

branch bipartite to tip (Fig. 3563). Species otherwise similar to *U. duodenalis*.

This form has only just been differentiated by Stiles from the long known European *U. duodenalis*, from which in fact it differs radically. It has been obtained from cases of uncinariasis in man in Texas, Virginia, Florida, Porto Rico, and Cuba, and its wide occurrence goes to show that the parasite, though not recognized hitherto, is endemic in the Southern States, where it causes the most common disease on the farms and among the poor whites. The life history of the parasite is unknown, though the early stages correspond to those of *U. duodenalis*. The cases of the disease have been collected and abstracted by Stiles, who holds with evident right that it is not a recently imported disease, but has existed unrecognized for years. It has been traced from Virginia to Florida, and is most abundant in sandy areas. Guiteras has also an unpublished case from Brazil.

*Physaloptera caucasica* von Linstow 1902.—Cuticula heavy, non-striated, forming a projecting ring about the head, within which a pair of equilateral lips bear four papillae in the submedian line and two conical teeth near the mouth opening. Oesophagus one-fifth the entire length; lateral lines strongly developed. Male, 14.22 mm. long by 0.71 mm. broad; bursa broad, rounded, with central longitudinal rows of small conical papillae; spicules two unlike; lateral to the cloacal orifice two pairs of long stalked papillae, in front one pair, behind two pairs, on the tail three pairs more. Female, 27 mm. long, 1.14 mm. broad, vulva at one-sixth the length from the anterior end; eggs heavy shelled, 57 by 39  $\mu$ .

The single account of this species by O. von Linstow is based on specimens, two males and nine females, in the collection of the museum at St. Petersburg, Russia. They are said to have been taken from the alimentary canal of man in the Caucasus. Further details are not given.

Family of the Ascaridae.—Body relatively thick; mouth surrounded by three lips, one of which is dorsal, the others ventrolateral; oesophagus long, muscular, inflated at the end and often accompanied by an oesophageal bulb; male with one or two spicules; female with double ovary, oviparous; development direct. All are intestinal parasites.

*Ascaris* L. 1758.—Polymyaria, with very prominent lips; males with two equal spicules and many preanal and postanal papillae; vulva in advance of centre of body. More than two hundred species are recorded; three have been reported from man.

*Ascaris lumbricoides* L. 1758.—Body reddish or grayish-yellow when living; spindle-shaped; lips (Fig. 3566) almost similar, approximately semicircular, with fine teeth on the edges, the dorsal possesses two papillae, and each of the ventral ones only a single papilla. Male, 15-17 or even 25 cm. long and 3 mm. thick, with the posterior end curved toward the ventral face; spicules two, short, 2 mm. long; papillae fifty-five to sixty preanal and

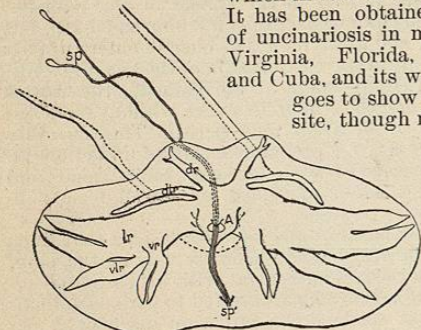


FIG. 3563.—Bursa of *Uncinaria americana*, Showing Ribs (dr, tr, etc.). a, Anus; sp, spicules. Magnified. (After Stiles.)



FIG. 3564.—Eggs of *Uncinaria americana* from Faeces.  $\times 235$ . (After Stiles.)

seven pairs postanal. The female, 20-25 or even 40 cm. long and 5-5.5 mm. thick, with straight conical posterior end. The female sexual opening at the limit of the anterior third of the body, and situated in a ring-shaped depression. Fertilized eggs (Fig. 3567) elliptical, shell with transparent mammillated covering, 50-75  $\mu$  long by 40-58  $\mu$  wide, laid before cleavage begins. Unfertilized eggs, irregular, with scanty albumin covering, coarser granules, and thinner shell, measuring 81 by 45  $\mu$ .

This, the common round worm of children, is one of the most abundant and widely distributed of human parasites. It is distributed over the entire world, and though more abundant in the warmer regions, is recorded from Finland and Greenland. It is also more common in the country than in cities, which may be due to the presence of the same species in the pig and sheep. This parasite was well known to the ancients, both the Greeks and the Romans, although the *ασκαρίς* of Greek authors is the form now known as *Oxyuris*.

