

visible in a segment taken about 40 to 50 cm. from the head. The general structure of these organs has been described above. Characteristic for this species are the two ovaries of unequal size, that at the pore side being the smaller and without the small accessory lobe cut off by the vagina as in *T. solium*. The whole proglottis has a more open aspect, and the various organs show relatively greater antero-posterior diameter than in *T. solium*. The uterus in the ripe proglottis (Fig. 1207) manifests a more crowded structure, the lateral branches are slenderer and more numerous, and two or three are stunted or lacking opposite the sexual pore.

**Development.**—In 1861 Leuckart fed ripe proglottides of this species to calves and succeeded in obtaining the then unknown cysticercus, although various facts had pointed out cattle as the probable intermediate host. These results have been confirmed by many other investigators. At six weeks the size of the cysticercus (Fig. 1211), shelled out from its cyst, is: length 3 mm., breadth 5 mm., diameter of the head 1 mm.; at twelve weeks corresponding measurements are 4, 4, 1.8 mm. (length of head); at twenty-four weeks, 6, 4, 2 mm.; at forty-eight weeks 7, 5, 2.5 mm. The length of life of the cysticercus is brief; at less than eight months they have been found completely calcified. A temperature of 47° to 48° C. is always fatal. Of course the internal portions of roasting pieces are often far from reaching this temperature. On the other hand exposure to cold-storage conditions for three weeks is sufficient to destroy all these cysticerci contained in a piece of beef.

Artificial infection of man with the adult by eating flesh containing living specimens of *Cysticercus bovis* has been tried with equal success. An average growth of 72 mm., or about thirteen to fourteen proglottides daily, was determined.

**Anomalies.**—*T. saginata* appears to be peculiarly subject to variation and malformation. Excessive pigmentation of the head and chain led to the establishment of the species *T. nigra* Laboulbène (1875) for a tapeworm expelled by a Frenchman who had lived for some time in the United States. Two genital pores, on the same or opposite margins of the proglottis, but each connected with a set of reproductive organs, indicates the probable disappearance of the segmental boundaries, and this may be manifested over a considerable stretch of the worm, giving the appearance of an unsegmented body. Welch has observed such an unsegmented region 5 cm. in length. Intercalated proglottides or roughly triangular joints are not of infrequent occurrence.

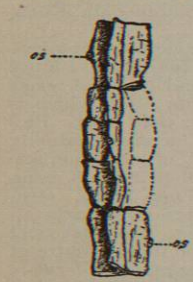


FIG. 1217.—Portion of the Chain from Prismatic Specimen of *T. saginata*. Showing also the Occasional Separation of the Three Wings for a Short Distance. os, Sexual Pore. Natural size. (After Cattaeart.)

Onchospheres of *T. saginata* have been observed of considerable size, and armed with from twelve to twenty-two hooks; and Cobbold has described specimens of *Cysticercus bovis* from the heart of a calf with only three, two, one, and even no suckers on the head.

The form described by Weinland as *T. solium* var. *abietina*, from a specimen collected by Agassiz from a

Chippewa Indian, is regarded by many as a small specimen of *T. saginata* with unusually dense and delicate branches of the uterus (Fig. 1218).

**Distribution.**—The adult occurs only in man and is cosmopolitan. Its presence in the Orient is recorded in writings of great antiquity; in Africa, Europe, and America it is also abundant, and its frequency has increased during recent years, whereas the contrary is true of *T. solium*. The evident reason lies in the custom of eating beef rare, but pork well done. The figures given by Bérenger-Féraud for French maritime hospitals during the six quinquennial periods from 1861 to 1890 show a steady relative increase of cases from 0.2 to 14.8 per mille. In Paris the increase, though real, was much less, being from 0.3 to 0.6 per cent. in the same time.



FIG. 1218.—Ripe Proglottis of *T. saginata* (= *T. saginata* var. *abietina* Weinland. (After Weinland.)

The larval form, *C. bovis*, has been produced experimentally in rare instances in other hosts, sheep and goat, but many experiments on these and other hosts have been entirely without results. In its normal host (cattle) the bladder worm was apparently rare, even in regions where *T. saginata* occurred abundantly. This apparent contradiction has been explained by the demonstration that in most cases normal infection is only mild and the cysticerci are so small and scattered as not to be easily found in the beef. Their predilection recently discovered for the pterygoid muscles affords, however, a surer means of diagnosis now than was formerly known.

A limited number of observations on the presence of *C. bovis* in man are on record. They include cases from the brain and eye, and the determination of the species rests on the absence of hooks and rostellum. Since, however, these organs may be wanting in *C. cellulosa*, the larva of *T. solium* (q. v.), the determination in the cases under discussion must be viewed with suspicion.

