these bladders or sacs are usually enclosed in a cyst or membrane, formed by the inflammatory action that they cause. The sac is soft and whitish, enclosing a watery fluid, and varies in size from that of a pigeon's egg, or less, to that of a child's head; but it is rather uncommon to find them larger than a hen's egg. In form they are often globular, but more frequently pear-shaped, as represented in Figure 60. If one of these bladders, while still enclosed in its cyst, be placed in a plate of warm water and carefully examined in a good light, there may be dimly seen in the interior, near the upper end, the outlines of the head and neck, which are turned inward, as usual in most young tape-worms; but what is singular in this case, the head and neck alternately rise and sink in the fluid of the interior, with remarkable regularity. From this peculiarity it has received the name of "diving bladder-worm." This motion is produced by a peculiar arrangement of muscular fibres in the interior, which are attached to the neck. At the top of the little knob on the upper end of the bladder there is a small slit, from which, by gentle pressure, the neck may be gradually forced out, so as to project externally, and finally the head also appears. In

this condition the creature has a flask-shaped form. The neck tapers gradually from the bladder to the head, and is divided transversely into a series of many short joints. The head is but little enlarged, bearing four suckers, as usual, and in the

Figure 60.

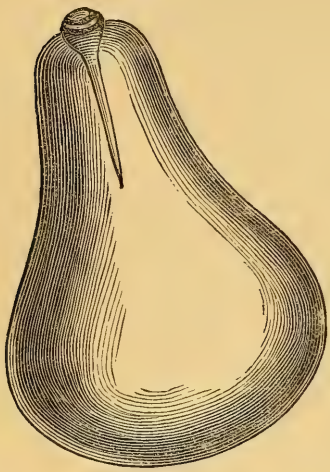
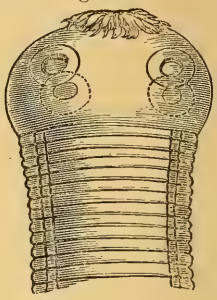


Figure 61.



center has a proboscis, surrounded by two rows of hooks, containing from sixteen to twenty-four pairs. Sometimes there are found in large bladders of this kind a few secondary bladders attached to the inside of the large one, produced by a process of budding, somewhat as in the water-brain, or *cœnurus*. This parasite, as thus characterized, was formerly supposed to be a distinct and peculiar species, and received the name of "*Cysticercus tenuicollis*," or slender necked bladder-worm. Recent investigation and experiments have, however, proved it to be only the young or larval condition of one of the common tape-worms of the dog (*Tænia marginata*). Bladder-worms of the same kind are found, though less commonly, in cattle and horses, as well as in pigs, monkeys, and many other animals, and very rarely in man. Owing to the large size to

Figure 60. Diving bladder-worm, from a sheep; natural size. Hearth and Home, after Thudichum.

Figure 61. Head of *Tænia marginata*, enlarged. Hearth and Home, after Thudichum.

which this parasite grows, it is always liable to produce serious disease, or even death; but the symptoms that it causes and the danger will depend very much upon the situation of the tumors. In some districts it is extremely common. According to Dr. Thudichum, it occurs in nearly every sheep slaughtered in London; and the dogs that feed upon the offal of slaughter-houses nearly always have the mature tape-worms in abundance.

When a dog swallows one of these bladders, either free or in its cyst, the bladder portion is digested, and the head becomes protruded; on reaching the intestine, it fastens itself to the membrane by means of its suckers and hooks. In this situation, it rapidly develops new joints, and in the course of three or four months becomes a mature tape-worm, about three feet in length, and begins to discharge its ripe joints filled with eggs. A dozen or more of these tape-worms may exist together in the intestine of one dog. In general appearance, this tape-worm (*Tænia marginata*) resembles the pork tape-worm of man (*Tænia solium*), but never grows so large, and its neck portion is much thicker, compared with the size of the head as shown in Figure 61.

The first hundred joints are very short; the mature joints are squarish, the posterior end of one somewhat overlapping the anterior end of the next. These joints contain a very much branched and subdivided female organ, with an oviduct terminating on one edge in a bell-shaped orifice; and an arborescently branched male organ or spermary, with small, round dilations connected with the small branches. Dogs harboring these tape-worms scatter the mature joints and thousands of eggs everywhere over the fields, and in the water of streams and ponds. The sheep and cattle swallow the eggs, either with their food or water or both. The eggs are hatched in the stomach of the sheep, and liberate minute worms, which are armed with three pairs of hooks for boring their way through the tissues, like the embryos of other tape-worms. By this means, these embryos force their way through the lining membrane of the intestine into the blood-vessels, and are carried to various parts of the body. Many lodge in the

lungs, heart, and other organs, and cause for a time great irritation and inflammation of these and other parts by their movements in forcing and boring passages for themselves in the tissues ; but they all eventually perish, while still small, in such localities, and those that get into the liver and abdominal viscera are the only ones that survive and develop to their full size, becoming the water-bladders, or "*Cysticercus tenuicollis*," first described.

The complete history of this, like the other tape-worms, previously described, has been ascertained beyond doubt by direct experiment. In this case the water-bladders have been given to dogs, and at the proper time the dogs have been killed, when the mature tape-worms have always been found corresponding in number to the number of water-bladders eaten, and in size to the length of time. And then the eggs or joints of the tape-worms have been given to lambs ; and although such lambs generally die in the course of five or six days, when they swallow large numbers, yet even in that short time the young worms have been found in vast numbers already distributed in the system ; but when only a few eggs are employed, they do not cause immediate death. And in this way Prof. Leuckart has studied their complete development. This tape-worm, in its mature state, does not inhabit the human body. Dr. Möller even swallowed several of the living bladder-worms without any result.

When these young worms have once got into the system of a sheep, there is no remedy. In this case, prevention is our only hope ; and to this end the same means should be used as against the *Tænia cœnurus* and *T. echinococcus*, to be described farther on. Especial care should always be taken to destroy the water-bladders and all other parasites observed in slaughtering animals, as well as those removed from living animals by medicines or surgical operations ; for in many cases the eggs are capable of retaining their vitality for many weeks or months. They should never be thrown aside as harmless, or even buried, but should be destroyed by scalding hot water or fire. Much may be done, also, in diminishing the numbers of this and other parasites by frequently doctoring those dogs

that are worth keeping, or are necessary, in order to expel their parasitic worms, of which there are generally many kinds. There are numerous drugs that are efficacious for this purpose, some of which are mentioned under the beef tapeworm (page 191). But the principal difficulty is this—those who keep the most dogs, the worst dogs, and the dogs most likely to harbor parasites in abundance, are the very persons who are least likely to adopt such measures, either not knowing or not caring for the consequences.

Tænia cœnurus Kuch., *of the Dog; and its young, the "water-brain" of Sheep.*

In the substance of the brain of sheep there is often found a soft tumor, often as large as a pigeon's egg, and sometimes larger than a hen's egg, which is filled with a watery fluid. Such tumors would go on increasing in size indefinitely, until

Figure 62.

death ensues. But even long before the result becomes fatal, the health is seriously impaired. The brain is often found much diseased, and in part quite disorganized—a state of things which in man would produce incurable insanity. In sheep, it causes "staggers," "gid," "vertigo," or "sturdy," and other cerebral derangements. This disease is, in most

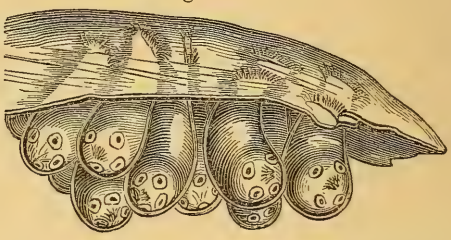
Figure 62.—*Cœnurus* or water-brain of sheep. Natural size. Hearth and Home, after Thudichum.

cases, incurable, and such diseased sheep are too often sent to the market. Fortunately, man cannot be infected with this parasite.

When one of these tumors is removed with care, it will be found to consist of a thin, white, translucent cyst or sac, roundish, oval, or irregular in shape. On one side may be

Figure 63.

Figure 64.



seen clusters of little white spots (Figure 62). If the spots be examined with a lens, each one will be found to consist of the minute head and neck of a young tape-worm, projecting from the surface, and provided with four suckers and a circle of

Figure 65.

hooks, as usual in young tape-worms in this stage of their growth (Figure 63). Or else the heads will be found to be withdrawn into the sac, each in its own capsule, and then the spots are made by small depressions or pits, with a slit-like opening at the bottom. If the interior of the sac-membrane be examined with a microscope, each pit will be found

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Figure 63.—Portion of the outer membrane, with the heads of *Cœnurus*. Enlarged four diameters. From Davaine.

Figure 64.—Inner surface of the membrane of the cyst, with inverted heads, magnified. Hearth and Home, after Thudichum.

Figure 65.—Brain of sheep in which the young embryos of *Cœnurus* have excavated galleries. Davaine, after Van Benedeu.

to correspond to one of the withdrawn and inverted worms, as represented in Figure 64.

Each little worm has a head with a circle of hooks in the middle, surrounded by four suckers, just as in the measle-worm of pork. In this case, each little worm with a head is the larva of one of the dog tape-worms (*Tænia cœnurus*), but in this the young worms have the power of propagating themselves by a kind of budding, in a manner similar to that by which the coral-animals bud from each other and so build great colonies. Thus it is that one of these little worms, lodged in the brain, by budding produces hundreds of others like itself, all connected together by the membrane of the sac; and thus the tumor constantly grows larger, instead of always remaining small, as does the measle-worm.

Effects.

Now, if a dog gnaws a skull containing such a tumor, and swallows the whole cyst, or any part of the membrane that has heads on it, the heads will be liberated from the membrane, and each one will fasten to the lining of the dog's intestine by means of its suckers and hooks. There they will rapidly grow larger and larger; new joints will be formed for the body, and in the course of three months each one will become a small tape-worm, with many joints, and each of the larger joints will have both male and female organs, and will be capable of propagating the race by itself. The female organs of each joint contain thousands of eggs, which are discharged when mature, and passing from the intestine of the dog in large numbers, they will be scattered about freely over the pastures and fields wherever the dogs go. If a lamb or sheep accidentally swallows some of the eggs with grass or in water, the eggs will hatch in the stomach into minute worms. These force their way, by means of their six little hooks, through the lining of the intestine into the blood-vessels, and are thus carried to different parts of the system; but usually only those that lodge in the brain live, and there excavate galleries (Figure 65) and grow, and bud, thus forming the "water-brain," and finally kill the sheep. *Cœnurus* cysts have been observed, however, beneath the skin of sheep, in the cellular tissue. Similar cysts have, also, been found in the liver

of rabbits, and in squirrels, and other animals, so that dogs may perhaps obtain the same tape-worms by eating rabbits, and then give the "water-brain" in turn to lambs. But the cœnurus-like cysts of rabbits, etc., may prove to be a distinct species, which does not produce the same dog tape-worm, as several writers suppose. Young lambs are more liable to be infected by this parasite than sheep, the liability decreasing with age. This parasite is by no means uncommon, and is always abundant in proportion to the number of dogs in any country. Thus, in Iceland, where both dogs and sheep are kept in large numbers, Dr. Krabbe found this tape-worm in eighteen per cent. of the dogs, while the two other tape-worms dangerous to sheep were found even in much greater numbers. "Giddy" sheep are, of course, very abundant in that unfortunate country. In this country the disease is far more common than most persons suppose.

That this disease is caused in the manner described above, has been repeatedly proved by direct experiments made by a number of naturalists. The following by Dr. Küchenmeister, was one of the earliest: "On the 6th of January, 1854, at 8 o'clock in the evening, and on the 7th of January, at 11 o'clock in the forenoon, I gave some mature proglottides (joints) of the *Tœnia cœnurus* of the dog to six lambs of from six to nine months old, taken from three different flocks, which were not subject to vertigo. On the 20th of January the animals exhibited the first symptoms of vertigo. They were then successively killed, and presented the following phœnomena on examination.

On the seventeenth day after the introduction, from twenty to thirty vesicles (Cœnuri) inhabited the surface of the brain; the substance of the brain was hollowed into galleries as though a *Sarcoptes* had been forming its passages (see Figure 65); the vesicles were still free and without envelopes, and of the size of a grain of millet.

