

earlier reports of Malpighi and others probably concern this species. Between twenty and thirty well-established cases are on record; they have been compiled and discussed by Leuckart, Blanchard, and Moniez. All degrees of infection are represented, from such as were so slight as to have been discovered by accident to such as were the direct cause of death. In the bile ducts the flukes have only rarely evoked serious symptoms, though in two or three cases fatal termination was due to obstruction of the ductus hepaticus s. choledochus by one of these flukes. In the majority of cases the parasite produced no noticeable symptoms, evidently due to the presence of only a small number of individuals, and it is possible that infection is more general than heretofore believed. At any rate Kratter proclaims it to be frequent in Dalmatia, and Perroncito found distome eggs frequently in faecal examinations among laborers at the St. Gothard tunnel. Even in severer cases the symptoms are general, indicating only some affection of the liver. Thus pain in that organ, swelling and icterus have been mentioned by different observers. In the majority of cases, also, the parasite has not been found in its normal seat, the liver, but as an erratic in the lungs, in blood-vessels, in subcutaneous tumors, and elsewhere. This is not strange in the light of Railliet's demonstration that the liver fluke subsists on blood; thus young flukes especially may make their way into the circulatory system and be carried by the blood current into any part of the body.

Such occurrences of erratic individuals give some basis for the interpretation of other doubtful organisms as also belonging to this species, and many authors regard the *Hexathyridium venarum*, reported by Treutler in 1793, from the tibial vein of a young man which ruptured while the patient was bathing, as an erratic specimen of *Fasciola hepatica*. Leuckart, however, says there is more reason to regard it as a free living planarian, which did not actually come from the vein, but was obtained accidentally from the water.

These cases of parasitism of *Fasciola hepatica* in man have been reported largely in European countries, the only one outside being from Australia. The record of Chabert in 1852, that this species occurred in Boston in company with *Tania*, rests upon an erroneous view regarding the isolated segments of the tapeworm, as Leuckart and Cobbold have clearly shown. Nevertheless in those parts of this country where *Fasciola hepatica* is common, cases of human infection are likely to occur. This takes place supposedly through the consumption of cress, lettuce, and other uncooked plants which have been grown in low, damp regions where infected snails were present, and where consequently the liberated cercariae had opportunity to encyst upon the leaves. The evident infrequency of such an occurrence coincides with the usually mild infection in man as compared with the domesticated animals.

Associated with the light infection and also with its infrequency is the absence of any definite symptoms in the human host which denote the presence of the parasite. As already explained, the infection usually becomes known only by chance; but even were it determined by accidental discovery of the eggs in faecal examinations, no special means could be suggested to bring about the evacuation of the parasite, which lies deep in the ducts of the liver, and is held against retrograde movements by the thick-set, retrorse spines that cover nearly the entire body. So far as can be determined the life of the adult lasts not more than about a year. Care in the use of uncooked plants should be exercised in all regions where these flukes are abundant.

Agamodistomum ophthalmobium (Diesing 1850).—(Syn.: *D. oculi humani* Geschiedt 1833; [?] *Monostomum lentis* Geschiedt 1833; *Distomum ophthalmobium* Diesing 1850.) Two cases of some interest may be noted here in which the parasites are too poorly known to allow of exact identification. In one case four immature distomes were removed from the eye of a five months' child with lenticular cataract with partial opacity of the capsule. The

other case was that of an elderly woman from whose eye eight so-called monostomes were removed from the lens substance. The descriptions do not enable one to determine the species or to assert the identity of the forms. They were undoubtedly erratic parasites, and it seems highly probable that in the former case at least the parasite was the young form of one of the liver flukes of man. Several authors regard them as very young lancet flukes (*Dicrocoelium lanceatum*) which had strayed into this unusual location. There is every ground for believing them to be pathogenic, as are other species in the eyes of other vertebrates (e.g., fish), and a repetition of the occurrence on the part of the erratic young of the same or other species may be confidently predicted. (For full data on these cases compare Stiles 1902.)

Fasciola angusta (Railliet 1895).—(Syn.: *F. hepatica* var. *angusta* Railliet 1895.) Body flat, linguiform, with sides nearly parallel and slender than *F. hepatica*. Length, 26–38 mm.; breadth, 6–8 mm. Anterior region short. Posterior end broadly rounded. Acetabulum large, prominent, only 2 mm. from anterior tip of body. Eggs oval, 0.143 to 0.151 mm. by 0.082 to 0.088 mm.