**Pathology.**—Most common in hosts between twenty and forty years of age, the beef tapeworm has been encountered in the aged and even in newborn infants. Its normal place of fixation is near the pylorus, where the head is firmly fastened to the mucosa by its suckers. It may, however, be found exceptionally in the stomach. Symptoms of its presence are direct and local in the digestive system, or nervous and reflex in character. The latter are rarer but may be severe. A. Stieda has recently described a case in which this species, in spite of its lack of hooks, had bored through the wall of the duodenum and some distance in a circuitous course into the pancreas. In this case there were neither abscesses nor perforated orifices of which the worm could have made use, while other evidence supported the view of active burrowing on its part. Possibly the rare cases in which tapeworms have made their exit through the navel or bladder may be susceptible of a similar explanation. This is, however, the only case on record which has been subjected to a thorough scientific investigation.

The proglottides of this species are expelled spontaneously and in the interval between stools. The movements after expulsion are active and long continued as is evinced by the discovery of segments high on the walls of sick-room or outhouses. The anterior margin is lacerated by separation from the chain, and in crawling the proglottis distributes eggs from the uterine branches. These detached segments are frequently diagnosed as flukes, a conclusion apparently strongly confirmed by their independent activity.

This species cannot be regarded as equally dangerous with *T. solium* since here there is no chance for auto-infection by the onchospheres. The disturbances attending its presence in the alimentary canal, however, are such as to call for its removal. Despite the absence of hooks in the species this is, as a rule, more difficult of accomplishment than in the case of the pork tapeworm. The removal of the body without the head and neck constitutes

but a temporary relief since a new chain is produced in a short time.

**T. TENIA AFRICANA** V. Linstow 1900.—Length 1.4 meters, greatest breadth 12 to 15 mm. Scolex unarmed, no-

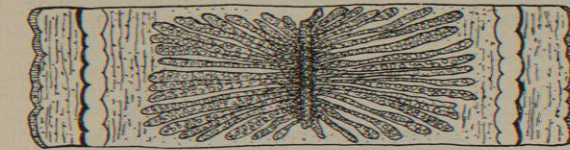


FIG. 1219.—Ripe Proglottis of *T. africana*. x 5. (After von Linstow.)

tably small, 1.4 mm. wide by 0.5 mm. long. Proglottides number about 600, decidedly broader than long; ripe proglottides measure 7 mm. long by 12 to 15 mm. broad. Uterus (Fig. 1219) with fifteen to twenty-four simple branches radiating from median trunk. Eggs thick shelled, 31 to 34 μ in diameter. Hooks of onchosphere 8 μ long. Adult parasitic in natives of German East Africa; development unknown.

This species, only recently described, was obtained from black soldiers near Lake Nyassa in Africa. It differs radically from the common unarmed tapeworm of man, as is evident from examination of the sexually mature proglottis (Fig. 1220). Of importance in consider-

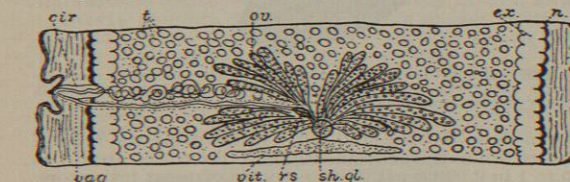


FIG. 1220.—Sexually Mature Proglottis of *T. africana*. cir., Cirrus; r.s., receptaculus seminis; sh.g., shell gland; vag., vagina; vit., vitellarium. x 5. (After von Linstow.)

ing its development is the report that these natives are accustomed to eat the flesh of the zebu raw.

**T. TENIA SOLIUM** L. 1767.—*T. pellucida* Goeze 1782 *T. vulgaris* Werner 1782, *T. solium* Rud. 1810. Length 2 to 3 meters, rarely 6 to 8 meters. Head (Fig. 1203) spherical 0.6–0.8 mm. in diameter. Rostrum short, often pigmented, with a double crown of twenty-four to thirty-two hooks in which large and small alternate regularly (Fig. 1221). Large hooks 0.16 to 0.18 mm. long, smaller 0.11 to 0.14 mm. long. Neck long and slender. Proglottides eight hundred to nine hundred in number, at 1 meter from the head square with sexual organs fully developed; at end of chain when ripe, 10–12 mm. long, 5–6 mm. broad. Uterus with prominent median stem and on each side seven to ten heavy branched lateral outpocketings. Embryophores 31–36 μ in diameter. Adult in small intestine of man; larva (*Cysticercus cellulosa*) in muscles and viscera of domestic pig, rarely also of dog, man, and ape.