On the twenty-fifth day the vesicles were larger. On the twenty-sixth day they were of the size of a lentil; the envelopes began to be formed, and the first traces of heads appeared. On the thirtieth day, the heads, under the form of tuber-

cles, were visible to the naked eye. On the thirty-eighth day, the eminences appeared more distinctly on the surface, and the heads exhibited signs of their suckers and hooks. Toward the forty-fifth day the *Cœnuri* were of the size of a bean, and the cavities in which the heads are lodged were formed." Encysted vesicles, containing strayed and aborted worms, were also found in the heart, the diaphragm, and the œsophagus. Some of the "water-brains" obtained in this experiment were given to a dog early in March, and in due time a good crop of the mature tape-worm (*Tœnia cœnurus*) was obtained by killing the dog, which was done May 24th. These were immersed in white of eggs, in which some of them were kept alive, by changing it daily, for eight days, and sent to several other naturalists residing in other parts of Europe, at Louvain, Copenhagen, and Giessen. Prof. Von Beneden received his at Louvain, May 27th, and tried the following experiments: "On the day of their arrival, at 9 o'clock A. M., half a proglottis was given to each of two young sheep, about two months old, and in the afternoon each of them took an entire proglottis. On the 3d of June, one of them, marked No. 1, swallowed another proglottis. The first symptoms of vertigo made their appearance on the 13th of June; on the morning of the 15th, I was told that the one marked No. 2 was dying. Its head was burning hot, its eyes red, its legs bent under its body; it beat with its head against the railings, and turned it constantly in one direction. It was then killed. The upper and lower surfaces of the two hemispheres of the brain presented irregular grooves which might be taken for the deserted tubes of certain annelids (Figure 65); these have been already mentioned by M. Küchenmeister. There were about a dozen of them. At the end of these tubes there were the same number of *Cœnuri*, almost all lodged in the cortical substance of the brain. Some of them were removed with the membranes of the brain. They were of nearly the same size, about three or four millimetres in diameter. These *Cœnuri* as yet only consisted of a simple milk-white vesicle filled with fluid. The heads were not yet to be seen. * * * * * The second sheep (No 1), was killed on the

29th of June. It presented nearly the same symptoms as the former. For the last few days of its existence the right foreleg was always bent, and in walking it could not support itself upon its hoofs. In removing the brain from the cranium, a *Cœnurus* of the size of a small nut fell upon the dissecting table. Two other *Cœnuri*, of the same size, were found in the right hemisphere, one above, the other behind; and in separating the hemispheres of the cerebellum, I found two others touching the quadrigeminal tubercles. The left lobe of the cerebellum also contained one. Eight were found in all. These *Cœnuri* were nearly all of the same size, except two or three, which were scarcely larger than a cherry-stone. Through the walls of the larger ones the naked eye could distinguish some little whitish flakes, the indications of so many heads (scolices). The smaller ones had no appearance of heads, nor of the place where they were to rise. The *Cœnuri* were enclosed in a membrane of recent formation, produced by the inflammation of the neighboring surfaces."

Similar experiments, with the same results, were tried by Eschricht at Copenhagen, and Leuckart at Giessen, to whom tape-worms from the same dog were sent. Three sheep were fed by Dr. Eschricht. Of these one was not affected, but the other two became ill on the 15th and 16th days and died four days afterward with the symptoms already described, and in their brains the same kind of young *Cœnuri* were found.

In these experimental cases, where large numbers of eggs are given, the symptoms come on violently and death takes place at an early stage in the development of the worms, but under ordinary circumstances only a few eggs are swallowed and then the sheep may live long enough to allow the cysts to become much larger, with more numerous heads. The number of the heads is often 300 or more on a large cyst, and each head is capable of forming a complete tape-worm, with many joints. Allowing 500 sexual joints to each tape-worm, and each joint to contain 5000 eggs, there might result, as the progeny of one egg in a single generation, 150,000 joints, containing 750,000,000 eggs!

Remedies.—The only remedy for sheep with this parasite at

work in the brain, would be trepanning, and that can seldom be effectual, unless the cysts be small and favorably situated, which is not often the case. As with most internal parasites, instead of remedies, we must seek means of prevention. It is very apparent that, in this case, prevention simply demands the absence of dogs that harbor the tape-worms, from all places where the sheep feed or drink. Prevention on the part of dogs can be secured by not allowing them to feed on the offal of slaughter-houses, and especially the heads of sheep. The mature tape-worms can be expelled from dogs by the ordinary remedies for other tape-worms, some of which are mentioned under *Tænia mediocanellata.*

Perhaps the most effectual of these remedies is oil or spirits of turpentine mixed with castor oil.

Tænia echinococcus Siebold, *of the Dog; and its young, the hydatid tumors of Man, Sheep, and Cattle.*

This is by far the most important and dangerous of all cestode worms. In the mature state it lives in the intestine of dogs and wolves in great numbers, as a very small tape-worm, about an eighth of an inch long, with only three sexual joints or proglottides (Figure 70). In its larval state it forms compound cysts and tumors in a great variety of animals.

Not unfrequently there may be found imbedded in the substance of the liver and lungs of sheep, watery tumors of considerable size, sometimes becoming several inches in diameter and causing serious disease, and even the death of the animal. Similar tumors occur, though less frequently, in the brain, kidneys, ovaries, among the muscles, and in various other situations in sheep. They occur also in pigs, horses, and cattle, though less commonly than in sheep, but unlike the *Cœnurus*, or "water-brain," these tumors are not confined to the lower animals. They are also found in the human body, and give rise to incurable and most horrible diseases, to which persons of all classes are liable, no matter how wealthy or refined. That large numbers of human beings of all ages and conditions die annually from diseases caused by this parasite is established beyond a doubt. And although such diseases are

most common among the poorer classes of society, and especially among those who associate most familiarly with dogs,

Figure 66.

Figure 67.

they are by no means confined to them. Many men of great eminence and talent have likewise perished from the same cause. And, unfortunately, society is so constituted that no one can be certain of escaping so long as the parasites that produce the eggs exist in the dogs of every country. It is estimated that 500 persons die annually by this parasite in Great Britain.

These tumors, in their simplest form, or when young, contain a roundish cyst or membranous sac, enclosing a watery fluid, as shown in Figure 66, which represents of natural size a parasite of this kind from the human kidney. More frequently the cysts become compound by a process of budding, either upon the outside or inside, or both without and within the membrane of the original cyst, so that its size goes on increasing indefinitely, sometimes becoming as large as a child's head, and often completely permeating and destroying the liver, lungs, or other organs. Thus the danger becomes constantly greater and greater by reason of the pressure upon and destruction of the adjacent organs. When the budding is external, it results in a cluster of secondary cysts, often a dozen or more, and sometimes hundreds, all more or less connected together (Figure 67). And each of the external secondary or daughter cysts, may increase and multiply itself in the same way, thus, at times, producing many hundreds of other tertiary cysts or "grand-daughter cysts." By internal budding,

Figure 66—Hydatid or echinococcus cyst, natural size. Hearth and Home, after Thudichum.

Figure 67.—Secondary cysts from a tumor in the liver, natural size. From Cobbold.

secondary or daughter cysts are formed inside the primary ones, and then others inside the secondary ones, within which the heads of the future tape-worms are formed by a peculiar budding process. If the inner membrane of one of the small cysts be examined when quite fresh with a good microscope, there will be seen attached to it by means of slender stalks, numbers of small oval or rounded heads, looking something like fruit on a miniature plant, as shown in Figure 68, which shows a few of these heads attached to the inner membrane of a cyst from an echinococcus tumor of a sheep. The heads may also bud forth from the outer as well as the inner surface of the cysts, or brood-capsules, as they are called. And these heads, either external or internal, may become changed by an enlargement of their bladder-like portion into new brood-capsules or cysts, and by budding produce other heads in their interior, as shown in Figure 69. The heads are found attached to the inner membrane of the primary cyst, together with secondary cysts or brood-capsules; they occur in the same way in the interior of the secondary cysts, sometimes associated with tertiary cysts, or grand-daughter vesicles; and also on the interior of the tertiary cysts. They sometimes appear even on the exterior surface of the secondary and tertiary vesicles. In all these situations they are similar in appearance and structure, and all are equally capable of developing into tape-worms in the intestine of a dog. Many of the smaller secondary and tertiary brood-capsules or cysts are not more than $\frac{1}{100}$ of an inch in diamter, and then generally contain only three or four heads.

Each of the oval heads is a hollow sac, which contains the real head of the young tape-worm turned in like the finger of a glove, just as the heads are turned inward in the *cœnurus* and in the measles of pork, or the young of any other tape-worm. Often the head is turned outward, as is seen in one case in Figure 68, which shows well the four suckers around the head and the proboscis in the middle with its circle of hooks. These same organs can be seen indistinctly even when in their inverted position, as in the other heads shown in Figure 68, owing to the partial transparency of the mem-

branes. As long as these cysts remain in a living animal, new heads are constantly formed, by their peculiar methods of budding, and when new cysts are formed either within or outside of the older ones, they develop on their inner membranes other heads in the same way, so that if the sheep or other animal lives long enough to develop a large tumor, it will finally contain many thousands of these minute tape-worm heads. In examining one of these tumors taken from a dead animal, most of the heads and also the internal secondary cysts are usually found floating freely in the watery fluid in great numbers, giving it a turbid appearance, and on standing they settle to the bottom as a granular sediment. This is due to changes after the death of the parasite, though some of the secondary cysts may be free during life.

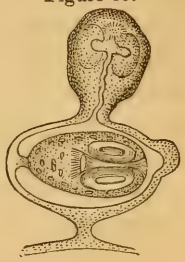
Development.

Now, if a dog eats the liver, lungs, kidney, or other parts containing such tumors, and swallows either the cysts or the detached heads, these will lose the enclosing membrane, stems, and other parts that are no longer useful, the heads with their suckers and hooks will be protruded, and, passing into the dog's intestine, each one will fasten itself by means of the hooks and suckers to the soft membrane lining the intestine. In this situation they remain and soon develop a small body, having only three separable sexual joints, as shown in Figure 70, which represents the mature tape-worm (*Tænia echinococcus*) greatly magnified. This tape-worm never becomes long, with hundreds of joints, as do the pork and beef tape-worms of man. It is only about an eighth of an inch long when mature. The last joint, which is much the largest, contains both male and female organs, and is perhaps capable of self-impregnation; it is therefore a complete hermaphrodite. After this has matured and discharged its eggs, the two next in turn develop their sexual organs and take its place. In Figure 70 the male organ may be seen projecting from one side, and the ovaries, containing many eggs, occupy the bulk of the joint. The eggs pass out through a duct that opens by the side of the male organ, and each egg is fertilized before being discharged. Thousands of these little tape-worms, derived from one large cyst, often live together in

the intestine of one dog, so that they make up by numbers what they lack in size. Such a dog is constantly discharging and scattering thousands or millions of the extremely minute eggs of this tape-worm wherever he goes.

Figure 68.

Figure 69.



They are scattered among the grass in fields and pastures; they get into the water of brooks and springs; they are liable to adhere to fruit that has fallen, or to lettuce and other garden vegetables.

Dr. Cobbold has calculated the number of progeny that might proceed from one egg during a single generative cycle. Allowing 500 secondary cysts to be formed and 10,000 heads or scolices to be developed by each hydatid cyst of average size, these might produce 5,000,000 tape-worms, each of which having three joints that become free, would give 15,000,000 joints or proglottides, and if each of these contains 10,000 eggs, the whole number of eggs in one generation, would be 150,000,000,000!

Figure 68.—Echinococcus heads attached to inside of brood-capsule, greatly magnified. Hearth and Home, after Thudichum.

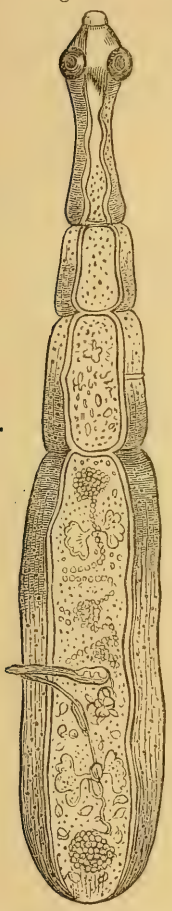
Figure 69.—A head or scolex, becoming a brood-capsule. From Leuckart.

Effects and Remedies.