Railliet described this form from the liver of cattle slaughtered in Senegal, and at the same time called attention to a case recorded by Gouvea, a physician in Rio Janeiro. The patient, a French marine officer, suffered from fever, cough, and blood spitting. The only pulmonary defect demonstrable was a sharply defined spot at the base of the left lung. Some twenty days later he coughed up a fluke, which probably belonged to this species, and was acquired during a residence in Senegambia. Blanchard regards it, however, as *F. gigantica* Cobb. mentioned below.

The case demonstrates also the susceptibility of man to other species of the genus *Fasciola* as well as to that ordinarily known, and renders it advisable to make brief mention here of the other species of this genus which are likely to be encountered in various regions.

Very closely related to the last species are *Fasciola aegyptiaca* Looss, which occurs in the domesticated herbivora of Egypt, and *F. gigantica* Cobbold, which was originally described from the liver of the giraffe, but which, according to Blanchard, occurs in the cattle of Senegambia and other regions in Africa. Probably these species may be introduced under favorable chances into the human host as well as the related species already described.

More important for American physicians is the allied native species which is so widely distributed on this continent. Although it has not yet been reported as a human parasite, the probability of its occurrence as such is sufficiently immediate to call for its description here.

Fasciola magna (Bassi 1875) Stiles 1894.—(Syn.: *Distomum magnum* Bassi 1875; *F. carnosus* Hassall 1891; *F. americana* Hassall 1891; *D. texanicum* Francis 1891; *D. crassum* [in part] Leidy 1891; *Cladocodium giganteum* [in part] Stossich 1892.) Body flesh-colored when alive, broad, thick; much larger and thicker than *F. hepatica*; length, 23–100 mm.; breadth, 11–26 mm.; thickness, 2–4.5 mm. The conical anterior part is not distinctly set off from the posterior. The posterior end is bluntly rounded, and margin more convex. In general the structure is very similar to *F. hepatica*, except that the oesophagus is longer, one-and-a-half to three times as long as the pharynx, the intestines more branched, and the yolk glands confined to the ventral side of the intestine; eggs oval, 0.109–0.168 mm. long by 0.075–0.096 mm. wide.

This fluke is found in cysts in the liver and lungs of cattle and of several species of deer, and is very widely distributed, occurring on the authority of various persons in Texas, Arkansas, California, Iowa, Illinois, New York (Adirondacks), and Italy. It is probably present in most parts of this country. In importance it stands hardly second to *F. hepatica*, but of its life history nothing is definitely known. Its close relationship to other species which have been reported occasionally from the

human host in Europe indicates that this species also may adopt the same rôle here when circumstances favor.

Fasciolopsis Looss.—Fasciolinae without distinct anterior and posterior regions. Cuticula smooth. Acetabulum powerfully developed with cavity extended posteriorly as sacculate invagination and much larger than oral sucker. Intestinal crura simple, slender, wavy but without evaginations. Testes dendritic, with branches growing smaller toward distal ends. Cirrus pouch very long, cylindrical, containing spiral tubular seminal vesicle with peculiar caecal appendage. Cirrus closely covered with fine spines. In alimentary canal of mammals.

Fasciolopsis Buski (Lankester 1857).—(Syn.: *Distomum Buski* Lankester 1857; *Distoma crassum* Busk 1859, nec v. Sieb. 1836.) Length, 24–37 mm., average about 30; breadth, 5.5–12 mm., average, 9 mm.; greatest thickness, 1.5 mm.; body (Fig. 4780) flattened, linguiform, anterior region tapering, but not sharply marked off from posterior body. Anterior sucker 0.5 mm. in diameter, acetabulum separated by not more than its diameter (1.6–2 mm.) from anterior end, with deep triangular lumen. Pharynx large, powerful; prepharynx present; oesophagus very short; intestinal crura slender, extending to extreme posterior end in three shallow curves. Testes dendritic one behind the other in median field, and both posterior to transverse yolk duct; cirrus sac median, cylindrical, much elongated, enclosing long spiral seminal vesicle with lateral elongate caecal appendage. Germarium small, dendritic, anterior to testes, and to transverse yolk duct; Laurer's canal present, receptaculum seminis wanting; uterus in scanty irregular open coils, anterior to ovary; yolk glands lateral with numerous very small acini extending length of body; genital pore immediately at anterior margin of acetabulum, cirrus covered with many fine spines; eggs numerous, 0.12–0.126 mm. in length, 0.077 mm. in breadth; similar to those of *Fasciola hepatica*.