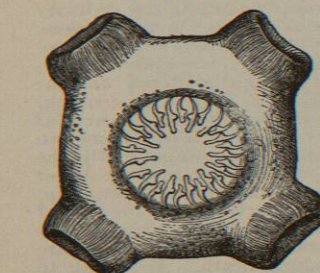


FIG. 1221.—Apical View of Scolex of *T. solium*. x 60. (After Leuckart.)

appearance the pork tapeworm is distinctly more delicate and its chain less muscular than the beef tapeworm, previously described, and all its measurements display this difference. The scolex is decidedly smaller and has a prominent rostellum with two rows of hooks. The points of the hooks lie in a circle, but since they alternate regu-

larly in size, the bases form two concentric circles. The hooks of the two sets show characteristic differences in figure (Fig. 1222) as well as in size.

The sexually mature proglottides do not exceed 4.5 to 5 mm. in width by 2.5 to 3 mm. in length, being thus decidedly inferior in size to those of *T. saginata*. On examination one sees the same organs in much the same relation as in the beef tapeworm; but there are minor differences which serve to distinguish



FIG. 1222.—Large and Small Hooks of *T. solium*. x 180. (After Leuckart.)

the two species. Most prominent is the unequal size of the two ovaries (Fig. 1223), the one next the genital pore being the smaller and being oval in outline rather than circular. In addition a small ovarian lobe lies in the angle between the vagina and the uterus, as if cut off by the former canal from the ovary to which it apparently belongs. This accessory lobe is a constant and reliable peculiarity of the pork tapeworm. One may notice also the generally compressed form of the various organs most marked in the flattened vitellarium near the posterior edge of the proglottis.

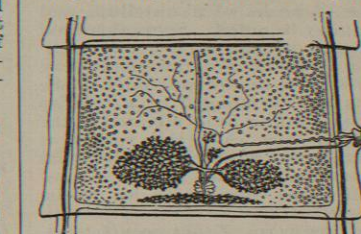


FIG. 1223.—Sexually Mature Proglottis of *T. solium*, Showing Reproductive Organs. x 10. (After Leuckart.)

The differences between the two species are less evident from examination of the ripe proglottides. Usually the segments of the pork tapeworm are given off in sets of two or three rather than singly. The individual proglottis is thinner, less muscular, in general also smaller and more transparent; yet these are highly variable features and often deceptive. The form of the uterus, however, gives to the proglottis a characteristic appearance. There are only seven to ten lateral branches which are more heavily and unevenly branched, while the ends of the branches are not infrequently enlarged (Fig. 1224).

**Development.**—The eggs (Fig. 1208) are oval, the outer shell is thin without polar filaments and transient; the inner shell is thick, radially striated, and spherical. The onchosphere is also spherical, measuring 20 μ in diameter. The development of the embryo is slow; in eight days it had only reached a size of 33 by 24 μ, and at the end of three weeks its diameter was but 0.8 mm., while in thirty-two days different individuals measured from 1 to 6 mm. by 0.7 to 2.5 mm. Even in the smallest, however, a head projection could be seen, and in the second month suckers and hooks are formed while the neck has grown so long as to produce one and a half complete circles within the bladder. By the close of the third month the bladder worm is probably ripe and capable of successful transference.

The longevity of the *Cysticercus cellulosa* is dependent upon various circumstances. Not infrequently it degenerates at an early period, but more often later, by the loss of its liquid and by deposition of lime, into a mere calcareous granule. The same individual has, however, by means of the ophthalmoscope,



FIG. 1224.—Ripe Proglottides of *T. solium*, Showing Form of Uterine Branches. x 2. (After Braun.)



been observed living in the eye for twenty years. Free cysticerci live only a brief time in water, but in flesh at normal temperature they remain living up to twenty-nine days.

Many experiments have demonstrated that the *Cysticercus cellulosæ* of the pig, when introduced into the human alimentary canal, gives rise to *Tenia solium*. From ten to twelve weeks are necessary for full development and for the expulsion of the ripe proglottides. Efforts to bring the cysticercus to development in other hosts than man have as yet failed.

**Anomalies.**—Though less frequent than *T. saginata*, much the same malformations occur. Both incomplete and complete fusion of two or more segments and fenestration of parts of the chain are on record. An unusually slender structure of the chain gave rise to Cobbold's species, *T. tenella*, sometimes regarded as a distinct variety even yet. A scolex bearing six suckers has been observed both with an ordinary chain and with one of the prismatic or triradial variety with proglottides Y-shaped in cross section.

The onchosphere has at times more than the usual six hooks, and the *Cysticercus cellulosæ* is subject to various malformations. Absence of hooks, of a rostellum, and presence of six acetabula may be noted. Some abnormal forms have received special names; such a one is *C. racemosus* (*C. botryoides* or *C. multilocularis*) which is very irregular in form. This variety occurs especially at the base of the brain and is not surrounded by a cyst, to which, no doubt, is due its peculiar form, adapted to the space in which it lies. In some cases this variety is without a scolex or possesses at most but an abnormal rudiment of one.