Life History.—The development of the eggs does not begin until long after they have been expelled from the human intestine, and is dependent upon both moisture

and warmth. Under mean temperature the embryo is completed in from thirty to forty days, and then lies in a spiral within a thin shell, which it does not seem to leave so long as the egg remains free, though it undergoes a moult here. The embryo may live long within the shell, even up to five years. The further development was believed by Leuckart to require the intervention of another host in which a larval stage is passed, but Davaine was successful in hatching the embryos in the intestine of the rat, and believes that the intervention of a second host is unnecessary. Subsequent experiments by various authors have strongly confirmed this view by raising experimentally adults in the human alimentary canal two months after the ingestion of eggs containing embryos. Accordingly the eggs are probably introduced into the human system with the embryo within by accident or by means of the drinking-water. The embryo is then set at liberty in the alimentary canal, and further development is merely growth. Of course the infection may be brought about by the means of contaminated vegetables, especially salads, which have been imperfectly cleaned.

Pathology.—It has already been mentioned that the worms are most frequently found in children of medium growth, but this is due to the ease of infection rather than to conditions for development, since the worm has been obtained from persons of all ages. Ordinarily one

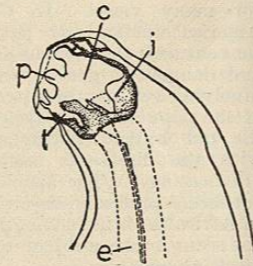


FIG. 3565.—Lateral View of Head of *Uncinaria americana*. c, Oral capsule; e, oesophagus; i, stylet; p, papilla; t, dorsal median tooth. (After Stiles.)

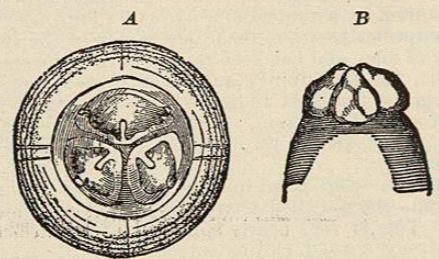


FIG. 3566.—Anterior End of *Ascaris lumbricoides*. A, Apical and B, Dorsal Aspect.

finds only a few specimens at once, but in some cases from five hundred to one thousand have been obtained from a single individual. It is noteworthy that haemoglobin has been detected in the alimentary canal of the

parasite, showing that its food consists in part of human blood. Their normal location is the small intestine, but specimens not infrequently wander into the stomach and are vomited. Rarely they have been known to make

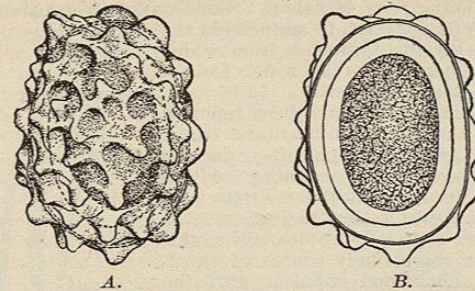


FIG. 3567.—Egg of *Ascaris lumbricoides* from Faeces. A, In surface view and B in optical section. (After Stiles.)

their way into the pharynx and choanae, with the result of causing fatal suffocation both in children and in adults; also into the Eustachian tube or ductus choledochus, and they have even been found in abscesses of the liver.

Recently a number of unimpeachable cases have been brought forward in which the worm has bored its way through the uninjured wall of the intestine and has been found in the peritoneal cavity. Their presence here after having pierced abscesses of the wall is also known, and in some cases even, in which adhesion of the intestinal to the abdominal wall was present, the worm emerged from the body through an abscess at this point. In fevers the Ascaridae will spontaneously desert the intestine.