Eight positive and several uncertain cases of the occurrence of this species are on record. They are all from southern or eastern Asia and all concern the human host. The parasite occurs in the duodenum according to Busk, and the symptoms of Cobbold's and Ollner's cases pointed unmistakably to this as an intestinal parasite. No facts on the life history are recorded as yet. In 1891 Leidy reported as belonging to this species specimens received from New York, Arkansas, and Texas, where they were collected from the liver of a doe in the first case and from cattle in the other two instances. The species he had under observa-

tion, however, was actually *Fasciola magna*, and there is no evidence that *Fasciolopsis Buski* has been found on this continent, although its occasional introduction by the Chinese is not a remote contingency in view of the known facts regarding other species (cf. *Paragonimus Westermanii* and *Opisthorchis sinensis*).

Fasciolopsis Rathouisi (Poirier 1887).—(Syn.: *Distomum Rathouisi* Poirier 1887.) Length 25 mm., breadth 16 mm., oval, with indistinctly marked anterior region (Fig. 4781). Cuticula smooth. Oral sucker 1.5 mm., ventral 2 mm. in diameter. Intestinal crura unbranched; germ gland dendritic, posterior to transverse yolk duct; vitel-

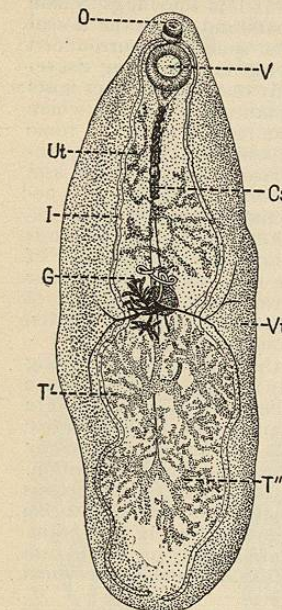


Fig. 4780.—*Fasciolopsis Buski* (Lankester). Cs, Cirrus sac; other abbreviations as before. $\times 3$. (After Odhner.)

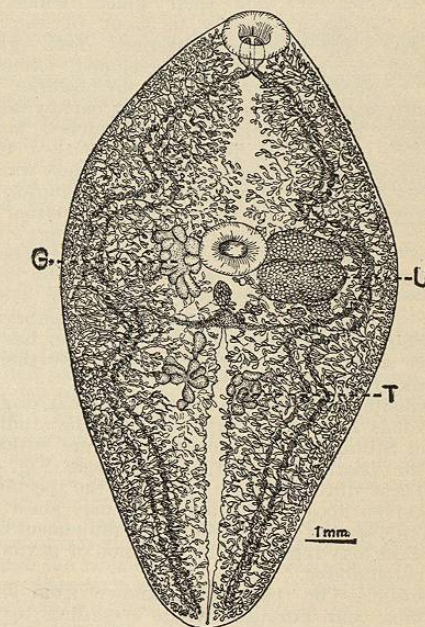


Fig. 4782.—*Paragonimus Westermanii* (Kerbert) in Ventral Aspect. American specimen from dog. Note reverse position of reproductive organs as compared with Fig. 4784. $\times 5$. (Original.)

laria lateral, not joined posteriorly; uterus in centre of anterior half of body; genital pore just in front of acetabulum. Eggs 0.150 by 0.08 mm.

Nothing is known of the development of this species. It has been observed only once in a Chinese woman, who vomited the specimens after violent pain in the region of the liver. Possibly the cases reported by Blanchard from correspondence with P. Manson belong to this species.

Paragonimus Braun 1899.—Body thick, oval, or spindle-shaped, and nearly circular in transsection. Cuticula spinous. Acetabulum near centre of body. Alimentary canal with prominent pharynx, very short oesophagus, and intestinal crura extending in irregular zigzag to posterior end. Excretory bladder large, extending nearly to pharynx. Genital pore lateral near acetabulum. Special copulatory organs wanting. Testes dendritic, right and left in posterior region. Germarium also dendritic, anterior to left testis. Receptaculum seminis lacking, Laurer's canal present. Vitellaria extensive, on side of body almost the entire length and dorsal also almost to median line. Uterus scantily developed as coil lateral to and near acetabulum. Eggs large. Usually by pairs in cysts in lungs of mammals.