Most interesting of all is the form which led to the establishment of a new species, *Cysticercus acanthotrius*, and by deduction a new tapeworm, *Tenia acanthotrius*. The *Cysticercus acanthotrius* was first observed by Weinland in 1858 at an autopsy of a white consumptive in Virginia. The bladder worms were in the dura mater, muscles, and subdermal tissues. Though in size and form like *C. cellulosæ*, these hydatids (Fig. 1225) possessed three rows, each of fourteen to sixteen hooks, longer and slenderer than those of that form and measuring severally 153 to 196  $\mu$ , 114 to 140  $\mu$ , and 63 to 70  $\mu$ . The discovery in several cases of identical bladder worms in European countries and the improbability of the existence there of an unknown large tapeworm with three circles of hooks, together with the occurrence in one case at least of this peculiar form side by side with *C. cellulosæ*, have led most investigators to regard *C. acanthotrius* as merely a variety of the common pork bladder worm.

**Distribution.**—*Tenia solium* is not so widely distributed as *T. saginata*, although partaking of the cosmopolitan character of the latter. It is rare in tropical

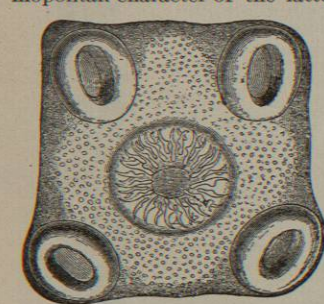


FIG. 1225.—Apical View of Scolex and Hooks of *Cysticercus acanthotrius*. X 50. (After Wetland.)

lands, and wanting among such races as abstain from the use of pork. On the other hand, especially in those regions where the inhabitants are accustomed to eat the flesh of the pig in a poorly cooked condition, the parasite is most abundant. Certain provinces of continental nations come within these limits. Contrary to the statements of a number of standard authorities, I am confident from the evidence gathered that this species is very rare at present in the United States. Some figures have been adduced to show that it is becoming decidedly rarer in both France and Germany. In Denmark it was, in 1869, the commonest human ces-

tole, being present in 53 out of 100 cases; in 1887-95 it was not found once in 100 cases (Krabbe).

*Cysticercus cellulosæ* is present not only in the pig but also in the wild boar, deer, dog, cat, rat, brown bear, ape, and even man himself. In the pig the bladder worm is more abundant in such animals as are allowed to range

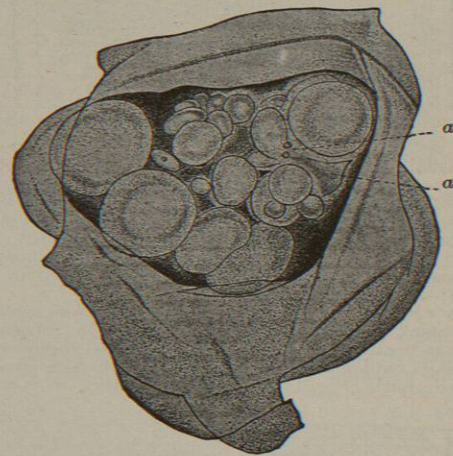


FIG. 1226.—Brain Cysticercus. Fresh specimen opened to show internal structure. a-a', Stalk of racemose body (scolex). X 3. (After Kratzer and Böhmig.)

than in those that are stall fed. In Germany the ratio of infected animals varies in different provinces from 1 in 100 to 1 in 2,000 according to reports of meat inspectors. As these cover, however, only the cases in which the infection is prominent, the actual figures are much larger. Leuckart calculated some years ago that two to three pigs per hundred were infected. This bladder worm also seems to be growing rarer during recent years.

**Pathology.**—*Tenia solium* lies with the head fastened in the anterior portion of the small intestine. The proglottides are passed in groups with fecal matter; exceptionally through abnormal communications they reach the body cavity, bladder, and abscesses, or finally are thrown out *per os* by vomiting. The troubles caused by the worm do not differ from those due to *T. saginata*, yet the former is a much more dangerous parasite since its bladder worm may also develop in man. When abundant the bladder worms produce in pork the conditions known as "measles," and measly pork is the ordinary means of introducing *T. solium* into the human system. Rarely it may be caused by the consumption of the infected flesh of the wild pig or deer. Smoking and salting, unless extended and thorough, will not kill the bladder worms in pork and ham. Thorough cooking, however, renders them entirely harmless. As early as 1558 the cysticerci were observed in the dura mater of an epileptic. While the brain and eye are apparently the most frequent seats of the bladder worms, the latter occur also in the muscles, subdermal tissue, heart, lung, liver, peritoneum, etc. Particularly dangerous are, of course, the cerebral cysticerci (Fig. 1226) which produce effects parallel to brain tumors. In this location they are not rarely the cause of sudden death. According to Verdun and Iversenc the bladder worm of the cerebral vesicles is ordinarily free and not of the racemose variety. The accephalocystic vesicle is most common, next comes the simple form with a single head, and rarest are those consisting of a few vesicles united by the stalk. The fourth ventricle is the most frequent location of the parasite. The symptoms due to the presence of such cysticerci do not permit of certain diagnosis; most general are, however, signs of compression due to ventricular hydrocephaly.