These eggs are well protected by a shell, but when taken into the human stomach, or into the stomach of sheep, cattle, or pigs, they are acted upon by the gastric-juice and then immediately hatch. The embryo is a very minute worm, very different from the parent, and provided with six little hooks, by means of which it digs its way through the lining of the intestine into the blood-vessels, and entering the circulation they are carried to the various organs of the body, where they develop into the peculiar cysts first described, and thus cause disease and death. When lodged in the brain, they are most dangerous, soon causing insanity and death by their rapid growth and consequent pressure. In the lungs they are also very dangerous and often fatal; in the liver they cause severe disease, often terminating fatally; and in other organs the effects differ according to the nature of the organ. When the lodgment is among the muscles, or near the exterior of the body, the tumors may be removed by a surgical operation, or even by simple puncture, they may be destroyed. The discharge of the contents is fatal to the life of the hydatid opened, but there may be many others adjacent that will not be affected. Injections of iodine, etc., after opening, are unnecessary. When in the internal organs there is generally no remedy, though by chance the cyst may of itself burst, as sometimes happens, when, if the discharge takes place through some natural channel, recovery is possible, but such cases are of very rare occurrence. In the majority of cases the true nature of the disease is not suspected until a post mortem examination reveals it, or until the tumors burst or are opened, when a microscopic examination of the matters discharged gives reliable evidence; but many of these hydatid tumors are no doubt observed and treated by physicians, who do not even suspect what their real character may be, because they have neither suitable instruments nor sufficient knowledge to make the requisite examinations. Chemical tests may be applied to the liquid discharged, it is said, with satisfactory results. The properties of the fluid are described as follows: "If the sac be not inflamed, it is limpid, has a specific gravity of 1007 or 1009, and contains no albumen,

but throws down a copious precipitate with a solution of nitrate of silver, owing to its strong impregnation with common salt. These characters apply to no other fluid in the body, whether healthy or morbid."—Dr. Murchison. In some cases hydatid tumors situated in the liver and other internal organs have been opened from the exterior, with success, by skillful surgeons, but these operations are always dangerous and often immediately fatal. The escape of the fluid, with the minute cysts and heads contained in it, into the abdominal cavity, will give rise to other tumors, and thus increase the disease, even if death does not immediately result.

Figure 70.



This is eminently a case where "an ounce of prevention is worth a pound of cure." The means of prevention are simple, though not easy of application in all cases. The first and most important rule is to diminish the number of dogs to the utmost possible extent, and then to keep them at the minimum number; second, avoid as much as possible the proximity of dogs and sheep; third, avoid feeding dogs with uncooked livers or other offal of sheep containing these parasites, or never give them such raw food without careful examination; fourth, avoid too much familiarity with dogs, and especially between children and dogs; fifth, be careful not to eat lettuce, fallen fruit, or other raw food that has not been thoroughly washed, both on account of this and other parasites; sixth, avoid by all means possible the use of impure water, or water liable to be contaminated by eggs of parasites and excreta of animals, both for household purposes and to supply sheep, cattle, and horses, for such water is not only liable to contain echino-

Figure 70.—Mature *Tœnia echinococcus*, much enlarged. Hearth and Home, after Leuckart.

coccus eggs, but those of several other tape-worms, round-worms, and many other parasites, and is of itself unhealthy and often the prolific cause of disease. If water from a good well, or a well protected spring, cannot be had, the water should be carefully filtered, and by preference through charcoal. Most of the water consumed in our cities, both from wells and the water-works, is wholly unfit to drink without filtering. In cities with loose sandy soils the well-water is the worst possible.

Finally, dog-kennels and other places much frequented by dogs, should be frequently cleaned and the litter burned, while frequent sprinklings with strong petroleum water or a solution of carbolic acid in water should be used to destroy the eggs that may have escaped from the intestine. By these precautions the numbers of this and several other dog-parasites might be much diminished. Dogs might also receive a thorough course of medical treatment, once in three months, to expel all their intestinal worms, with great advantage, and this might, with propriety, be made obligatory by law. In this case the dogs should be confined while treated and all excreta should be burned.

The frequency of this parasite is in direct proportion to the extent to which the precautions are neglected in different countries. In Iceland, the conditions for its rapid increase and perpetuation have been favorable, and in that unfortunate country, Dr. Krabbe states that there are at all times about eighteen hundred patients suffering with severe forms of this parasitic disease—a number equal to about one-fortieth of all the inhabitants. In some districts, the proportion is said to be one in every seven, and scarcely a family can be found without two or more cases! It is also stated that one-sixth of all the deaths are due to diseases caused by this parasite! The number both of dogs and sheep in Iceland is very large, and the dogs mingle with the natives and live with them in their rude dwellings, and are used in bringing the sheep together, so that abundant opportunities occur for propagating the parasite. According to Dr. Krabbe, there is one dog for every three to five inhabitants in Iceland, while in Great

Britain, with a high tax on dogs, there is only one to fifty. Doctor Krabbe found the echinococcus tape-worms in twenty-eight out of one hundred Icelandic dogs examined, while in Denmark he found them in less than one per cent. of the three hundred and seventeen dogs examined for this purpose.

Tape-worm of the Horse (*Tænia perfoliata* Goeze).

This is a small species, seldom becoming more than three inches long and a third of an inch broad. The head is rather square, with four prominent suckers, but without a proboscis and hooks. There is no distinct neck, the first joints behind

Figure 71.

Figure 72.

the head being broad, but short. There are about 45 joints in full-grown specimens. The reproductive organs open on one edge of the joints, the first 22 segments having both male and female organs, the rest only female.

It occurs quite frequently, in considerable numbers, in the cœcum and colon of the horse, and more rarely in the small intestine. The development and the source from which horses derive them are unknown. The larvæ may, perhaps, live in insects accidentally swallowed with grass. It does not appear to produce any serious disease, unless in great numbers, and may be expelled by the same medicines used against the human tape-worms.

A still smaller species, *T. mamillana* Mehlis, only about half an inch long, and also without a distinct neck, but with wedge-shaped joints, lives in the large intestine of the horse. A much larger species than either of these (*T. plicata* Rud.) lives in the small intestine and sometimes in the stomach of the horse. It grows to the length of three feet or more, and has a remarkably large head, with four suckers, but no hooks

Figure 71.—Young *Tænia perfoliata*, natural size. From Cuvier.
Figure 72.—Head of *T. perfoliata*, magnified. From Cuvier.

or proboscis. The neck is short and thick, transversely plicated, and the reproductive organs are in a single series on one edge. If in considerable numbers, this species may produce serious symptoms, such as loss of flesh, tight skin, loss of strength and spirit, and general debility.

The Sheep Tape-worm (*Tænia expansa* Rudolphi).

This species, which is found both in sheep and cattle, grows to the length of eight or ten feet, varying in breadth from a quarter of an inch to upward of an inch, in large specimens. The head is very small with four suckers directed forward, and close together. The neck is scarcely distinct, or very short. The posterior border of the joints are uneven, divided up into rounded lobes and notches, or wavy. The reproductive organs are double, opening on each edge of every joint. Its young stage is unknown, and consequently the source from which the sheep obtain it. It does not appear to be very common in this country, judging from the few cases recorded. In Germany it is very common in sheep. It does, without doubt, produce effects in sheep similar to those caused by the tape-worms in man.

Tænia cucumerina Bloch, *of the Dog.*

This species is very common in the small intestine of the dog. It grows to the length of ten or fifteen inches up to nearly ten feet, with a width of one-twelfth to one-eighth of an inch. The head is somewhat rhomboidal, with four suckers and a central proboscis, which is surrounded by three circles of claw-shaped hooks, the whole number being about 48. The mature joints are elliptical, or shaped somewhat like the seed of a melon or cucumber. From this peculiarity it takes its name. There are two genital orifices to each joint, one in the middle of each edge. The eggs are much fewer in each joint than in most other tape-worms. Its development is unknown. It has been supposed that the larvæ live in flies or other insects.

When in large numbers in a dog, it occasions more or less severe symptoms, especially if associated, as it usually is, with several other species of tape-worms and round-worms. It can be expelled by the same remedies mentioned under some of the previous species.

Tænia elliptica Batsch is a similar species living in the cat, and by some is thought to be the same.

Several tape-worms of the dog have already been described (*Tænia echinococcus*, *T. cœnurus*, *T. marginata*), but there is another that is equally common in some districts.

Tænia serrata Goeze closely resembles *T. cœnurus* and *T. marginata*. The larvæ live among the viscera of rabbits and hares, producing small round cysts, and the dogs get this tape-worm by eating rabbits or the refuse thrown aside in dressing them. The young state or larva was formerly named *Cysticercus pisiformis*, in allusion to the pea-shaped cysts.

The Broad Tape-worm of Man (Bothriocephalus latus Bremser).

The genus *Bothriocephalus* differs greatly from the true tape-worms (*Tænia*) in many anatomical characters, but has a similar form of body, divided into many flat joints. The head has no suckers, but is long-oval in shape, with a long and deep groove on each side. It has no proboscis and no hooks. The reproductive organs open at the *middle of the side* of each joint, instead of the edge.

There are numerous species living in fishes and quite a number in birds. The present species grows to an enormous size—probably larger than any other known tape-worm. It grows to the length of 25 or 30 feet, and according to some authors to 50 or 60 feet. It is sometimes an inch wide. The joints seldom break off, either singly or in chains, but the eggs are discharged by the bursting of the joints while still attached within the body of the infested person. The male and female organs open separately, the male organ being a little in advance of the female orifice. The female uterine organ forms a sort of rosette, with eight or ten lobes, around the external orifice.

Its fertility is remarkable, even for a tape-worm. Prof. Eschricht found in one specimen 10,000 joints; allowing each of these to contain only a thousand eggs, this worm would have produced 10,000,000 young. The full history of this parasite is not yet known. The eggs, however, will hatch in water, producing curious embryos, which are provided with vibrating cilia by means of which they swim around for a

few days. The external skin, with the cilia, is then cast off, liberating a very different looking embryo or larva, which is provided with six boring hooks, similar to those of the embryos of ordinary tape-worms. Their subsequent history has not been ascertained, but it is probable that they enter some fish (most likely trout and salmon) and become encysted among the muscles, and that persons who eat imperfectly cooked or raw dried fish get the parasite in that way.

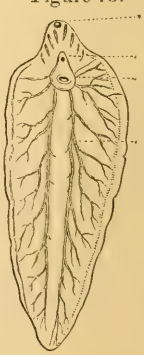
It is remarkable that this species is not known to be indigenous in any but European countries, and even in Europe it is peculiar to certain districts. It is particularly common in certain parts of Switzerland. In Geneva it is said that about one-fourth of all the inhabitants are afflicted with this worm. It occurs also in some parts of Russia, Poland, and Prussia. In America it has only been observed in emigrants from Europe, and in persons who have traveled in the European countries where it naturally occurs. It causes similar symptoms and is removed by the same remedies as the common tape-worms.

TREMATODE WORMS.

The Liver-fluke of Sheep and Cattle (*Fasciola hepatica* Linn.).

This common and notorious parasite has a very flat body, different on the two sides, and more or less oval in form, the anterior end suddenly narrowing to a sort of neck, which tapers off to the mouth end, where it is either rounded or pointed. The posterior end of the body is somewhat tapering, but blunt. Ordinary specimens are about three-quarters of an inch long and half an inch wide, but large ones become an inch and a quarter long and three-quarters broad. While living they often curl up the ends of the body, toward the lower side. The color is pale brownish or greenish yellow, sometimes with a faint rosy tint. At the anterior end of the body there is a small, cup-shaped sucker, at the bottom of which the mouth is situated (Figure 73, *a*); near the origin of the neck-like portion, on the middle line of the lower side, there is

Figure 73.



another larger sucker (*b*), with no opening at its bottom; just in advance of this there are situated, side by side, the male and female genital orifices (*c*). The external male organ is long, slender, and when protruded is curved in a spiral. It can be retracted into a small cavity.

Anatomy.

The reproductive system is very largely developed and complicated. The male organs, or testicles, consist of large clusters of vermiform, convoluted, yellowish tubes, situated in the middle region of the body, and filling up about one-half of the whole interior. The female organs, for they are hermaphrodites, are also largely developed and complicated. The lateral and hinder parts of the body are filled with innumerable, very small, yolk-sacks, which communicate, by a complicated system of branched ducts, with a heart-shaped ovary, and this in turn has a short duct leading to the uterus-like organ, which consists of a convoluted, wide tube, forming a sort of rosette behind and around the ventral sucker. The uterine tubes show through the skin and are brownish yellow, owing to the numerous minute eggs with which they are filled. These eggs are discharged, one by one, from the small external orifice as fast as they become mature. The mouth communicates with a small dilated œsophagus, and this gives rise to two large intestinal tubes, which diverge in advance of the genital orifice and extend backward, along each side, to near the posterior end, sending off numerous lateral branches, which again subdivide into many short divergent branchlets, as shown in Figure 73, *d*. The branches of these digestive tubes are all closed at the ends, and they communicate with the exterior only through the mouth. In life these tubes are all filled with food, consisting chiefly of bile, with some blood-corpuscles, etc. Another system of numerous, arborescently branched tubes is found nearer the dorsal surface, and as they show through the skin, on that side, they may be examined

Figure 73.—*Fasciola hepatica*, natural size, seen from below; *a*, mouth and oral sucker; *b*, ventral sucker; *c*, genital orifice; *d*, branches of intestine. From Cuvier.

with an ordinary lens. These tubes commence in fine, rootlet-like branches, with rounded and closed ends, but the small branches constantly unite into larger trunks, which in turn all unite into one main trunk, running along the middle line of the body, and this terminates in an external orifice at the posterior end. The use of this system of tubes is to remove the waste materials from the body. It may therefore take the place both of the kidneys and liver of the higher animals. There is no blood circulation and no true blood in these animals.

Development.