It is evident that these wanderings are associated with great danger to the host. The presence also even of a few individuals in the intestine gives rise at times to marked nervous disturbances, hysteria, epileptic attacks, congestion of the brain, aphonia, etc., which are most easily explained on the basis of a poison excreted by the worms. In fact, recent investigators have been able to obtain such a toxic substance from the body of this species, and students in the laboratory handling specimens of *A. megaloccephala* from the horse have been distinctly affected by poisonous emanations. The symptoms disappear with the removal of the worms. Moniez, however, is inclined to attribute the troubles in large part to the use of santonin for the expulsion of the worms, as this substance has an unfavorable effect upon the human organism. Guiart has called attention to the important fact that the parasites by their movements produce lesions of the wall so as to afford a point of attack for intestinal fevers, and thus become a source of great danger for the host. Knotted masses of this parasite have also been the cause of fatal intestinal obstruction.

Treatment.—In general opinion santonin is the specific against *Ascaris*, and no one of the many other substances tried has achieved the same results. Moniez advises the use of centigrams equal to the number of years in a child's age, and for an adult 20-25 cgm. The drug kills the parasites, and the administration at the same time of a purgative is advantageous in bringing about their immediate expulsion. Careful watch should be kept for the violent symptoms which sometimes accompany the use of santonin and means taken at once to counteract them.

*Ascaris canis* Blanchard.—(Syn.: *Lumbricus canis* Werner 1782; *A. teres* Goeze 1782; *A. cati* and *canicula* Schrank 1788; *A. canis* and *felis* Gmelin 1789; *A. tricuspidata* and *felis* Bruguière 1791; *A. Wernerii* Rud. 1793; *Fusaria mystax* Zeder 1800; *A. marginata* and *A. mystax* Rud. 1802; *A. alata* Bellingham 1859.)

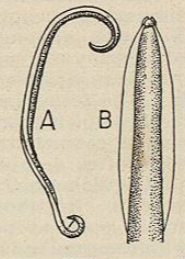


FIG. 3568.—*Ascaris canis*. A, Male. (Natural size.) B, Head showing papillae and wings. Magnified. (Original.)

Anterior end ordinarily curved and provided with two wing-like membranes which extend one along each side (Fig. 3568), lips almost equal, three to six-cornered. Male, 40-90 mm. long, 1 mm. broad, with twenty-one preanal and five postanal papillae. Female, 120-200 mm. long, vulva in the anterior fourth of the body; eggs almost spherical with thin shell, 0.068-0.072 mm. in diameter.

An abundant parasite in the small intestine of cats and dogs and also reported from various allied wild species, it has been found several times in man in England, Germany, Denmark, and the United States. Grassi doubts the accuracy of these determinations since experimental infection was not successful.

The development is direct and in general like that of the preceding species. The thin shell is highly impervious so that development continues in alcohol, turpentine, etc. It is probable that the embryo does not desert the shell until taken into the stomach of the host.

*Ascaris maritima* Leuckart 1876.—Known only from a single immature female, which was vomited by a child in North Greenland in 1865. The specimen was 43 mm. long and 1 mm. broad, and is regarded by some authors not as a normal parasite, but as one accidentally ingested with the viscera of some food animal. According to Leuckart it is very near *A. transfuga* of the bears.

*Oxyuris Rudolphi* 1803.—Three lips poorly developed or wanting; oesophagus long and provided with a distinct bulb. Male with only one spicule and with two pairs of preanal papillae. Female with greatly elongated, pointed posterior end, two ovaries and vulva in anterior part of the body.

*Oxyuris vermicularis* Bremser 1819.—(Syn.: *Ascaris vermicularis* L. 1767; *Fusaria vermicularis* Zeder 1803. Oesophagus long and followed by a distinct bulb with teeth; body white, cuticula striated, forming wing-like projections from the dorsal and ventral surfaces near the head and also a low crest along the lateral lines of the body; three small retractile labial papillae. Male, 3-5 mm. long, with spirally rolled tail; a single spicule and six pairs of papillae. Female, 9-12 mm. long, 1 mm. broad, tail awl-shaped; vulva a little in front of the limit of the anterior fourth of the body; eggs elliptical, thin-shelled, 50-54  $\mu$  long by 20-27  $\mu$  wide, containing an embryo when deposited (Fig. 3569).

This species, known from remote antiquity, is a cosmopolitan parasite of the human intestine. It has not been definitely recognized as a parasite of other animals, but Leidey's *O. compar* from the cat is very likely the same form. It is more abundant in cities than in the country, and occurs equally in cold and warm regions. These parasites are most abundant in infants, a fact which accords with the ease of auto-infection as shown by the development.