The introduction of the onchospheres into the human stomach, which is a necessary preliminary to further development in the system, is brought about by impure drinking-water, by the use of salads or uncooked vegetables contaminated by the embryophores, and by the careless use of unsanitary closets. More frequently, no doubt, the host of the adult tapeworm infects himself through lack of cleanliness in defecation, or possibly, as has been suggested, by internal auto-infection. Any circumstances which might lead to the passage of adult proglottides containing ripe onchospheres from the intestine

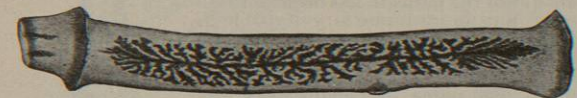


FIG. 1227.—Ripe Proglottis of *Tenia confusa*. X 25. (Original photomicrograph.)

back into the stomach would result in infection by those onchospheres which remained there a short time as if they had been introduced through the mouth.

The danger of internal or external auto-infection demands immediate action by the physician for the removal of the parasite under great care that all regurgitation should be prevented. The success of the operation must be confirmed by the discovery of the tapeworm head, and the parasite destroyed rather than merely thrown away.

**TENIA CONFUSA** Ward 1896.—This species, originally described by the writer and later studied in greater detail by one of his students (Guyer), was obtained in Lincoln, Neb. In general appearance it is much like the two species just described, but may be recognized at once by the extraordinary length of the ripe proglottides, some measuring as much as 35 mm. long by only 4 to 5 mm.

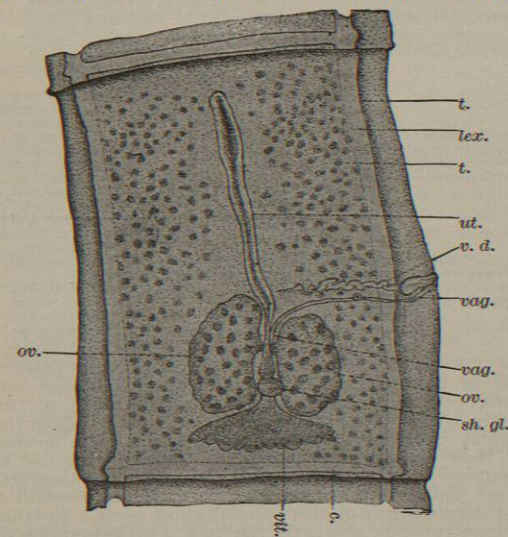


FIG. 1228.—Sexually Mature Proglottis of *Tenia confusa*. X 15. (After Guyer.)

broad. The shape of these proglottides differs also from that of the terminal segments in the other species (Fig. 1227, cf. Fig. 1207 and Fig. 1224). The head of this species is unknown, consequently its exact position and relationship are for the time being uncertain. The whole body is thinner and more fragile than that of *T. saginata*. It measures 5 to 8 meters in length and has some seven hundred to eight hundred proglottides, nearly all of which are longer than broad. The sexually mature proglottides (Fig. 1228) are distinguishable by the long reniform lobes

of the ovary. In the ripe proglottides the median stem of the uterus bears fourteen to eighteen irregularly branching offshoots swollen at the end into irregular club-shaped masses. Of the approximately forty points of difference in structure between this and the common species, *T. saginata* and *T. solium*, as tabulated by Guyer, the most important are subjoined. Nothing is known of the life history of this species.

	<i>T. saginata</i> .	<i>T. solium</i> .	<i>T. confusa</i> .
Size of terminal proglottides.	12-19 mm. long by 5-6.5 mm. wide.	10-12 mm. long by 5 mm. wide.	27-35 mm. long by 3.5-5 mm. wide.
Greatest breadth.	12-14 mm.	7-8 mm.	8-10 mm.
Length of proglottides exceeds breadth.	Only in last 100.	In last half.	In nearly entire worm.
Proglottides 35 cm. behind head measure.	1.5-2.6 mm. long by 5-10 mm. wide.	0.8 mm. long by 1.3 mm. wide.	1-2.5 mm. long by 0.8-3 mm. wide.
Sexually mature proglottides measure.	4-6 mm. long, 8-10 mm. wide.	2.5-3 mm. long, 4.5-5 mm. wide.	4-4.5 mm. long, 3.5-4.5 mm. wide.
Neck is.	Unsegmented.	Unsegmented.	Segmented.
Calcareous bodies.	Abundant; to 0.018 mm.	Sparse; to 0.012 mm.	Sparse; to 0.011 mm.
Longitudinal nerve trunks.	Dorsal to genital ducts.	Ibidem.	Divide, passing both dorsal and ventral to ducts.
Depth of genital cloaca.	0.22 mm.	Smaller.	0.05-0.08 mm.
Width of genital pore.	1 mm.	Smaller.	0.45-0.6 mm.
Ovarian lobes.	Round.	Part of smaller cut off by vagina.	Reniform.
Lateral branches of uterus.	20-30.	7-10.	14-18.
Size and form of eggs.	0.03 mm., slightly oval.	0.03 mm., nearly round.	0.039 by 0.03 mm., oval.
Pyriform process.	Present.	In young proglottides.	Absent entirely.