The fluke is a very prolific creature. Prof. Leuckart estimates that the ovaries may at any one time contain 45,000 eggs. The number of broods that they produce is not known. The eggs that are discharged pass out of the intestine of the sheep, or other animal in which they live, with the excrement. Those that get into water or moist places hatch after several weeks, producing minute conical embryos, which are covered with vibrating cilia or lashes, by means of which they swim freely about in the water. In this state the embryo is $\frac{1}{190}$ of an inch long and $\frac{1}{300}$ of an inch broad at the larger end. The cilia are $\frac{1}{1388}$ of an inch long.

In a few days the external skin, with the cilia, is cast off, and after that the embryos are obliged to creep about, instead of swimming. Its farther development has not been traced, but it probably has a history similar to that of other species of flukes of which the entire history is known. Therefore it is supposed that the young embryos, above described, attach themselves to the bodies or enter the tissues of the fresh-water spiral snails, such as *Limnæa* and *Physa*. In this situation the form probably changes, and they become the so-called "nurses," and then a brood of larvæ of another form is developed in their interior, by a process of internal budding. These larvæ are provided with a tail and have a form somewhat resembling minute tad-poles. In this state they are known as *cercariæ*. They are finally discharged from the body of the "nurses," and escaping from the snails, may again swim actively about in the water, by means of

their tails, but eventually they, in all probability, again enter the bodies of other small snails, and losing their tails, become encysted in little capsules. Finally these snails, with their parasites, are swallowed by sheep and cattle, while adhering to the herbage growing on moist land or near the water, or when adhering to water-cresses they might be swallowed by mankind. In the stomach and intestine of these higher animals they are again liberated from their cysts. They then gain access to the liver, where they rapidly develop their sexual organs and become mature. Eventually, after they have matured and perhaps discharged a large part of their eggs, they themselves, or at least a part of them, enter the intestine and are discharged, while still living, in company with innumerable eggs. The eggs that they still contain may be laid after they reach the earth or water. These eggs are exceedingly minute and may be diffused in various ways, as by rains, winds, insects, and the feet of animals, and getting into water, or moist situations, they are ready to hatch and commence another series of transformations.

The history of most of the flukes, which have hitherto been fully investigated, agrees in the main with that above given, and there can be little doubt but that this will prove to be the case with the common fluke, when its full history shall have been ascertained. At any rate it is certain that the eggs can hatch only in water, or in moist places. Therefore it is evident that sheep and cattle will be much more liable to the disease when kept in low wet pastures, than in dryer and more elevated situations; and also that wet seasons will be favorable for the parasites and dry ones unfavorable. These conclusions have been fully sustained by the experience of sheep-owners in all countries.

Modes of Occurrence.

The liver-fluke is one of the few internal parasites that is capable of living in several very different animals. It is most common in sheep; less so in cattle, goats, horses, and the ass; and quite rare in man. It has also been found in the hog, elephant, camel, beaver, squirrels, rabbit, hare, deer, and antelopes of several kinds, and in the great kangaroo.

It is chiefly found in the gall-bladder and bile ducts, but occurs also in the intestine, and sometimes in blood vessels. In the human subject it has, in some instances, been found in tumors beneath the skin. In these cases it is supposed that the larvæ entered from the exterior by boring through the skin.

Effects.

The injurious effect of this parasite is best known in the case of sheep. In these animals it produces the fatal disease generally known as "rot,"* "water-rot," or "fluke-rot." In severe cases of this disease there are always large numbers of flukes in the bile-ducts and gall-bladder,—often several dozens and sometimes several hundreds, or even a thousand in some fatal cases. A few may exist in a sheep without causing any marked disease; in proportion to the number, the symptoms become more marked and the disease more fatal. In some wet seasons, and in certain districts, these parasites have destroyed immense numbers of sheep. Thus in 1830–1 it is estimated that between one and two million sheep died of this disease in Great Britain. If the number was but 1,500,000, it would represent a loss equal to about $20,000,000. In a single year, in England, individual farmers have lost from 300 to 800 sheep in the same way. In France, during the year 1812, according to Davaine, 300,000 sheep died by the same cause in the vicinity of Arles, and 90,000 at Nimes and Montpellier. In Germany, Holland, and most other European countries similar disastrous outbreaks of the disease have occurred every few years, while during the most favorable years the aggregate annual loss is far greater than is generally supposed. In this country there are no reliable statistics by which the losses from this cause can be estimated. Yet there can be no doubt but that it amounts in reality to a large sum annually. Even those sheep that have the disease in a milder form and are sent to the market before they become too sick to be moved, lose very much in value, and are

*This must not be confounded with an entirely different disease, known as "foot-rot."

really unfit for food, though it is to be feared that farmers, as well as butchers, are not always over scrupulous in such cases.

Symptoms.

In severe cases any one at all familiar with sheep can readily detect the disease even by the general looks of the animal. They also show a peculiar weakness in the loins when the hand is pressed along the back over that region. In very bad cases the back becomes hollow and the belly hangs down, while the sheep become more and more emaciated and weak, dull, and dejected, with a feeble gait. The skin loses its natural color and becomes dry, while the wool is also harsh and dry, and comes off easily.

The skin on the inner parts of the thigh, especially where it is naked, becomes dry or scaly early in the progress of the disease. The eye affords very certain evidence, even at an early stage, so that even shepherd boys are able to select from a flock those that are diseased, by this symptom alone. If the lids be turned back and the membrane at the corner of the eye be pushed away, the conjunctiva and other parts will present an unnatural watery appearance, the vessels being swollen and filled with pale or yellowish colored blood. When the disease is farther advanced the blood-vessels lose their color and are scarcely distinguishable, though a few of them may be swollen and filled with dark, unhealthy looking blood.

Remedies.

It can be safely stated that when these parasites have once entered the liver in considerable numbers there is no known specific remedy. All that can be done is to keep up the general health and strength of the animal until nature effects a cure, or until the parasites complete the natural course of their lives and voluntarily leave the sheep. To this end the afflicted animals should be removed to a dry pasture or good shelter, and be liberally fed with a variety of nutritious and palatable food, while they should be freely supplied with salt.

This is another of those instances where *prevention* is far easier and better than *cure*. From what we already know of the history of the parasite it is evident that sheep will be

little liable to get it if pastured on uplands, or other dry places, and supplied with pure spring water, by preference from a trough or other similar arrangement. On the other hand, sheep pastured on meadows, or swampy lands, or in places where they have access to the marshy banks of streams, ponds, and swamps, will be far more liable to get this and several other parasites.

An exception should, however, be made in the case of salt marshes and meadows, for sheep pastured in such places seldom get the disease. This is probably owing to the fact that the fresh water snails, that harbor the young flukes, cannot live in salt or brackish water.

Smaller Liver-fluke (*Distoma lanceolatum* Mehlis).

This species is also found in the bile-duct and gall-bladder of sheep and cattle, and occasionally in man. It is sometimes associated with the common fluke. It is much smaller, the length being about one-third of an inch and the breadth an eighth. It has a smooth, flat, lance-shaped body, broadest behind the middle, narrowing to each end, the mouth-end being most pointed. There are two suckers, as in the common fluke, the one at the front end having the mouth at the bottom.

The anatomy is quite different, for in this, as in all other true *Distomas*, the digestive tube only forks once, each branch remaining a simple, closed tube, running down on each side of the middle region of the body. The testicles are two large, roundish, but somewhat lobed organs, just below and near the ventral sucker. The uterine tube has numerous branches arranged on each side of a main central trunk, in the hinder part of the body. The ovaries are comparatively small and situated on each side of the middle region of the body.

Development.

The eggs hatch in water, after several weeks, producing very small, nearly round embryos, which have the vibrating cilia only on the head end, which is a little smaller than the other end. They are not such lively swimmers as the em-

bryos of the common fluke. They are about $\frac{1}{833}$ to $\frac{1}{990}$ of an inch long, and $\frac{1}{1562}$ of an inch broad. The head end is provided with a dagger-like boring spine, which can be alternately thrust out and withdrawn. It is supposed that these embryos become parasitic in fresh-water snails, for a time, and undergo transformations like those described under the preceding species. Their effects and remedies are the same as for the common fluke, though owing to their small size they would be less injurious, unless in much greater numbers.

The Stomach-flukes of Cattle (*Amphistoma conicum* Rud. and *A. crumeniferum* Creplin).

The flukes belonging to the genus *Amphistoma*, which includes, besides the two indicated, *A. explanatum* from the bile-ducts of cattle and *A. truncatum* from the cat, have a small, rather thick, and somewhat conical body, the mouth-sucker being at the small end. The large end is rounded and bears the other sucker, which is always much larger, near the posterior end. The stomach and reproductive organs are nearly like those of *Distoma*. The eggs also produce ciliated embryos in the water, and they are supposed to go through similar transformations. I do not know that either of them have been observed in sufficient numbers to produce serious diseases in cattle.

ACANTHOCEPHALA.

(*Thorn-headed worms.*)

Echinorhynchus gigas Goeze. Figures 74, 75.

This, which is the only representative of the order hitherto found in our domestic mammals, is quite frequent in the intestine of hogs. It may at once be known by the peculiar proboscis, which bears several circles of small but sharp hooks, which are arranged alternately, in quincunx, mostly toward the end of the proboscis (Figure 75). These worms have a long roundish body, tapering to the posterior end. The skin is generally crossed by numerous transverse wrinkles, but is sometimes smoothish. The color is whitish or a little bluish. The males grow to the length of three or four inches, with a

diameter of one-eighth to one-fifth of an inch. The females may become six inches, or even a foot in length, and sometimes one-quarter of an inch in diameter, though generally

Figure 74.

smaller. The female is very prolific, producing an immense number of somewhat oblong-oval eggs.

The history of its development and transformations has not yet been made out. There can be little or no doubt, however, that the young worms are parasitic in some other animals,—most likely in insects, worms, or snails,—and that the hogs get them by devouring the embryos included in some such small animals.

Effects and Symptoms.

This is the commonest and most injurious intestinal worm found in swine. These parasites live in the small intestine, and more rarely in the large intestine. They usually adhere to the lining, or mucus membrane, by means of the hooks on the proboscis, which is thrust into the substance of the membrane. Not unfrequently they perforate the walls of the intestine and stray into other parts of the viscera, producing serious disease. Sometimes the intestine of a hog is found perforated by so many of these holes that it cannot be used in the manufacture of sausages!

Figure 75.

In severe cases, hogs afflicted with this parasite are weak in the loins, and have the membranes in the corners of the eyes swollen, watery, and lighter colored than usual. The excrement is hardened and highly colored, and the animal often keeps up a continual squealing and grunting, especially in the morning. Such hogs are generally cross and morose,

Figure 74.—*Echinorhynchus gigas,* natural size. From Cuvier.

Figure 75.—Head of *E. gigas,* enlarged showing the reticulated vessels in the skin. From Cuvier.

biting and snarling at its companions, but is usually too weak to defend himself, if attacked in return, and is easily thrown down. Finally the weakness increases until the poor creature is unable to walk about, or to stand. This parasite will probably yield to the same remedies used for tape-worms, or those employed against the common round-worms of man (*Ascaris lumbricoides*), to which, therefore, the reader should refer.

NEMATODES.

(*Round-worms and Thread-worms.*)

The Flesh-worm (*Trichina spiralis* Owen). Figure 76.

This most important and most dangerous of all human parasites, is a very minute round worm, which in the larval state lives in the muscles of man, swine, dogs, cats, rats, mice, rabbits, Guinea-pigs, and many other animals, and in the mature state inhabits the intestines of the same animals. The body is slender, smooth, and round. The intestine is composed of a series of small, bead-like swellings, separated by constrictions. The male is much smaller than the female, when mature measuring only $\frac{1}{18}$ of an inch; its body is filiform, pointed at the head, enlarged at the opposite end, generally somewhat bent or curved upon itself; the head is very small and pointed, unarmed, but with a minute central mouth; the posterior end of the body is furnished with a bilobed appendage, the anal opening being between the lobes; the penis is a single spiculum, cleft above so as to have a V-shaped outline. The female is stouter than the male and longer, measuring about $\frac{1}{8}$ of an inch, when mature; the posterior end is bluntly rounded; the genital orifice is at about a fifth of the length from the anterior end of the body. They are viviparous and the uterus occupies most of the body, in the form of a long and wide tube, in which the embryos are closely packed. The eggs are $\frac{1}{1270}$ of an inch long. The young Trichinæ, like young tape-worms, occur imbedded in the muscles of the hog and various other animals, and man. But unlike the young tape-worms or "measles," the young *Trichinæ* are so small as to be quite invisible to the eye, and millions of them may exist in the flesh of a pig without producing any unusual appearance in the meat sufficient to attract the attention even of an

expert, unless examined with a powerful microscope. This is one reason why deaths so frequently occur from eating pork filled with this parasite. When recently introduced into pork or human flesh, the little worms are free and coiled up among the muscular fibres, but after four or five weeks they become enclosed in minute, whitish, elongated, oval or roundish cysts or capsules, due to the irritation and inflammation that they cause by feeding and moving (Fig. 76). After a year or more these cysts become calcified by a deposit of carbonate of lime in the membrane, and at this time are visible to the eye as minute specks, about the size of hemp-seed, scattered through the muscles. When enclosed in the cyst, the worms become dormant, and though they may live for years, and even some weeks after the death of their host, they can do no further harm unless swallowed by man or some animal. Each cyst contains a little slender worm about one twenty-fifth or one thirtieth of an inch long, and one seven hundredth thick, coiled up in two or three turns. The cysts average about one eightieth of an inch long and a hundred and thirtieth thick.