Life History.—The embryo develops within the egg shell while still contained in the uterus, and it was long thought that the further development could take place



FIG. 3569.—*Oxyuris vermicularis*. a, Female; b, male; c, posterior end of latter; d, egg with embryo; t, vulva; sp, spicule. Magnified. (After Leuckart.)

in the canal. In fact, however, the female at the time of oviposition lives in the lower part of the rectum and even attains the vicinity of the anus, although the earlier portion of the adult life history is passed in the small intestine, where the worms acquire sexual maturity and copulate. Evacuated from the body, the embryo undergoes transformation to the second embryonic stage while still within the egg shell, and now awaits ingestion by a new host. The primary infection is by drinking-water or contaminated fruit or vegetables, which are eaten uncooked; but self-infection and transference to other individuals are brought about by scratching and rubbing with the fingers to allay the intense itching caused by the daily migration of the females out from the anus on to the perineum and the surrounding parts. Perhaps in the distribution of *Oxyuris* eggs the flies play a part such as Grassi has demonstrated for *Trichocephalus* and eggs of *Tenia*. The direct development is very rapid, as Leuckart obtained experimentally *Oxyurides* 6-7 mm. long within fourteen days after ingestion of the eggs; Grassi and others have confirmed this by further experiments.

Pathology.—The females are far more numerous than the males, and by their migrations determine unbearable pruritus, which recurs periodically on retiring. In a number of cases among young girls the worms have migrated into the vagina and have produced onanism, and even the inception of nymphomania. In many cases large numbers in the rectum have excited no untoward symptoms, but in others they have produced reflex nervous activities of all grades up to epileptic attacks, such as have been noted under *Ascaris*. Recent investigations in Egypt have demonstrated the responsibility of this parasite for nodules on the rectal wall, previously attributed to *Schistosoma*, which contain eggs of *Oxyuris vermicularis* in a calculus. *Oxyuris* has also been recorded in tuberculous nodules in the cavum Douglasii of a female, and Vuillemin has recently discovered them in a tumor near the anus of a boy. The latter case shows definitely the wandering of the worms through 2 cm. or more of solid tissue. This habit exhibits a new and evidently dangerous feature in the parasitism of this species through the disturbance of the tissues and the introduction into them of bacteria from the rectum.

Treatment.—It is difficult to remove these worms entirely. Vermifuges and purgatives with enemata, etc., are successful to a degree; but the ease of auto-infection is an obstacle to a complete cure. Local application of mercurial ointment will alleviate the pruritus, and manual extraction, if prolonged, will reduce their numbers rapidly. But in any event treatment is prolonged.

The sub-class of the Gordiacea includes forms familiarly known as "hair snakes" or "hair worms." They are greatly elongated, slender worms, somewhat filaria-like in external appearance, but of radically different internal structure. Lateral fields are wanting, and the body musculature is of a different histological type from that of the Euneematoda. The mouth is occluded and the alimentary canal persists in the adult only as a functionless vestigial strand. In both sexes the reproductive organs open to the exterior with the alimentary canal at a terminal or subterminal cloaca. The reproductive system is constructed on a different plan, and the lateral canal system is wanting.

The male has no spicules, but the posterior end of the body is forked and functions as grasping organ. The adult lives free in ponds, swamps, and other bodies of water, and the eggs are deposited on the stems of

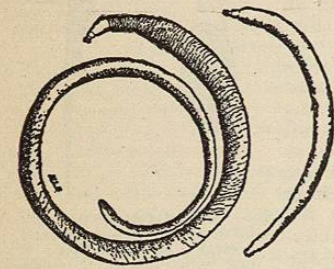


Fig. 3570.—*Gigantorhynchus gigas*. Male at right, female at left. Half natural size. (Original.)

water plants. The larva possess a proboscis armed with hooks and bore into the body cavity of aquatic insect larvae, or rarely mollusks, where they encyst. According to Villot the second stage is passed in the intestine and body cavity of fishes. More commonly apparently the worms develop to maturity in the body cavity of insects, from which they emerge into the water for the adult free existence.