Further information is needed regarding the frequency and distribution of this form, which though distinguishable on careful examination, has doubtless often been regarded as the common species—whence the name *confusa*.

**TENIA SERRATA** Goeze 1782.—Length 0.5 to 2 meters. Head 1.3 mm. in diameter with a double crown of thirty-four to forty-eight hooks, the larger 225 to 250  $\mu$  long, the smaller 120 to 160  $\mu$ . Embryophores oval, 36-40  $\mu$  by 31-36  $\mu$ . Adult in small intestine of dog; larva (*Cysticercus pisiformis*) in peritoneum of rabbits.

The single record of its presence in man, reported from Algeria, is undoubtedly an error in the determination of the species found. In its normal host it is common everywhere in Europe and America so far as the records stand at present.

**TENIA CRASSICOLLIS** Rud. 1810.—Length 0.15 to 0.6 meter. Head 1.7 mm. in diameter with a double crown of twenty-six to fifty-two hooks, the larger 380-420  $\mu$  long, the smaller 250-270  $\mu$ . Embryophores spherical, 31 to 37  $\mu$  in diameter. Adult in small intestine of domestic cat and related wild species; larva (*Cysticercus fasciolaris*) in rats, mice, etc.

Braun records after Krabbe that in Jutland chopped mice are consumed uncooked on bread as a popular medicament against enuresis. Evidently the introduction of living larvæ of this species into the human alimentary canal would be not only possible but probable under these circumstances.

**TENIA MARGINATA** Batsch 1786.—Length 1.5 to 5 meters. Head reniform, 1 mm. in diameter. Hooks thirty to forty-four in a double row; the larger measure 180 to 220  $\mu$  in length, the smaller 110 to 160  $\mu$ . Ripe proglottides 10 to 14 mm. by 4 to 7 mm. Uterus with short main trunk and five to eight large branches on each side. Embryophores spherical, 31 to 36  $\mu$  in diameter.

The adult lives in the small intestine of dog and wolf; larva (*Cysticercus tenuicollis*) is found in the peritoneum of apes, ruminants, and pigs. Experiment has shown that the larva will not develop to the adult worm in the human alimentary canal. The larva has been reported



twice as a human parasite; but the record of its presence in the liver of man in Iceland has been shown to be a mistake. Hodges also reported its occurrence in man in the United States, but Wyman, who examined the specimens, stated that the hooks resembled rather those of *Cysticercus cellulosa*, while the size of the cyst and the number of hooks favored *C. tenuicollis*. Since the latter features are known to be much more variable than the former, it is probable that the determination is erroneous in this case also.

Since the most dangerous of all human parasites is a dog tapeworm, and since several other canine cestodes are either known to be found or suspected to be parasitic in man at some age or in some stage of life, the dog tapeworms are evidently most important for the physician from the sanitary point of view, quite apart from the fact that by virtue of their serious effects on other domestic animals these cestodes demand attention from an economic standpoint. A strict control should be exercised over the condition of the dog in every household where such a pet is found, and the removal of the army of stray curs should be urged in every community; for these vagrants are the very ones most likely, by virtue of their omnivorous habits, to become infected and, in consequence of their nomadic life, to carry parasites from place to place. The presence of tapeworms in dogs may be recognized by the proglottides found in the feces, and I have known of such having been taken from the back of a dog and submitted to a physician as a curiosity! Manifestation of an anal or subcaudal pruritus on the part of the dog is also good evidence of their presence. In all such cases the health of the family demands that the physician insist on the treatment of the dog for their removal.