Paragonimus Westermanii (Kerbert 1878).—(Syn.: *Distoma Westermanii* Kerbert 1878; *D. Ringeri* Cobbold 1880; *D. pulmonale* Baelz 1883; *D. pulmonis* K. S. and Y. 1881; *Mesogonimus Westermanii* Railliet 1890.) Length 8–16 or even 20 mm., breadth 4–8 mm., body thick and plump, posterior end more pointed, ventral surface more flattened (Fig. 4782); color, deep red or reddish-brown when alive, or dark gray in alcoholic



Fig. 4781.—*Fasciolopsis Rathouisi* (Poirier). $\times 2$. (From Leuckart, after Poirier.)

material, with conspicuous black dendritic acini of the yolk gland along the side. Cuticula spinous; oral sucker 0.53-0.75 mm. (Leuckart), or 0.86-1.2, or even 1.4 mm. (Ward). Acetabulum 0.6-0.75 mm. (Leuckart), 0.75-1.02 mm. (Ward); slightly larger than oral sucker, situated anterior to middle of body; oesophagus short, intestinal caeca wavy, with irregular outline, extending to posterior end of body. Germarium branched, posterior to acetabulum, lateral, opposite the lobate shell gland, which lies directly in front of the condensed uterus. Yolk glands highly developed, extending from anterior to posterior end, absent only over narrow median field. Testes branched, lateral, in posterior portion of body; cirrus and cirrus pouch wanting genital pore, near posterior margin of acetabulum, either median, right, or left; eggs oval, 0.08-0.1 by 0.05 mm. (Leuckart) or 0.096-0.118 by 0.048-0.055 mm. (Ward) (Fig. 4783).

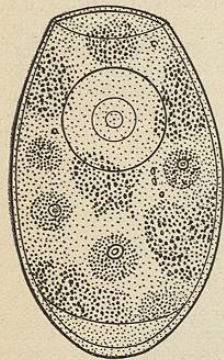


FIG. 4783.—Egg of *Paragonimus westermani* (Kerb.). Magnified 500. (After Katsurada.)

The oval ciliated embryo develops within the egg some time after the latter has been discharged with sputum from the host. Further life history unknown.

This parasite has been found in the tiger, cat, dog, and hog as well as in man. It appears from the studies of Ward and Stiles that differences in size are noticeable between the Asiatic (Fig. 4784) and American (Fig. 4782) forms. These differences are noted in the specific description given above. Further study may show them to be distinct species. The different arrangement of the sexual organs may represent the condition of sexual amphitopy noted above.

Distribution.—The parasite is known from Japan, China, Korea, and Formosa, where according to good authorities fifteen per cent. of the entire population is infected. In this country it has been reported from Michigan and Ohio by Ward, and from Kentucky and West Virginia by Stiles, according to whose accounts it seems to be common in hogs of the infested district. Thus far it has not been reported from a human host in the United States. Stiles has made an exhaustive study of the species, but is unable in spite of the recorded differences in size to differentiate specifically the American and Asiatic forms. Even should they prove to be distinct, however, possible danger to man would not be eliminated since the Asiatic form has been found in cat, dog, and hog as well as man, and the American form, which has thus far been reported only from the cat, dog, and hog, may confidently be expected to recur in man in the infested district. Until the announcement by Stiles of the existence of an extensive infection among hogs, it was not clear that the species had actually established itself in the United States, as the two cases in cat and dog which Ward reported might have been introduced from Asia after infection. Now that a large number of cases is known from this country, the endemic character of the species cannot be doubted. It is of the greatest importance that the distribution be more precisely established, and the life history worked out to show the points of danger for the infection of man and the precautions which must be taken to guard against it.

Pathology.—The disease was first reported from man in 1880 by Manson, who called it parasitical hæmoptysis and later endemic hæmoptysis. The term pulmonary distomatosis has also been used. From the cases thus far on record in detail, it is apparently much more prevalent in males than in females, and seventy-five per cent. of these cases occurred among farmers. Both of these facts undoubtedly point to factors in the life history which make infection of such persons easier rather than to any

inherent susceptibility; in fact Yamagiwa states that strong persons are more susceptible than weak, but this is evidently because they are more given to outdoor occupations, and hence more open to infection.

Ordinarily the worms are found in the lungs, where they lie in tumors about the roots and along the dorsal border directly under the pleura, sometimes surrounded by a capsule or again burrowing into the lung tissue. The worms occur in man usually one, but in other hosts two, in each cyst, although instances are not rare where one or several have been taken from a cyst, and some cysts contain eggs but no adult worm. The cysts contain not only the worms, but also masses of eggs, and Charcot's crystals, while cholesterol crystals are also occasionally present. The eggs and crystals reach the exterior in masses of mucus and blood through fine openings which communicate with the bronchi. The number of eggs discharged in the course of a single twenty-four hours may be enormous, and was estimated in case of one patient who had suffered thirteen years from the disease as not less than twelve thousand daily.