If pork or other flesh containing these worms, either free or enclosed in cysts, be eaten by man, they become liberated in the stomach, and, entering the intestine attach themselves to its soft lining, and there, surrounded with abundant food, they grow very rapidly and become mature, with fully developed sexual organs, in two days.

Figure 76.

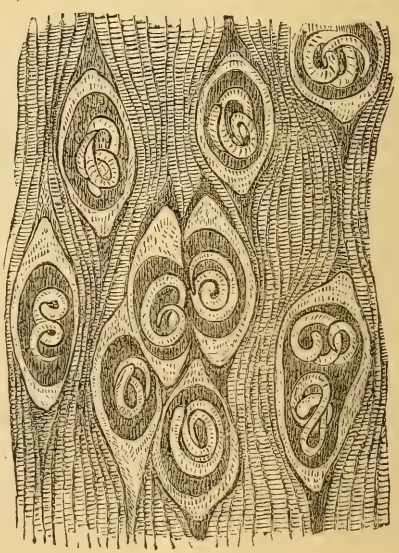


Figure 76.—A small piece of human muscle containing encysted young of *Trichina spiralis* Owen, enlarged forty-five diameters. From Hearth and Home, after Leuckart.

The females are larger and more numerous than the males, and become about one-eighth of an inch long when full grown. They pair as soon as mature, and the males soon die; but the females begin to give birth to living young in five or six days from the time when they enter the stomach, and they live long enough to produce a brood of from five hundred to one thousand young worms each. As one ounce of pork sometimes contains a quarter of a million or more of the worms, it is not surprising that the millions of adult worms and their offspring, sometimes resulting from a single meal of raw pork, should, by their presence, produce great irritation and inflammation of the intestine and violent diarrhœa and vomiting, which are often the first symptoms in severe cases. But the young worms, almost as soon as born, begin to eat or force their way through the membranes of the intestine into the minute blood-vessels and other organs, thus vastly increasing the irritation. Entering the circulation they are carried by the blood to the heart, thence to the lungs, and then become diffused through the whole system. According to other observers, the young worms force their way directly through the intestine and all other intervening organs, until they finally reach a suitable habitation in the voluntary muscles. It is, however, difficult to understand how they can become so evenly and generally distributed through the whole muscular system as they often are, if this be their only mode of diffusing themselves. It is, therefore, not improbable that they migrate by both these methods, part entering the circulation and part going directly through the tissues, while in either case, if they find themselves in an unfavorable locality, they have the power of changing their position while still in the free state. According to Dr. Leuckart, they travel by the way of the intermuscular connective tissues, and are found most abundantly in the groups of muscles nearest the abdominal cavity, especially in those that are smallest and have the most connective tissue.

Effects.

Large numbers often lodge in the heart, lungs, and various other organs, producing great irritation and various danger-

ous symptoms, but the majority finally reach and remain in the voluntary muscles, where they live and thrive for some weeks, making for themselves passages, and even entering and destroying the fibres themselves. All these operations cause, of course, an immense amount of inflammation and irritation, if, as often happens, millions of these flesh-worms are at work at the same time in all parts of the system; and it is no wonder that many violent symptoms and high fever result, or that there should be intense soreness and pain or paralysis of the muscles, and dropsical swellings. Death in severe cases may occur at any time from the fifth to the fiftieth day. The duration of the disease, like its severity, is in direct proportion to the number of living Trichinæ swallowed, and varies from two weeks to three or four months. Even in many comparatively mild cases, the suffering is intense and the recovery slow and tedious, while many secondary diseases, like pneumonia, etc., are liable to ensue. When all the worms have become lodged in the muscles and enclosed in cysts, the direct symptoms cease, and, if the strength of the patient has been kept up, recovery is probable. Some persons, especially females, are much more severely affected than others, by the same number of the parasites.

Persons in robust health may be able to survive the attack of half a million or more of these flesh-worms and recover, but there is a limit to all human endurance, and the numbers often contained in the muscles of animals or persons who have been killed by them, are almost incredible. In a cat fed with trichinous flesh by Leuckart, they were so numerous that he estimated that one ounce of the flesh contained at least 325,000 worms. Microscopic preparations, not much larger than a pin's head, often contain from ten to forty worms, and one bit of muscle, weighing about one-fifth of a grain, from a child that died on the seventy-ninth day, contained fifty-eight. Allowing only one hundred worms to a grain of muscle, a man weighing 150 pounds might contain over forty millions of the parasites, and the length of the muscular fibres actively inflamed by such a number, if placed in a line, would amount to more than 120 miles.

In some very severe cases the numbers contained in human bodies have been estimated, by reliable authorities, as high as forty and sixty millions.

The cysts containing *Trichinæ* were first observed in human muscles in 1822, but the worms from similar cysts were first named and described by Owen, in 1835, but were only regarded as anatomical curiosities of no practical importance, until 1860, when Zenker proved that they are capable of producing the severe and often fatal disease now well known under the name of Trichiniasis, but which had been previously (as it often is still) confounded with typhoid fever, inflammatory rheumatism or rheumatic fever, poisoning, and various other diseases.

Symptoms and treatment of the disease.

The disease caused by this parasite has three more or less distinct phases:

First. While the mature worms and young remain in the intestine, and while passing through its walls. In this stage the symptoms are derangement and inflammation of the intestine, often resulting in severe diarrhœa, nausea and vomiting, swelling and pain, and sometimes peritonitis, due to the perforations of the intestinal walls. These symptoms ensue in two or three days after swallowing the trichinous flesh, and may last a fortnight or more. Animals experimented upon often die in this stage. Purgatives and anthelmintics are used in this stage to expel the mature and pregnant females, but after three or four weeks have passed this will be useless. Castor-oil and calomel have been used with success for this purpose.

Second. While the young worms are migrating and working in the muscles, a variety of symptoms are developed, varying in different persons, and depending, also, upon the number of worms. This stage commences in ten to fourteen days, and generally lasts four or five weeks. The principal symptoms are lassitude and swelling of the muscles, with soreness, or intolerable pains, resembling rheumatic pains but not affecting the joints; profuse sweating sometimes occurs; the pulse is very rapid, but the heat of the body is usually

low, often never exceeding 102° Fahr.; the face frequently becomes suddenly and greatly swollen, and sometimes the whole body is affected in the same way. In certain cases, a peculiar congestion of the eyes has been observed. In general, many of the symptoms in this stage resemble those of typhoid fever.

In very severe cases the patient is unable to use the muscles or move the limbs without the most intense agony, and finally is obliged to lie passively, flat upon the back, with the arms and legs somewhat bent, in the position that gives the least pain; and later the limbs are rigidly stretched out, somewhat apart, the body stiff, and the muscular system in a state of more or less complete paralysis. Children generally lie on the side, with the body bent and the legs drawn up. The jaws are sometimes closed as in lock-jaw. The breathing is difficult, shallow, and rapid. The lungs are often affected, and frequently, also, the heart; and many secondary diseases are liable to ensue.

The most that can be done in this stage of the disease by the physician relates to the relief of special symptoms and secondary diseases, and sustaining the strength of the system until nature may in time effect a cure. Most experimental animals die in this stage, and human patients, also, frequently perish even during the early part of this period.

Third. In case the patient survives the two first stages, the inflammation gradually ceases, breathing becomes more natural, and recovery generally commences, but in very severe cases the muscles and other organs have been so much injured as not to perform their proper functions, and general debility often results, ending in a kind of consumption that finally proves fatal. In many cases of recovery, lameness lasts for several months. In many cases, however, the final recovery is complete and may be followed by robust health, although tens of thousands of living worms may be still enclosed in the capsules in the muscles.

From this it is obvious that a hog may be fat and appear in every respect healthy, and yet his flesh may contain such immense numbers of the parasites as to be capable of killing a

hundred or more persons, should they eat it raw or but slightly cooked.

Cases of Trichiniasis.

Since 1860 thousands of cases have been observed and hundreds of deaths are known to have occurred, especially in Germany, where the custom of eating various forms of raw or imperfectly cooked pork is much more common than in this country. At Hettstädt, in 1863, the flesh of one pig infected one hundred and thirty-five persons, of whom twenty died. Several other similar "epidemics" have also occurred in the same country. In the United States, many sad cases have also been recorded, as the following instances will show:

At Marion, Iowa, May, 1866, Mr. Bemis and eight members of his family ate rare-done and raw ham, and were immediately taken sick. Up to June 3d, three had died, and others were considered critical. A post-mortem examination showed about two hundred thousand worms to a cubic inch of muscle in one of those who died.

At Dubuque, Iowa, according to Dr. Asa Horr, two families were attacked. In one five persons died; in the other, five or six. Through him we also learn of a case where the mother of a family ate of the interior, rare-done part of a ham and took the disease, while those who ate the outside escaped.

At Springfield, Mass., February, 1867, Mr. Ransley Hall and family ate of raw ham, and all seven were attacked in various degrees, according to the amount eaten. A daughter, aged seventeen, died, and the father had a long and very dangerous illness.

At Albany, N. Y., January, 1869, two boys ate of raw ham and were infected; the rest of the family ate of the same ham, when cooked, and escaped.

At Rome, Oneida County, N. Y., December, 1868, Mr. John Wilbrecht and family, nine persons in all, ate raw smoked and dried sausages. All were dangerously sick, and four adults, the father, son, and two daughters died before January 15th. Their sausages and salt pork were examined and found to be full of *Trichinæ*, as were also the muscles of those who died.

In New York City, January, 1869, eight cases occurred in a boarding-house in Carlisle Street, from eating sausages. Two of the victims died in the New York Hospital, and others were dangerously sick. It is a significant fact that the physicians in two hospitals mistook these cases at first for typhoid fever, and only discovered the mistake after one death had occurred.

In Bridgeport, Conn., January 30th, 1870, raw smoked ham was eaten by five persons. Of these Mrs. Koch died of acute Trichiniasis, February 15th; Mrs. Winter died February 16th; Mr. Winter died March 1st; a daughter of Mrs. Koch, aged two and a half years, died March 7th. Mr. Strasburg was for a long time very dangerously ill, and was left in a very feeble condition. Another person who ate some of the same ham fried, escaped entirely. Mr. Winter thought himself not seriously ill when his wife died. Some portions of his pectoral muscles, which I have had an opportunity to examine, were filled with *Trichinæ*, not yet encysted. There were perhaps 100,000 to the cubic inch.

Prevention.

Experiments have fully shown that nothing less than the most thorough cooking, so prolonged as to destroy all redness of the juices even in the interior of the meat, is capable of destroying these parasites and rendering pork a safe article of food. Cases, some of them fatal, have occurred from eating ordinary fried sausages, roast pork, and pork that had boiled two hours. But the majority of severe and fatal cases have happened from eating smoked ham, raw or partly cooked, and various kinds of smoked and dried sausages, which are often eaten raw, or but slightly cooked.

Therefore, if people will eat pork at all, they should make it a fixed rule never to eat it unless thoroughly cooked, if they would avoid one of the most painful and dangerous diseases known.

There appears to be no certain way of preventing the disease in hogs, for it is probable that in most cases they get it by eating rats or mice, which are often full of *Trichinæ*, but it is quite probable that they may often be infected by

eating slaughter-house offal. It is possible, also, to infect hogs and other animals by means of the mature female *Trichinæ* that have been discharged from the intestines of men or animals, before all the young worms contained in their uteri have been born. Therefore hogs may obtain this, as well as the larvæ of the tape-worm of man and many other parasites, by being kept in places where they have access to manure, as is too often the case. Cats, rats, mice, rabbits, Guinea-pigs, young dogs, and various other animals may be infected, but adult dogs, like old hogs, are not nearly so likely to become infected as the young. Although lambs, calves, and horses may be infected by forcing them to eat trichinous meat, it is probable that they seldom or never become infected naturally.

Trichocephalus dispar Rudolphi. Figure 77.