As the determination of the species may be of importance in such cases there is appended a table, modified from Neumann, of the canine cestodes thus far reported:

Four suckers on the head.	Head armed; genital pore marginal and—	Single.	Numerous proglottides. Strobila several centimeters long. Segments—	Bifid; hooks	230-260 $\mu$ long, genital pore very salient. <i>Tænia serrata</i> .
					136-157 $\mu$ long, genital pore not very salient. <i>T. serratis</i> .
Two suckers on the head; genital pores on the ventral surface.	Head unarmed. Sexual orifices on the ventral surface.	Double and bilateral.	Three or four segments; some millimeters long	Entire; large hooks—	180-220 $\mu$ long, length of mature segments double that of their width. <i>T. marginata</i> .
					150-170 $\mu$ long, length of mature segments treble their width. <i>T. coenurus</i> .
					Much broader than long except the distal segments which suddenly elongate; genital pore usually large and prominent. <i>T. Krabbei</i> .
					<i>T. echinococcus</i> .
					<i>Dipylidium caninum</i> .
					<i>Mesocestoides lineatus</i> .
					<i>Dibothriocephalus fuscus</i> .

**TÆNIA ECHINOCOCCUS** von Siebold 1853.—Small cestodes (Fig. 1229) measuring from 2.5 to 5 or 6 mm. in length with only three to four proglottides the last of which measures when ripe 2 mm. in length by 0.6 mm. in breadth. Head 0.3 mm. broad with prominent rostellum bearing in a double row twenty-eight to fifty hooks which vary considerably in form and size. Onchospheres oval, 32-36  $\mu$  by 25-30  $\mu$ . Adult found in large numbers in small intestine of dog, wolf, jackal, dingo; the larva (*Echinococcus polymorphus*) in many organs of a multitude of hosts, including man.

**Structure.**—The adult of this species was long regarded as an immature form by virtue of its small size and limited number of proglottides until von Siebold produced it by feeding dogs with echinococcus bladders from sheep. The experiment has been repeated successfully many times with echinococcus from various sources including man, and shows a developmental period of seven to eight weeks to be necessary for the production of ripe individuals. The experimental production of the echinococcus has proved more difficult, but Leuckart has succeeded in following it by feeding the adult tapeworms

to suckling pigs. The development proceeds so slowly that in one month there has been formed a spherical solid only 0.25 to 0.35 mm. in diameter enclosed in a connective-tissue cyst formed by the host, the entire mass making nodules in the liver barely 1 mm. in diameter. At two months the larvæ are twice as large, the wall consists of a thick external lamellar cuticula and a delicate granular internal membrane enclosing a watery fluid. At five months the diameter of the parasite has become 10-12 mm., but no structure is yet visible in the interior. To the parasite in this condition, consisting of cuticula, parenchyma layer (endocyst), and fluid contents, the name *Acephalocystis* has been applied by some authors, and frequently the organism makes no advance in structure beyond this condition. Normally, however, there appears a protuberance on the endocyst (Fig. 1230, a) which develops rapidly into a brood capsule (b) in which the parenchyma is external and the cuticular layer internal. According to the views of some investigators these may become detached and continue their development floating (f) in the cavity of the mother cyst, in which case, however, a cuticular layer is formed on the outside and disappears within. In the opinion of others such free daughter cysts or secondary capsules arise in the wall of the parasite when a cuticular layer is formed about small centres of detached parenchyma; as these grow they burst out from the wall, and if they fall within the mother cyst and continue their development within the



FIG. 1229.—Entire Specimen of *Tænia echinococcus* from the Dog,  $\times 12$ . (After Claus.)

of the fully formed head takes its origin in a second annular furrow outside the first, which gradually surrounds the parts already described (g) and on its completion leaves the head projecting into the cavity of the brood capsule. Suckers and hooks originate and the entire structure presents the form of an inverted scolex

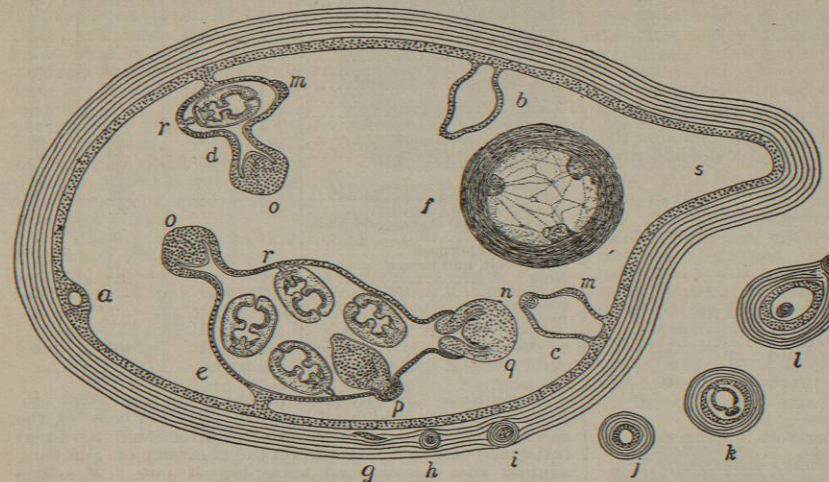


FIG. 1230.—Diagrammatic Representation of *Echinococcus* Seen in Section. a, Origin of a brood capsule; b, c, d, further stages in its development; e, fully developed brood capsule; f, endogenous daughter cyst formed from brood capsule; g, origin of an exogenous daughter cyst; h, i, j, k, its further development; l, an exogenous daughter cyst forming an exogenous and an endogenous cyst of the third generation; m, origin of a scolex as a minute elevation in the wall of a brood capsule; n, its delimitation by a shallow internal groove; o, later stage; p, the same as last, but invaginated; q, the enclosing of the papilla by a second outer furrow; r, a fully developed scolex with head inverted. (Original.)