Yamagiwa has also found in the brain cysts containing the parasites and eggs or simply the eggs. Foci of these eggs and small blood-vessels filled with them occurred in the cortical substance of occipital and parietal lobes; these were associated with giant cells and surrounded by proliferating connective-tissue and round-cell infiltration. The lungs of the same host showed characteristic lesions due to these flukes, so that Yamagiwa concluded that this was the source of the egg emboli found in the brain. These cases, of which several are already on record, are characterized by epileptic attacks (Jacksonian or cortical epilepsy).

Yamagiwa has also found cysts containing the eggs of this species in the liver, causing or associated with cirrhosis of that organ, as well as in the diaphragm, peritoneum, mesentery, and walls of the intestine.

Symptomatology.—When in the lungs, its common abiding place, the distome gives rise to periodic hæmoptysis and chronic cough, with rusty, mucoid expectoration; spitting of blood is common but not constant. The condition of the patient remains good, and almost no abnormal sounds can be detected by percussion of the chest. Yamagiwa says that the general appearance of the expectoration is identical with tuberculosis, and that the disease was formerly diagnosed as such in Japan. The presence in the sputa of the eggs already described makes a positive diagnosis by microscopic examination easy. Accidental rupture of a large blood-vessel by the destruction of lung tissue, and in severe cases general anæmia, are the dangers to be feared.

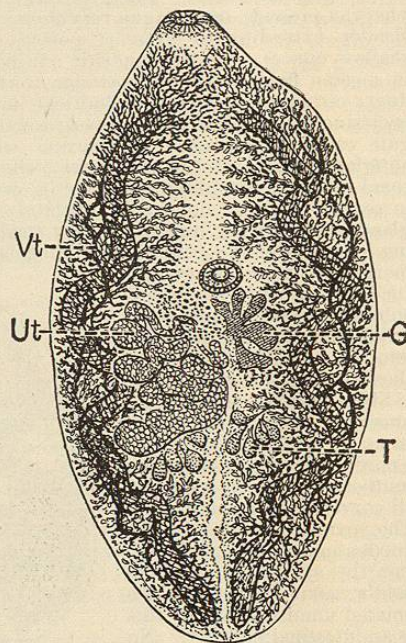


FIG. 4784.—*Paragonimus westermani* (Kerb.) in Ventral Aspect. Japanese specimen from human lung. $\times 7$. (After Katsurada.)

Removal from an infected district is followed usually by complete recovery.

In absence of any knowledge regarding the life history the mode of infection is entirely in the dark, and equally also the means of prevention. On general grounds drinking-water has been suspected; more suspicious are all uncooked plant foods, and especially such as are grown in moist places. In the light of present knowledge little weight can be laid upon the ideas of certain Japanese that fish, eggs, and meat are responsible for the transference of the parasite to the human host.

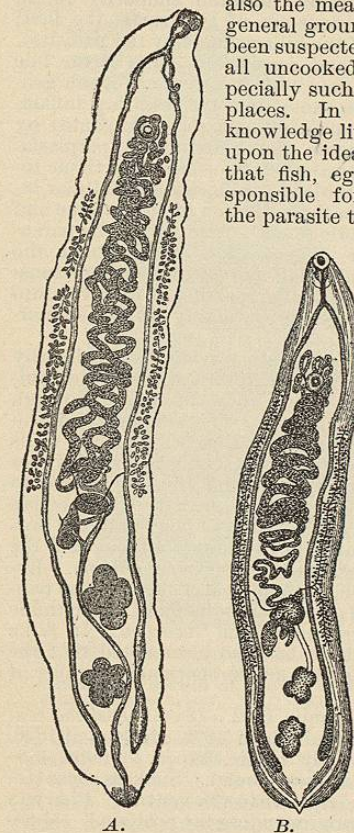


FIG. 4785.—*Opisthorchis felineus* (Riv.). A, Elongated Specimen from Liver of Cat. (After Braun.) B, "*Distomum sibiricum*" from liver of man. (From Braun, after Winogradoff.) Magnified.

Opisthorchis felineus (Rivolta 1885).—(Syn.: *Distoma conus* Gurlt 1831, nec Creplin 1825; *D. lanceolatum* v. Siebold 1836, v. Tright 1889, nec Mehlis 1825; *D. sibiricum* Winogradoff 1892; *D. tenuicolle* Mühling 1896.)