This is a small round-worm, living in the human intestine, and remarkable for its long, very slender, filiform neck, which is about two-thirds of the entire length. The male grows to the length of one inch and a half, and the female to two inches. The surface of the body appears smooth to the naked eye, but when magnified, a longitudinal band of minute, wart-like papillæ is seen on one side. The male has the posterior end of the body spirally curved, with a single spicule, which is emitted from the extremity of the body, and is enclosed in a short, tubular sheath, that is covered with minute recurved spinules. The female has the posterior end of the body nearly straight and bluntly pointed (Figure 77). The genital orifice is situated at the origin of the neck. The eggs are elliptical, with a small projection at each end, and are $\frac{1}{4\,5\,0}$ to $\frac{1}{4\,8\,0}$ of an inch long. They are discharged from the human intestine before the contained embryos are fully developed. If kept in water for six months or more they hatch, liberating a minute embryo $\frac{1}{3\,3\,3}$ of an inch long, which tapers from behind toward the head.

Figure 77.

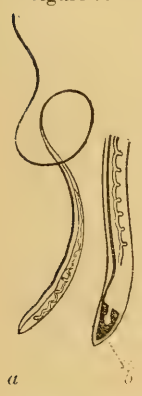


Figure 77.—*Trichocephalus dispar; a*, female, natural size; *b*, posterior end, enlarged. From Guerin.

It is therefore probable that they are taken into the human system in impure water. In some regions it is very common. Davaine estimates that one-half of the inhabitants of Paris entertain this parasite. Its effects are not well made out, but it does not seem to cause, ordinarily, any marked inconvenience. It lives in the cœcum and small intestine.

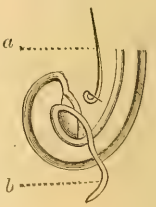
Trichocephalus affinis Rud.

This species lives in the cœcum of cattle, sheep, deer, and antelopes. It closely resembles the preceding, but the neck part is still longer and more slender. The posterior end of the male is curved in a close, conical spiral, and the spicule, like its sheath, is much longer, being equal to about a third of the length of the body. The genital orifice of the female is situated at the summit of a prominent, hour-glass shaped papilla, which is obliquely truncated at the summit and covered with minute spinules, like those of the spicule-sheath in the male. The eggs are similar to those of the preceding species and, without doubt, develop in the same way. It is not known to cause any serious disease.

Spiroptera strongylina Rud., *from the Hog*. Figure 78.

The genus *Spiroptera* includes numerous species of small, whitish or reddish, slender, round worms, which taper somewhat toward the anterior end, or toward both ends. The head is small, and either naked, or with small papillæ. The male has the posterior end curved in a spiral, with membranous expansions, and with two unequal intromittent spicules. In the female the posterior end of the body is nearly straight and conical, and the ovary is either simple or double, with the genital orifice situated at one side of the body.

Figure 78.



The *S. strongylina* has a smooth, tapering body, with a simple head and mouth. The male spicules are very long, relatively to the entire length of the body. The male grows to the length of half an inch or more. The female to more than three-fourths of an inch. It lives in the stomach of the hog, but ordinarily does not produce any serious disease.

Figure 78.—*Spiroptera strongylina*; *a*, male, natural size; *b*, spicules and posterior end of the body, enlarged. From Guerin.

Spiroptera megastoma Rudolphi, *of the Horse.*

This is a small species, which has a more cylindrical body, tapering a little toward each end. The head is separated by a slight constriction and bears four lobes. The mouth is large. The male becomes rather more than a quarter of an inch long, and the female nearly half an inch. It lives in the stomach and œsophagus of the horse and produces tubercles, or hard tumors, of considerable size, most frequently situated near the pylorus. These contain many cavities, connected together and filled with purulent matter, in which there are numerous specimens of the parasite. The tumors are sometimes one and a half inches in diameter, and there are at times several in the same stomach.

Spiroptera sanguinolenta Rudolphi, *of the Dog.*

This is a larger, reddish species, which produces similar tumors in the œsophagus and stomach of the dog. This species usually grows to the length of one and a half to three inches, but it has been found ten inches long, living in the cavities of the ventricles of the heart of dogs at Shanghai, China, where it appears to be very common. Its complete history is unknown, and therefore little can be said about the special means of prevention, or cure. It often produces death.

Pin-worm of the Horse (*Oxyuris curvula* Rudolphi). Figure 79.

This is a small, whitish worm, quite commonly found in the cœcum and colon of the horse and ass. The female is about one inch and a half to two inches long, when mature. The male is far more rare and but one-third to two-thirds of an inch long. The body is fusiform, tapering to a slender tail, thicker in front, with the anterior end more or less pointed. The mouth is situated at the end, and usually has the form of a small, round pore, but is provided with three or four small retractile papillæ, which can be protruded. The buccal cavity contains a peculiar apparatus of folds and tooth-like processes; the œsophagus is long and muscular, round externally, but with a three-cornered cavity; it is separated from the round, gizzard-like stomach by a constriction, and

then a second constriction separates the stomach or gizzard from another somewhat enlarged cavity, which tapers gradually into the slender intestine. The anal orifice is near the posterior end of the body, and in the male also gives exit to the intromittent organ, which is a single, sharp, grooved spiculum, with a very small accessory one. The female

Figure 79.

orifice is situated near the anterior third of the body. This, like the other species of *Oxyuris*, produces eggs having firm shells. These probably hatch in water, and the embryos may thus be swallowed in drinking. The intestines of these parasites are generally filled with vegetable matters derived from the food of the animals in which they live, and the structure of the digestive organ seems to be adapted to vegetable food. For this reason it is probable that they ordinarily cause little or no inconvenience to the horses that they inhabit.

The Pin-worm of Man (*Oxyuris vermicularis* Bremser).

This is a much smaller species than the preceding, but is similar in form. It is very common, often in great numbers, in children, and occurs also in adults, especially in aged and debilitated persons, and inhabits chiefly the lower part of the rectum and the vicinity of the anus.

The male is about one-eighth of an inch long, with the tail curved in a spiral form, terminating in a very short point. The female is about four-tenths of an inch long and one-fiftieth in diameter, with the posterior part of the body tapering to a very slender tail.

The digestive system and structure of the mouth is similar to that of the preceding species. But the head sometimes shows inflated lateral lobes.

Reproduction.

This species is very prolific; each female produces thou-

Figure 79.—*Oxyuris curvula*, female, twice natural size. From Guerin.

sands of eggs, in which the embryos are considerably developed before they are laid. The embryos enclosed within the eggs are shaped somewhat like tad-poles, the slender tail being bent up against the lower side of the body, which faces the flattened side of the egg. The body is broad and well fills the egg. The full history of the development of the eggs is not yet known. It is probable, however, that a portion of the eggs imbedded in the mucus membrane of the intestine hatch in that situation, remaining thus in the same person. But it is also probable that the eggs that are discharged will hatch in water, and that persons become infested by swallowing the embryos with their food and drink.

Symptoms.

The most marked symptom of these parasites is an intolerable itching in and about the anal orifice, which is generally worst in the evening or during the night, when the worms are migrating or changing their localities. This is usually accompanied by sensations of heat and inflammation. Not unfrequently, by irritation of the adjacent nerves, they cause similar sensations in the genital and urinary organs, which sometimes become very distressing. They sometimes even migrate into the genital passages of female children, causing great irritation and very serious symptoms. By the irritation of the sexual organs, in both sexes, various unfortunate secondary diseases and bad habits not unfrequently result, especially if they occur at the period of early puberty. Other symptoms caused by the irritation of the nervous system, are restlessness, general nervousness, involuntary twitchings, itching of the nose, chorea, convulsions, and sometimes epileptiform seizures.

Remedies.

The various medicines ordinarily used as anthelmintics, or vermifuges, will often bring away large numbers of these worms. Of these the etherial extract of male fern is probably the best, but santonine and panna have been used with good results. Ordinarily they can be treated more easily and effectively by means of injections of cold, or nearly cold,

water, to which may be added a small amount of salt, oil of anise-seed, or assafœtida. Sometimes decoctions of quassia, worm-wood, or southern-wood (*Artemisia abrotanum*) are used for this purpose, with good results. To these a portion of olive-oil may be added. But any remedy that may be employed must be repeated as often as once every three or four days for at least three weeks, in order to destroy the young ones as fast as they develop. An application of mercurial ointment to the parts about the anus is recommended to prevent the migrations of the parasites and the uncomfortable itching sensations that they thus produce.

The common Round-worm of Man (Ascaris lumbricoides Linn.).

This species is well known as a parasite of the human intestine, especially in children, though often found in persons of all ages. The round-worm of cattle is generally regarded as the same species.

These worms are round and smooth, tapering to both ends, with a tough, elastic skin. The mouth is situated at the more pointed end, and is provided with three prominent papillæ, or fleshy lobes. The male grows to the length of six inches, and has the posterior end curved and provided with two slender spicules. The female is much larger, sometimes becoming twelve or fourteen inches long and one-fourth of an inch in diameter; the female genital orifice is in advance of the middle of the body.

Development.

The females produce great numbers of minute eggs, which are provided with thick, rough shells. The eggs are discharged and pass from the human intestine before the development of the embryos commences. If kept in water the embryos go on developing slowly and gradually, the whole process requiring from six months to nearly a year. The fully developed embryos are round and slender, about $\frac{1}{100}$ of an inch long, with an obtuse head and an acute tail. They have not been observed to quit the eggs of their own accord, but may live for at least a year within the egg-shell, after they attain their full

size. It is probable that such eggs, containing embryos, when swallowed in the water that we drink, will be hatched in our stomachs by the action of the gastric juice, and that the young worms thus reach their destined abode. It is possible, however, that under the proper circumstances the eggs will hatch in the water, and that the free swimming embryos may be swallowed in the same way. This part of their history still remains uncertain.

Symptoms.

The presence of one or two of these parasites in the human intestine does not ordinarily cause any marked effects or noticeable symptoms. But when they occur in persons of delicate health, and when in great numbers, as sometimes happens, they may cause great disturbance of the natural functions of the digestive system, and induce various serious consequences. Cases have occurred in which from 100 to 500 of these worms have passed from one child. They live chiefly in the small intestine, but sometimes enter the stomach and may even be expelled by vomiting. In some instances they have been known to perforate the walls of the intestine and enter the abdominal cavity, and thus even to get into the other organs, including the lungs, pleura, gall-bladder, etc. In such cases death often results.

Their presence in the stomach and intestine causes colic and shooting pains, often accompanied by nausea, vomiting, dyspepsia, itching of the nose, and diarrhœa. Owing to the irritation of the nervous system they may cause restlessness, convulsive twitchings, especially during sleep, and various mental disturbances. In some cases, serious convulsions, epilepsy, and insanity have been caused by them, and have been cured at once by expulsion of the worms.

Remedies.

The most reliable remedy appears to be *santonine*, but this is a powerful preparation, and must be used with caution. For children the dose is one to three grains, in the form of powder, which does best if taken in castor-oil or honey, though it may be sprinkled over a piece of bread and butter.

For an adult the dose is four or five grains, twice a day, on every second day, for a week, the quantity to be diminished if the medicine causes ill effects, such as spasms, tenesmus, etc. It often causes temporary perversion of vision, things appearing of unnatural colors, etc., but this effect soon passes away.

The root of male fern (see page 191), given in powder, in connection with purgative medicines, is also recommended.

As means of prevention, the use of impure water should be avoided. And if water from streams and ponds must be used for drinking, as in most large cities, it should be thoroughly filtered through powdered charcoal.

The Round-worm of the Horse (*Ascaris megalocephala* Cloquet).

This species inhabits the intestine of the horse, ass, and mule, and is quite common. It closely resembles the preceding species in form and general appearance, but grows to a larger size, the male becoming ten inches long, and the female twelve inches or more. The mouth is surrounded by three large, rounded, very prominent lobes or papillæ. In the male the tail is provided with wing-like folds along the sides; in the female it is conical, terminating in a point, the female genital opening being situated in the anterior fourth of the body.

This species likewise produces vast numbers of eggs, which develop embryos externally to the body, in water. Dr. Cobbold states that he has reared free, active embryos from these eggs by keeping them five months in water. The horses, most probably, swallow these embryos in the water that they drink.

These parasites, when numerous, will no doubt produce effects analogous to those caused in the human body by the preceding species, and the remedies will be similar.

The Round-worm of the Cat (*Ascaris mystax* Rudolphi).

Although very common in the cat, this parasite is of interest chiefly on account of its occasional occurrence in the human intestine.

It may be easily distinguished by the presence of peculiar

wing-like membranous expansions on each side of the head or anterior end of the body. The male grows to the length of two and one-half inches; the female sometimes becomes four inches long and one-twelfth in diameter.

This worm probably propagates its kind in a manner similar to that of the two preceding species, and no doubt gains admittance to the human intestine, as well as to that of the cat, by the medium of impure water and unclean vegetable food.

Its effects and remedies are the same as those of the common round-worm.

The Round-worm of the Hog (*Ascaris suilla* Dujardin).