(r). In each daughter cyst (d, e) five to ten, or even as many as thirty-four heads may develop, so that the entire number in one echinococcus reaches into the thousands. By the rupture of the brood capsule scolices may extend directly into the cavity of the hydatid or even be found floating free in its contents. The echinococcus is now mature, and if eaten by a suitable host these scolices will develop in its alimentary canal into adult tapeworms.

The form of the hydatid cyst is subject to considerable variation, the more extreme types of which have received special names. Evaginations in the wall (s) frequently occur under mechanical influences in the environment and suggest the origin of the form known as *E. racemosus* (Fig. 1231), from which, however, *E. multilocularis* cannot be distinctly separated in all cases. The latter, known also as an alveolar colloid, represents a mass of many small hydatids 0.1 to 5 mm. in diameter which in section display numerous irregular cavities filled with a transparent gelatinous substance and embedded in a common stroma of connective tissue. Gall duct and blood-vessels may be detected in places, but the liver cells are completely atrophied. These growths were long interpreted as colloid cancers until Virchow demonstrated their hydatid origin. The scolices or hooks, often rare and single or at most few in any bladder, are entirely wanting in forty per cent. of the specimens tested. These multilocular hydatids undergo regularly degenerative processes by which a central cavity is formed filled with a fluid containing among tissue remnants also calcareous corpuscles, secondary bladders, brood capsules, scolices, hooks, hematoidin and margaric crystals, concretions, etc. The size of the



FIG. 1231.—*Echinococcus racemosus*. Natural size. (After Leuckart.)

hooks (Fig. 1232), which varies very considerably, is due, as Leuckart has shown, to the age and stage of development of the specimen.

**Anomalies.**—A specimen of *T. echinococcus* has been described with six suckers on the head. Regarding the larval form some observers hold that the varieties noted above as *Acephalocystis*, *E. racemosus*, and *E. multilocularis* are abnormal. According to others the latter form, which appears to be confined to Switzerland, represents a different species from the common type. Isolated cases have, however, been reported from other localities, one even from the United States (Stiles).

**Distribution.**—The adult parasite appears to be most common in Iceland, where it occurred in 28 per cent. of the dogs examined. In Australia the percentage is even higher, 40 to 50 per cent. being recorded. On the continent of Europe it occurs in from 0.4 to 7 per cent. of the dogs examined in different localities. Stiles records its presence, though very rarely, in dogs examined at Washington, D. C. I have found no other record of the presence of the adult tapeworm in this country. When present its occurrence in large numbers is natural. The hydatid is most abundant in Iceland and in India, where from one-fourth to three-

fourths of all domestic animals are infected. In Germany, where records are of a most precise nature, the percentage of infection varies very greatly, being as low as 5 per cent. in a few cases and as high as 65 per cent. in one locality (for precise figures see Stiles and Hassall, p. 122). In the United States hydatids have been recorded from cattle, hog, and camel, and for localities in Maryland, the District of Columbia, Missouri, Nebraska, and Louisiana. In New Orleans 117 cases of liver echinococcus were recorded from 2,000 hogs.

In man the frequency of hydatid disease corresponds in general with that for domestic animals. In Iceland estimates of the number of inhabitants infected vary from 2 to 15 per cent.; in Australia 3,000 cases were reported between the years 1861 and 1882. In Europe the results of autopsies are given in the table at the top of the next page, which is taken from Ostertag.

In this country the hydatid is rare in man. Sommer has compiled statistics of one hundred recorded cases

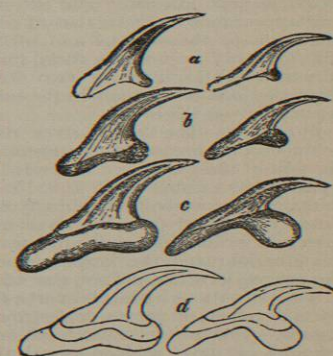


FIG. 1232.—*Echinococcus* Hooks. a, From bladder worm of cow; b, from young *Tænia echinococcus*; c, from adult *Tænia echinococcus*; d, the three forms superposed to show gradual modification in form.  $\times 500$ . (After Leuckart.)