Body much flattened, with sides parallel save that the region anterior to the acetabulum is conical and very changeable in form when alive. Posterior end often slightly pointed. Color faint reddish-brown or yellow; when alive, transparent. Length 8-11 mm., breadth 1.5-2 mm. Suckers separated by only one-fifth to one-sixth of the length, nearly equal in size (0.23-0.25 mm.). Oesophagus very short, intestinal crura reaching nearly to posterior end. Excretory bladder forking anterior to testes. Anterior testis four-lobed, posterior five-lobed. Germarium median, transverse, smaller than the pyriform seminal receptacle, just behind it. Uterus entirely within intestinal crura. Vitellaria, in the broad lateral fields, composed of seven to eight distinctly separated groups of follicles, all anterior to ovary. Genital pore immediately preacetabular. Eggs oval with distinct lid at pointed pole, 0.030 by 0.011 mm.

This much confused species has been carefully studied by Braun. It inhabits the gall ducts and gall bladder of the cat, dog, fox, glutton, and man. Of the life history little is known. The eggs when laid contain a ciliated miracidium which, according to Braun, will not hatch out in water, although in Winogradoff's experiments they are said to have done so. Further knowledge on the development is lacking.

Distribution.—Germany, France, Italy, Holland, Scandinavia, Hungary, Russia, Siberia, and if correctly reported Japan also, are the countries in which the species has been found. It is apparently most abundant on the shores of the Baltic, and the general correspondence of its distribution with that of the human tapeworm, *Dibothriocephalus latus*, is worthy of note.

Pathology.—In 1892 Winogradoff found in post-mortems at Tomsk (Siberia) cases of what he thought to be a new human parasite. This he described as *Distoma sibiricum* (Fig. 4785, B), but it is probably identical with the species from the cat studied by Braun (Fig. 4785, A). Fifteen cases have been reported from Siberia, Russia, and East Prussia. In Tomsk it is the most common human parasite and in East Prussia is also common. Although in no case was a fatal termination attributable to this parasite, yet pathological changes in the liver were noted, such as dilatation of the gall ducts with inflammation and thickening of the walls, and atrophy of hepatic tissue. In recently infected cases the liver was enlarged; in older ones, on the contrary, smaller than normal. Ascites was noted in three cases, icterus in five. Askanazy found hepatic carcinoma in both of the cases he studied closely, and noted that it occurred in the region most visited by the parasites. He was accordingly inclined to place these facts in causal relation since the changes incited by the flukes consisted in manifold, even dendritic, proliferation of the mucosa into the likewise proliferating connective tissue. In both these cases there were over a hundred parasites found in the infected organ, and they were met with also in the pancreatic duct and in the intestine. In other cases on record the number of parasites found varied from a few to several hundred.

In view of the frequent confusion of this species with *Dicrocoelium lanceatum* it is possible that some records included under the latter actually concern the former species. It has been conjectured with good reason that man acquires this species, like *Dibothriocephalus latus*, through the consumption of uncooked fish in which the young distome is encysted, and it is striking that in all of Askanazy's cases in East Prussia both these parasites occurred together. That author, however, was unsuccessful in the effort to infect experimentally with this parasite, or to discover its immature stage.

A closely related American species is one which I originally described as a variety of *O. felineus*, but now believe to be entirely distinct. This is *O. pseudofelineus* Ward 1900 (Fig. 4772), which is a frequent parasite of the cat in some parts of the country, and has been found in the dog and coyote also. The intermediate host is unknown, but many facts point to some fish. Its transfer to the human host might be brought about by chance, or as in the case of the closely related species of the Old World. It occurs here in much the same hosts save man, and consequently would probably be able to maintain itself in the latter host also.

A small spiny distome which Winogradoff found in man in one instance, and which he regarded as the immature form of *O. felineus*, has been tentatively identified by Braun as *Metrochis truncatus* (Rudolphi 1819). This species is a normal parasite of the cat and had probably reached the human host in the same manner as *Opisthorchis felineus*, with which it is moreover often associated in the cat. As this form is parasitic not only in the cat, dog, fox, and glutton, but also in two species of seal, still further evidence is furnished of the transmission of this and the preceding species through fish food.

Opisthorchis sinensis (Cobbold 1875).—(Syn.: *Distoma*



FIG. 4786.—*Opisthorchis sinensis* (Cobb.). Contracted specimen from man in Japan. $\times 6$. (After Katsurada.)