Several species have been reported from the human alimentary canal. They are pseudoparasites, having been swallowed, according to one view, in the adult condition with drinking-water; but their occurrence in fruit, especially apples, makes this even a more likely source of infection. Lockwood noted in 1876 the frequent presence, in fruit, of *Mermis*, another genus of Euneematoda, and suggested the probable occurrence of this form as a pseudoparasite of man under conditions; this has not been actually recorded so far as I find. But of *Gordius* as a pseudoparasite Parona has recently listed eleven cases, the first as early as 1638; of these Kirtland's (Ohio) is the only one from the United States. Two other unpublished cases have recently been communicated to me from Michigan and Maryland. It will be of no particular value to enter here upon a detailed description of the species found.

The Gordiacea are, however, emphasized by Cobbold as important for the medical practitioner, since they have been passed off as the guinea-worm and as having been evacuated with fecal matter by neuroathenic persons under treatment.

The Acanthocephala may best be discussed as an appendix to the class Nematoda, although they are regarded by many as a cognate class and by others are separated even more widely. The forms included here, though parasites of the most complete type, are not common in man. The group may be characterized as follows: Elongated, cylindrical body, often deeply corrugated, bearing at anterior end a retractile proboscis provided with many minute hooks in rows. No trace of alimentary canal. Reproductive organs open at posterior end; sexes separate. Male with campanulate bursa about the orifice. Mostly small forms, parasitic as adults in vertebrates only. The structure is uniform, and can be learned from the brief account which follows of the largest and commonest species.

*Gigantorhynchus gigas* Hamann 1892.—(Syn.: *Tenia hirudinacea* Pallas 1781; *Echinorhynchus gigas* Goeze 1782.)

Body milk white, sometimes slightly tinted, with transverse irregular ridges. Posterior end somewhat smaller; proboscis spherical, armed with five or six rows of hooks. The proboscis can be retracted into a neck-like region, which is much slimmer than the following portion of the body. Male, 60-90 mm. long by 3-5 mm. broad, with bell-shaped caudal pouch. Female, 230-350 mm. long by 4-9 mm. broad; tail blunt; eggs almost cylindrical, 0.087-0.1 mm. long with three embryonic envelopes.

The adult worm is found in the small intestine of the pig, ordinarily fixed to the wall by the proboscis, and is widely distributed.

Structure.—The elongated body (Fig. 3570) is largest near the head and tapers gradually toward the posterior end. At the anterior end a sharp constriction separates

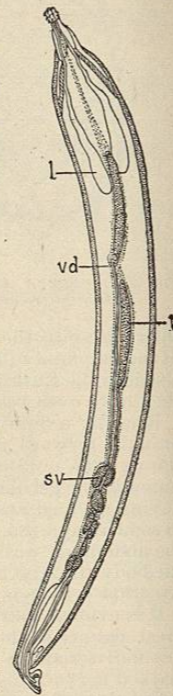


Fig. 3571.—*Gigantorhynchus gigas* Opened to Show Internal Anatomy. t, Lemniscus; sv, seminal vesicle; vd, testis; vd, vas deferens. Modified. (Original.)

the body from the short neck portion, which is not more than one-fourth or one-fifth the diameter of the body close to it. From the apex of this region may be projected the proboscis which is contained within it, like the reversed finger of a glove. As the proboscis rolls out the hooks also turn outward, and when the proboscis is completely extruded the shape of the organ is nearly that of a sphere on which are from five to six irregular rows of hooks. Behind these the proboscis is slightly smaller.

If the internal structure be examined, it will be seen that the proboscis is provided with retractor muscles, by means of which it may be withdrawn into the body. At the base of the proboscis is the small mass of nervous matter which represents the brain. There is no trace of an alimentary canal, hence these forms, like the tapeworm, take nourishment by absorption. Two elongated sac-like organs hang down into the body cavity along the sides of the proboscis. These are the lemnisci (l. Fig. 3571); their function is uncertain.

The mass of the body is made up of the organs of the reproductive system. All these worms are dioecious. The male organs (Fig. 3571) consist of two large testes, together with the ducts and accessory glands connected with them. The tail of the male has a hemispherical expansion, something like the caudal bursa of other Nematoda; the male sexual opening in the centre of this sac at the tip of the body is provided with a small copulatory organ. The internal sexual organs of the female are much similar in general appearance; the ovaries lie toward the front of the body cavity, which is largely filled with eggs in various stages of development. These are discharged by the oviduct, which opens at the posterior end of the body.