This very closely resembles the *Ascaris lumbricoides* of man, and probably has nearly the same habits. It differs chiefly in the structure of the reproductive organs. The male spicules are not so sharp, and the tubes of the uterus are much longer. The eggs are smaller. It appears to be less common than the *Echinorhynchus gigas* in the intestine of hogs, and probably produces less injurious effects.

STRONGYLUS.

The genus *Strongylus* includes slender, filiform worms, mostly of small size, and often reddish in color. Several of them live in the windpipe and bronchial tubes of various animals, including sheep, deer, cattle, pigs, etc., and when numerous may occasion the death of the animals that they infest, by suffocation.

The body generally tapers toward the head, and sometimes in both directions. The mouth is small, situated at the end of the small head, which is either simple or with lateral expansions. It is sometimes surrounded by small papillæ, but is often simple, and either round or triangular, but not enclosed by a hard or chitinous organ, as in *Sclerostoma*, etc. The œsophagus is enlarged, club-shaped, and muscular.

The male has the posterior end of the body provided with an expanded, often lobed pouch, or bursa, for adhering to the female during copulation. The spicule is slender and filiform, enclosed in a sheath. In the female the posterior end is

conical or pointed, and the genital orifice is placed in advance of the middle of the body, or more rarely toward the posterior end.

The Strongylus of Sheep (*Strongylus filaria* Rud.).
Figure 80.

The present species is whitish, very long and slender. Th head is obtuse and without appendages, the mouth surrounded by three small papillæ. The caudal pouch of the male is entire, with ten rays (Figure 80). The male is about two and a half inches long, and the female three and a half, though generally not more than two or three inches long, the interior of the body of the female is mostly occupied by two long convoluted uterine tubes, containing eggs in which the embryos are in all stages of development. These open at an orifice situated at about one-third of the length of the body from the head.

Figure 80.

Habits.

This species lives in the lungs, air-passages, and bronchial tubes of sheep and other ruminants. They often occur, singly or several together, in cavities in the substance of the lungs, producing great inflammation and destruction of the tissue, which often results in the death of great numbers of lambs, and greatly injures the health of old sheep, even if it does not actually kill them. In this way many thousands of lambs are annually lost in certain districts in England. In this country we have far less information concerning the extent of its ravages, but have no reason to suppose that it is less common than in Europe, in localities that are favorable for its development. Sheep infested by this parasite continually cough up the eggs and embryos of the worms, and either discharge them directly from the nose or mouth, or swallow them

Figure 80.—*Strongylus filaria*, male, enlarged. From Thudichum.

and thus pass them with the fæces. In either case they will often adhere to grass and other herbage, and may thus be swallowed by other sheep or lambs, fed in the same pastures, and pass directly into the windpipe, or else do so when the cud is raised for mastication. Therefore lambs should never be put into fields or pastures where diseased animals have been kept, but such infected lands should be tilled, or at least left at rest for several months. As soon as an animal gives any indication of the presence of the parasites by the peculiar cough, it should be separated from the rest of the flock for treatment; or else immediately killed and the parasites should be effectively destroyed, and not thrown on the ground as harmless, for all these worms are remarkably tenacious of life, and often may even be dried up completely for months, and then revive when moistened.

Remedies.

When these parasites are once lodged in numbers in the substance of the lungs, there is probably no reliable remedy whatever. When merely in the windpipe and bronchial tubes, expectorant medicines that will produce a copious secretion of mucus may be useful. It might be possible to remove them by a surgical operation, opening the windpipe from the exterior, but this would require surgical skill and would not pay, perhaps, except as a last resort for valuable animals.

The Strongylus of Cattle and Horses (*Strongylus micrurus* Mehlis).

This species closely resembles the preceding. The male grows to the length of about one inch and a half; and the female to three inches or a little more. The body is very slender with a simple, blunt head. The bursa of the male has five rays. The female genital orifice is near the middle of the body. It is said to be viviparous.

The habits of this species are nearly the same as those of the last, except that this inhabits the air-passages of cattle, horses, asses, and mules, instead of sheep. It is much more liable, like the former, to infest young animals than adults. Calves less than a year old are particularly liable to be in-

vaded, and those that are once attacked seldom or never recover. The same remarks, concerning the means of prevention, made under the preceding species, will apply equally to this. If neglected, these parasites increase with great rapidity, and thus the disease that they cause appears like an epidemic, in certain localities destroying hundreds or thousands of animals, while adjacent farms may be entirely free from it.

The Strongylus of the Hog (*Strongylus parodoxus* Mehlis).

This is a slender, whitish or brownish worm, with a small, simple head. The mouth has three small papillæ. The œsophagus is long and muscular. The anus is situated somewhat in advance of the posterior end of the body at the summit of a small papilla. The male becomes half an inch or more in length, and has the caudal bursa bilobed, each lobe with five rays, the lateral ones divided. The female grows to the length of about an inch and a half, but is usually about an inch long; the tail is terminated by a point, turned to one side; the genital opening is near the posterior end and a little prominent. This species is viviparous. It inhabits the windpipe, bronchial tubes, and lungs of swine. Its history and the effects it produces are nearly the same as those of the *Strongylus filaria*.

The Strongylus of the Intestine of the Hog (*Strongylus dentatus* Rud.).

This is a slender filiform species, about half an inch long, which lives in the small intestine, cœcum, and colon of hogs. The head is obtuse and surrounded by six acute papillæ. The œsophagus is short and thick, muscular. In the male the tail is truncated and provided with an oblique bursa, formed of a single piece, strengthened by three subdivided rays; there are two slender spicules. The tail of the female is elongated and slender, ending in a fine point; the genital opening is near the posterior end.

The effects of this species and its history are little known.

The Strongylus of the Intestine of Sheep (*Strongylus contortus* Rud.).

This is a filiform species, tapering to both ends, but more slender toward the head, which is provided with two semi-elliptical, wing-like appendages; the mouth with three small papillæ. The male is about three-fourths of an inch long, with a bilobed bursa, each lobe with about eight rays; the sheath of the male spicule is very long. The female sometimes becomes four inches long.

It is not uncommon in the small intestine of sheep, but its history is very imperfectly known. When abundant it may, without doubt, cause serious trouble.

Strongylus filicollis Rudolphi.

This species also inhabits the small intestine of sheep. The body is very slender and whitish or reddish. The head has two, very small, lateral, wing-like appendages. The male bursa is bilobed, each lobe with six rays. It is from a third to four-fifths of an inch long.

Strongylus radiatus Rudolphi.

This worm lives in the small intestine and colon of cattle and several other ruminants. The head is simple; the mouth naked. The male is about half an inch long, with a bilobed caudal bursa, the lobes many rayed. The female is about three-quarters of an inch long; the genital opening is near the tail.

Its complete history is unknown.

The Kidney-worm (*Eustrongylus gigas* Diesing). Figure 81.

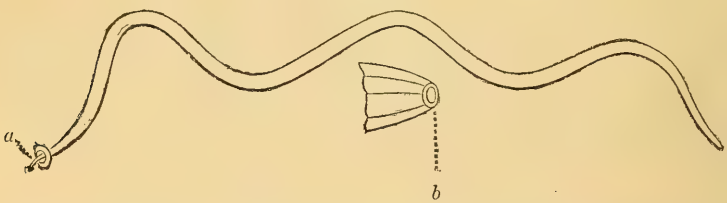
This is the largest of all the Nematode worms, the females sometimes becoming three feet long and half an inch in diameter, though usually much less. The body is smooth, cylindrical, tapering somewhat to each end, and more or less deeply tinged with red. The head is simple, obtuse. The mouth is terminal and surrounded by six rounded, chitinous papillæ. The male becomes ten to twelve inches long and one-fourth of an inch in diameter; the caudal bursa is cup-shaped, circular and entire, without rays; the male spicule or

penis is very slender. The female has a nearly straight, obtuse tail; the anus is triangular, near the end; the genital orifice is anterior, near the mouth; the ovaries and oviducts are simple, but long and convoluted. The intestine is large and blackish, with thin walls, and quite simple, running directly from one end of the body to the other, and is attached to the sides of the body, along its whole length, by fibres.

Habits.

This formidable parasite lives in the kidneys of man and various animals. It has been found in the dog, horse, cattle, hog, wolf, weasles, mink, otter, seal, glutton, raccoon, and coati. In this country it has been found quite frequently in the kid-

Figure 81.



neys of the mink. It has been found very rarely in the bladder, in the abdominal cavity, and, it is said, in the heart. In man it is very rare. When lodged in the kidney it gradually, but completely, destroys the substance of the organ, which becomes filled with purulent and bloody matter, upon which the worm feeds, while the walls often become hardened with calcareous deposits. The effects and symptoms are the same as in other acute diseases or abscesses in one of the kidneys. The only positive evidence of the presence of the worm would be the discovery of the eggs in the urine. It is probable that no remedy can be applied when the parasite is once lodged in the kidney.

The history of this worm is not fully known. According to Leuckart, a slender worm found coiled up in cysts in the muscles and peritoneum of fishes is the young or larva of some species of *Eustrongylus*. The larval form referred to

Figure 81.—*Eustrongylus gigas*, male, less than natural size; *a*, spiculum and bursa; *b*, anus of female, enlarged. From Guerin.

is the *Filaria cystica* Rudolphi, originally found in a Brazilian fish (*Symbranchus laticaudus*). It is, therefore, probable that the eggs or young embryos of *E. gigas* are swallowed by fishes, and in their bodies develop into the larval form and become encysted, and if then swallowed by some mammal, migrate into its kidneys to become sexually mature. The frequency of these parasites in those animals that feed chiefly on fish, such as the otter, mink, and seal, renders this view very probable.

The Gape-worm of Chickens, etc., (*Syngamus trachealis* Siebold). Figure 82.

This parasite lives in the windpipe and bronchial tubes of chickens, turkeys, pheasants, partridges, crows, wood-peckers, and many other birds. In young chickens and turkeys it often proves very destructive, by filling up the air passages, and thus quickly killing whole flocks. In some parts of this country at least three-quarters of all the young chickens and turkeys are sometimes destroyed by this parasite. The worms are reddish in color and have a smooth skin, but spiral depressions run around the body, giving it a twisted appearance. The reproductive organs show through the skin, as slender, whitish, convoluted tubes. The males and females are almost invariably found united firmly together, as shown in the figures, the integument of the male soon becoming organically united to that of the female, so that the copulation is permanent or for life. The females are very much larger than the males, becoming about three-quarters of an inch in length, and one-sixteenth of an inch in diameter. The anterior end, in both sexes, suddenly expands into a trumpet-shaped, concave disk, in the middle of which the mouth is situated, surrounded by six small chitinous lobes; the posterior portion of the body of the female is more

Figure 82.

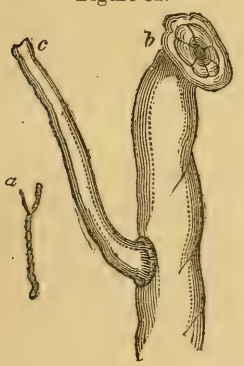


Figure 82.—*Syngamus trachealis* Siebold; *a*, male and female united, natural size; *b*, anterior part of female, enlarged; *c*, male, enlarged. From Cobbold.

or less bent and folded, and suddenly narrows at the end, terminating in a small point. The genital orifice is near the anterior fourth of the body, where the caudal bursa of the male is attached and conceals it. The male is only one-eighth or one-seventh of an inch long and very slender; the caudal bursa is simple, sucker-like, with an entire margin, strengthened by about ten rays; the penis consists of two very small, cylindrical spicules, about $\frac{1}{225}$ of an inch long. The eggs are oval, about $\frac{1}{350}$ of an inch long. The embryos develop while the eggs are still in the oviducts and uterine tubes, and the eggs or young probably escape by a rupture of the integument of the body of the female.

The history of the young worms, after they are expelled from the windpipes of the birds, is not yet known, however. Possibly they may enter the bodies of insects to pass their larval state, but it is more probable that they bury themselves in the surface of the soil or other moist places, and are thus picked up directly by the birds and gain admittance to the windpipe by their own active motions.

Symptoms.

The disease commonly known as "the gapes" is caused solely by the presence of numbers of these worms in the windpipe, which thus becomes so filled up as to render respiration difficult, and if in considerable numbers, by their growth the obstruction becomes complete, and death results from suffocation. Young chickens, thus attacked, seldom recover without special treatment for the removal of the worms. Chickens only three or four days old often show symptoms of the disease by opening wide their mouth and gasping for breath, and attempting to swallow. They also frequently sneeze. As the disease grows worse these symptoms become more marked; they continually gasp and struggle for breath, grow weak and dispirited, and finally droop and die. In fatal cases, one or two dozen of these worms are often found in the windpipe, completely filling it up.

Remedies.

The worms may be removed by a feather from which the web has been stripped, except a small portion near the tip.