Life History.—The eggs of *Gigantorhynchus* are discharged from the alimentary canal of the host and distributed with feces. When eaten by some insect they are hatched in its intestine. The embryo, which has a conical form armed at one end with four hooks like tapeworm hooks, and a number of smaller ones, penetrates into the abdominal cavity of the insect and encysts there. In this condition the embryos may even live through the metamorphoses of the insect until the host is eaten by some pig. In the alimentary canal of the pig the embryo is set free, attaches itself and acquires maturity. There is some dispute as to what insect is the intermediate host; the white worm-like larva of the May bug and the larva of the common rose chafer have been found to contain these worms in Europe, and Stiles has experimentally infected the larva of the June bug in this country. It is also maintained that various species of snail may function as the larval host. In all probability the larva is not confined to a single host, but may develop in many.

Leuckart accepts some reports of the occurrence of this species in man as trustworthy, and Lindemann says that it is not rare as a human parasite in Southern Russia. Schneider notes the consumption, as food, of the larvae and adults of *Melalontha*, the May beetle, which acts as the intermediate host, so that infection is evidently possible.

*Gigantorhynchus moniliformis* (Bremer 1819).—Body attenuated anteriorly. Proboscis, 0.425-0.450 mm. long, 0.175-0.19 mm. broad, with hooks in fifteen transverse and twelve longitudinal rows. Male, 4-4.5 cm. long. Female, 7-8 cm. long, or even up to 27 cm., according to Westrumb. Eggs ellipsoidal, 85 μ long, 45 μ broad.

The normal hosts of this species are field mice, rats, etc., and the intermediate host in Italy has been determined as *Blaps mucronata*. Calandruccio in experimenting on the life history succeeded in infecting himself with the adult. The severe symptoms which manifested themselves were dispelled by the evacuation of the worms. In other cases of the occurrence of this species as a human parasite its identity was less definitely established.

*Echinorhynchus hominis* Lambl 1859.—Length, 5.6 mm.; width, 0.6 mm.; proboscis almost spherical with twelve transverse rows of eight hooks each. Large hooks, 103 μ long, small hooks, 77 μ.

An uncertain species of which Lambl found a single specimen at Prague in the small intestine of a boy who had died of leukæmia.

*Echinorhynchus* sp. Welch 1872.—In 1872 Welch described as *Echinorhynchus* a body which he found encysted in the mucosa of the jejunum of a soldier. According to Railliet it was evidently a Linguatulid (see *Arachnida*).

*Echinorhynchus* sp. Moniez 1896.—Kunstler and Pitres found certain peculiar bodies in the pleural cavity of a patient who had suffered two years from pleurisy, but without fever. They interpreted these structures as coccidia, but Moniez holds with greater probability to their likeness to eggs of *Echinorhynchus*. The case is entirely isolated under either explanation.

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NEOPLASMS. See *Tumors*.

NEPHRECTOMY; NEPHROTOMY. See *Kidneys, etc.*

NERVES, GENERAL PHYSIOLOGY OF.—HISTOLOGICAL AND GENERAL.—Nerves consist essentially of the long, slender processes of nerve cells. They are hence composed of protoplasm, and they possess the general chemical and physical properties of this substance; but they differ physiologically from other forms of protoplasm, in that they possess to a high degree the properties of conductivity and excitability, while the properties of growth, metabolism, respiration, and contractility are feebly developed or altogether absent. There is in these respects a marked physiological difference even between the nerve and the cell body from which it arises. Many of the reactions of the cells to external conditions are the opposite to the reactions of the nerve. The cell generates nerve impulses; it possesses spontaneity or automatism, absent in the fibre; it is closely dependent on a supply of oxygen, while the nerve is almost independent; it has an active metabolism, which the nerve lacks almost entirely; it respire, while the nerve respire little or not at all; it or some of its dendritic processes may be contractile, the nerve has lost this property altogether. The physiology of the nervous tissue, which includes nerve cells, differs therefore in many respects from that of the nerves proper, which we shall consider here. In short, the nerve cells possess pre-eminently the property of automatism or spontaneity; the nerve fibre, the property of conduction.