This may be moistened with oil, salt-water, or a weak solution of carbolic acid, and introduced into the windpipe, when if it be twisted round once or twice and removed, it will usually bring away several of the worms. The operation should be repeated at intervals until all the worms are destroyed. All worms removed in this or any other way should be carefully destroyed, preferably by fire, for the embryos are extremely tenacious of life, and if left upon the ground are likely to spread the disease. For the same reason, those birds that are infected should be separated from the healthy ones, and poultry should never be allowed to run in the same yards or grounds, or be kept in the same houses where infected ones have previously been kept, unless the premises have first been thoroughly sprinkled with a strong solution of carbolic acid or petroleum-water, to destroy those old worms or the eggs and embryos that may have been discharged from the sick ones. The vessels from which they feed should be frequently and thoroughly cleansed, and they should be supplied with pure water, frequently renewed.

In extreme cases, the worms may be safely removed by a surgical operation; but this requires some skill. This is done by first carefully securing the bird, or still better by administering a few drops of chloroform, placed upon cotton and held to the nostrils. The skin of the neck is then to be divided with a very sharp knife, and the windpipe opened by a longitudinal slit about a quarter of an inch long. The worms may then be removed by a pair of small forceps or other suitable instrument. The incision in the skin may be closed by one or two stitches, and the wound will generally heal in a few days. By this operation an almost instantaneous cure may be effected, even when the disease has progressed nearly to the point of suffocation; but in unskilful hands it is not likely to be so successful as the remedies already described.

The Sclerostoma of the Horse (*Sclerostoma equinum* Dujardin, or *S. armatum* Davaine). Figure 83.

This is a small, slender, cylindrical worm, reddish or brownish in color, which lives in the intestines, and in peculiar enlargements of the arteries of horses, asses, and mules. The

head is round, nearly globular, supported by a chitinous bulb or capsule, truncated at the end, where the large, round mouth is situated. The mouth is surrounded by one to several circles of fine denticles, or converging hooks. The œsophagus is muscular and thick, club-shaped, separated from the intestine by a strong constriction.

The male is an inch or an inch and a quarter long, with a large, membranous, caudal bursa, divided into two lateral lobes, which are strengthened by numerous rays; there are two long and slender spicules. The female grows to the length of one and a half to two inches, with a long, tapering, caudal portion, the anus not terminal; the ovaries long and convoluted around the intestines, and showing through the integuments; the uterine tubes are double and contain great numbers of eggs, in which embryos are developed.

Habits.

This parasite is very common in the horse, generally living attached by the hooks of its head to the lining membrane of the intestine, particularly in the cœcum and colon, but sometimes in the small intestine and duodenum, and even in the pancreas. At the points where it adheres it causes small, dark-colored, raised spots. They sometimes occur in vast numbers in the large intestine, completely covering the surface; the number sometimes amounting, it is said, to a million or more. Ordinarily, however, these parasites, when lodged in the intestines, do not appear to produce any marked disease or notable symptoms, although when in great numbers, there can be no doubt but that they must cause some inflammation and pain. More serious results, sometimes proving fatal, happen when the worms enter the blood-vessels. They produce large aneurisms or dilations of the arteries, chiefly in the anterior mesenteric artery, but

Figure 83.

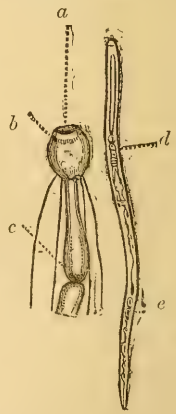


Figure 83.—*Sclerostoma equinum*, female, natural size; and anterior portion enlarged; *a*, mouth; *b*, circle of hooks; *c*, œsophagus; *d*, intestine; *e*, reproductive organs. From Cuvier.

also in the arteries of the colon, cœcum, small intestine, and liver, as well as in the posterior mesenteric and renal arteries, and others adjacent to the intestine. These tumors are generally fusiform, and as large as a man's finger; but they are sometimes globular, and may become as large as a man's head. The middle membrane of the artery in these dilations becomes enormously thickened, sometimes being twelve times as thick as in the healthy artery. In old tumors various hard or calcareous deposits often take place in the thickened walls or in the inner membrane; and in such cases, the walls being weakened, are liable to be ruptured by some unusual exertion of the animal, when death results almost instantly. In the interior of the aneurism there is generally a deposit of fibrin, firmly adherent to the inner surface. In this and in the different layers of the walls the worms are found, — sometimes only a few, but frequently large numbers. This disease is very prevalent among old horses. In France, as many as ninety-six out of one hundred have been found affected with the disease.

I am not aware that any remedies have ever proved useful. Generally it would be impossible to detect the disease during life, unless the tumors became very large.

Sclerostoma pinguicola Verrill.

On two occasions I have received specimens of a rather large parasitic worm, which lives in the fat of hogs. In the first case, five specimens were obtained, at New Haven, by Dr. M. C. White, from the fatty portion of a spare-rib; in the second instance, at Middletown, Conn., Dr. N. Cressy found large numbers of the worms in the fat about the kidneys of a young Suffolk pig, brought from New Jersey. Unfortunately, none of these specimens are in so good a state of preservation as to enable me to determine with certainty all the points of their structure. Those which I owe to the kindness of Dr. White, had been mounted in glycerine as microscopic objects and pressed out flat, before they came into my possession, and the tissues were thus injured and the organs deranged. Those from Dr. Cressy, were both pressed flat and dried. Yet by careful masceration, and with much labor, I believe that most of the important char-

acters have been made out. The body is rather robust, especially in the female, and tapers to both ends; the color is yellowish white, and the integument is seen to be finely striated transversely, when considerably magnified. The head is smaller than the body, truncated at the end; the mouth is terminal, roundish, or somewhat angular, surrounded by the thickened rim of the chitinous capsule, or pharynx. This chitinous ring rises at intervals into four to six denticles, or very small teeth, which correspond to thickened longitudinal, chitinous bands, that strengthen the pharynx, and give a slightly angular form to the mouth. The pharynx itself is small, short, and rather squarish, when seen in profile, and has three or four small, conical teeth at the bottom. The œsophagus is thick, club-shaped, and very muscular.

Figure 83 *a*.

The male is 1.12 of an inch long, and about .05 of an inch in diameter; the tail ends in a small blunt lobe, united with two small, entire, membranous expansions, one on each side, forming a small bursa, which is strengthened by several short rays, the exact number of which could not be determined in my specimens; there are two long, slender spicules. The females are 1.25 to two inches in length, and, as flattened between glass, they are .10 to .13 of an inch in breadth. The posterior end suddenly and obliquely narrows to a small conical point, which is turned to one side. The anal opening is close to the end, and the genital orifice appears to be adjacent to it. The oviducts are long, voluminous, much convoluted, and unite in a large and capacious uterus, which fills most of the cavity of the body near the posterior end. The uterus and oviducts are both filled, in the larger specimens, with immense numbers of small oval eggs.

It is probable that this parasite is by no means uncommon.

Pentastoma tænioides Rudolphi. Figure 84.

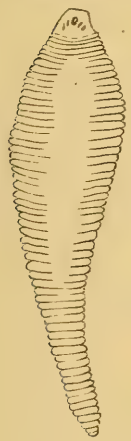
This parasite is not a true worm, but is now generally re-

Figure 83 *a*.—*Sclerostoma pinguicola*; *a*, male, natural size; *b*, posterior end, enlarged; *c*, female, natural size; *d*, head, enlarged. Original.

garded as belonging to the Acarians, with the true mites. In the adult state it inhabits the nostrils and frontal sinuses of dogs and wolves, and more rarely, of horses and sheep. The larvæ, formerly described under the name of *Pentastoma denticulatum*, lives in cysts on the outside, or in the outer portion, of the liver of sheep, deer, antelopes, peccary, porcupine, Guinea-pig, rabbit, hare, rat, and cat; and sometimes invades the human body in the same way. It has also been found free in the visceral cavity of the body.

In the mature state (Figure 84) the body is long, lance-shaped, tapering behind, flattened below, and divided into about ninety segments by transverse lines. The segments next to the head bear two pairs of small, but strong and sharp, retractile claws, which represent the true legs of ordinary mites. The mouth is broad-oval, and provided with a hard chitinous lip. The segments behind the head are perforated by small openings, regarded by many as spiracles, or breathing pores. The adult is smooth, but the larvæ are covered with many rows of small, sharp spines. The male is only .07 to .08 of an inch in length, but the female becomes three or four inches long, and half an inch wide. The female genital opening is in the tail, that of the male, in the middle of the front part of the abdomen. They are oviparous, and the young undergo a complete and remarkable metamorphosis.

Figure 84.



The adults live in the nasal cavities of dogs, and produce an irritation of the delicate membranes, which causes a flow of mucus, often accompanied by sneezing. The eggs discharged with the mucus may adhere to vegetables or fruit, or get into drinking-water, and in these ways gain admittance to the stomach of man, or other animals. In the stomach they hatch into minute embryos, furnished with a boring apparatus and two pairs of double claws. They bore their way through the intestines and lodge in the liver or other parts, and soon become dor-

mant and enclosed in cysts, in which they pass a sort of pupa state. During this period of their life, the skin is cast several times, and the appearance changes at each moult, until they attain the next period of their life, when they again become active; this is the state described as *Petastoma denticlatum*. These larvæ are long-oval, broadest anteriorly, and covered with numerous rows of transverse tooth-like spinules. They have two pairs of sharp, curved claws, which are situated near the mouth and placed obliquely, diverging from the median line of the body, and directed downward. Each claw has a sort of hood or capsule, into which it can be retracted. If dogs feed on the liver or other viscera of animals containing these larvæ, they come in contact with, and manage to enter the nose, working their way up by means of the motions of the body, aided by their spines and claws. In this situation they gradually become mature.

In the human body the larval form is quite frequent, especially in some parts of Europe; but there is little known concerning the effects that it produces. When in small numbers, it probably causes very little disturbance, but if in large numbers, in the liver and lungs, it would no doubt produce serious disease, as does another species (*P. constrictum*), which is very common in Egypt, living in the same way encysted in the liver and lungs. The latter, when in considerable numbers, frequently proves fatal.

As a means of prevention, dogs that show symptoms of the parasites in the nose, should be treated to a solution of carbolic acid, thrown up the nostrils by a small syringe. Feeding dogs with the offal of slaughter houses, or with uncooked livers, etc., should be avoided, both on account of this and the other dangerous parasites that they get in this way, (see *Tænia echinococcus*, p. 202, *T. marginata*, p. 192, *T. cœnurus*, p. 196, and *Trichina spiralis*, p. 222). Too much familiarity, especially of children, with dogs is always liable to result in the transfer of these and other parasites to the human body.

In making up the author's copies, and revising, several errors have been introduced, which the reader should correct:—

Page 3 third line of foot notes, for *Corydalus cornutus*, read *Corydalis cornutus*.

" 8, " 31, for pain, read pains.

" 12, " 13, for Ichim, read Ishum.

" 13, figure 18 is inverted.

" 17, " 17 for page 89, read page 15.

" 18, " 10, for page 109, read page 85.

" 49, " 31, for page 109, read page 85.

" 60, " 10, for *nemorum*, read *cinereum*.

" 61, " 23, for page 101, read page 80.

" 86, " 6, for page 101, read page 80.

" 100, " 34, It should be stated that Dr. Cobbold, in 1860, fed dogs with a small specimen from the liver of rabbits, but distinct from "*C. pisiformis*," and obtained specimens of *Taenia cucumerina*, which he thought were developed from them.

" 110, " 30, for "such dogs are," read such a dog is.

" 110, lines 32 and 33, for page 202, read 91; for 132, read 91; for 136, read 85; for 222, read 111.

ERRATA.

In making up the author's copies, and repaging, several errors have been introduced, which the reader should correct:—

Page 3 third line of foot notes, for *Corydalus cornutas*, read *Corydalis cornutus.*
" 6, line 19, for orceps, read forceps.
" 8, " 31, for pair, read pairs.
" 12, " 13, for labium, read labrum.
" 13, figure 18 is inverted.
" 47, " 17, for page 89, read page 16.
" 48, " 10, for page 109, read page 38.
" 49, " 31, for page 109, read page 38.
" 60, " 10, for *nemarum*, read *venarum.*
" 61, " 23, for page 101, read page 30.
" 85, " 5, for page 191, read page 80.
"100, " 34. It should be stated that Dr. Cobbold, in 1860, fed dogs with a small *cysticercus*, from the liver of rabbits, but distinct from "*C. pisiformis*," and obtained specimens of *Tænia cucumerina*, which he thought were developed from them.
"110, " 30, for "such hogs are," read such a hog is.
"126, " 6, for page 191, read page 80.
"140, lines 32 and 33, for page 202, read 91; for 192, read 81; for 196, read 85; for 222, read 111.