A STUDY OF THE HELMINTHES OF THE DIGESTIVE TRACT OF THE CAT (FELIS DOMESTICA)

by

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I. INTRODUCTION AND LITERATURE

A great amount of work has been done in connection with the parasites infecting the cat, *Felix domesticus*, and a correspondingly great volume of literature on the subject has appeared. This is especially true as regards the helminthic parasites.

The work upon which this paper is based consisted of a study of the helminthic parasites of the digestive tract of 50 cats. The cats were collected at Lawrence, Kansas, and at places near Lawrence. The objects of the investigation were:

first, to make a survey which could serve as a basis for comparison with the parasites of the cat in other localities,

second, to study the parasites from the standpoint of their possible effect upon the health of the host, and third, to make observations as to the occurrence in the cat of parasites which may infect man.

The greater part of the material for the study was obtained through the kindness of Dr. H.B. Latimer, of the Department of Anatomy at the University of Kansas. Some was obtained through the help of Dr. E.H. Taylor and of Mr. A.B. Leonard, both of the Department of Zoology. The work was done under the direction of Miss Mary E. Larson, assistant professor of zoology at the University of Kansas. Dr. H.H. Lane, head of the Department of Zoology, assisted in criticism of the final draft of the paper. To these people the writer expresses her gratitude and her appreciation of their help.
A survey of the literature shows that a great many helminthes have been described as occurring in the cat. Some of these are quite common, while others have been reported but a few times. Some are known to be practically cosmopolitan in distribution, while others have been found only in certain localities.

The following lists of Trematodes, Cestodes, and Nematodes have been compiled mainly from (1) Beylis, A Manual of Helminthology, (2) Yorke and Maplestone, The Nematode Parasites of Vertebrates, and (3) Hall, The Adult Taenioid Cestodes of Dogs and Cats, and of Related Carnivores in North America.

**TREMATODES:**

- *Lepoderma massino* Petrov and Tichonov, 1927
- *Platynosomum fastosum* Kossack, 1910
- *Opisthorchis felineus* Rivolta, 1884
- *Opisthorchis wardi* Wharton, 1921
- *Opisthorchis pseudofelineus* Ward, 1901
- *Clonorchis sinensis* Cobbold, 1875
- *Metorchis albidus* Braun, 1893
- *Parametorchis complexus*, Stiles and Hassall, 1894
- *Parametorchis novoracensis* Hung, 1926
- *Pseudamphistomum truncatum* Rudolphi, 1819
- *Pseudamphistomum damubiense* Ciurea, 1913
Heterophyes heterophyes v. Siebold, 1852
Heterophyes continuus Onji and Nishio
Heterophyes acqualis Looss, 1902
Heterophyes disper Looss, 1902
Rossicotrema venustum Ransom, 1920
Metagonimus yokogawai Katsurada, 1912
Ascocotyle minuta Looss, 1899
Monorchotrema taihoku
Monorchotrema taihoku
Paragonimus westermani Kerbert, 1878
Paragonimus kelicotti Ward
Echinococmus perfoliatus v. Ratz, 1908
Schistosoma japonicum Katsurada, 1904
Prohemistomum appendiculatum Ciurea, 1916
Alaria elata Goeze, 1782
Alaria americana Hall and Wigdor, 1918
Pharyngostomum cordatum Diesing, 1850
Flukes of the genus Lepoderma occur as adults in the small intestine of members of all groups of vertebrates except fishes. The encysted cercariae, so far as is known, occur in insects. Species parasitic in mammals occur chiefly in bats. Lepoderma massino is a small form which has been found in the alimentary tract of the dog and cat in Kasakstan and Armenia.

Platynosomum fastosum was originally described from a wild cat, Felis minuta, in the Königsberg Zoological Garden, but has since been found to occur fairly commonly in the liver of domestic cats in British Guiana, Brazil, and the Malay States.

Opisthochris felineus, the European Cat Fluke, lives in the bile-ducts, and sometimes in the pancreatic ducts, of man, the dog, cat, fox, glutton, and pig. It is widely distributed in Europe and Asia. According to Stiles (1904), it may occasionally be found in European immigrants to the United States, and possibly in American troops who have served in China or the Philippines. The early larval stages occur in mollusces and the later larval stages in fishes.

Opisthochris wardi, which was described by Wharton (1921) from the cat in Iuzon, Philippines, is said to differ from O. felineus in certain characters. According to Baylis, however, it seems possible that it may be only a variety or local race of that form.
Ward (1895) recorded Oísthorchis felineus from the cat in Nebraska, but a comparison of his specimens with authentic material of O. felineus convinced him that the parasite is a distinct form. It was given the name Oísthorchis pseudofelineus Ward, 1901. The parasite has also been recorded from Canis latrans in North America. It is a more elongate form than O. felineus; it may attain a length of 22 mm., while O. felineus is only from 7 to 12 mm. in length. The two forms differ also in several other characteristics.

Clonorchis sinensis is widely distributed in the East from the east coast of India to Japan. It is the cause of "Asiatic liver-fluke disease". It occurs in the bile-ducts, and sometimes in the pancreas and duodenum, of the dog, cat, pig, and man. The first intermediate hosts of this fluke are various snails, and the second intermediaries are fishes. According to Faust, almost every fresh-water fish examined in China has been found to be capable of acting as a host for this species.

Metorchis albidus is a small form which occurs in the liver and gall-bladder of the cat, wild cat, and fox in Europe. The second intermediate host is apparently a fish, and the roach, Leuciscus rutilus, is apparently one of the hosts.
**Parametorchis complexus** occurs in the cat in North America. It is a small form closely resembling *Metorchis albidus*. A second species, *P. novæboracensis*, has been described from the cat in New York, but, according to Baylis, it seems doubtful whether it can be considered a distinct species.

**Pseudœamphistomum truncatum** occurs in Europe and India in the bile-ducts of the cat and dog, and possibly occasionally of man, besides the fox, glutton, and seals. The intermediate hosts are probably fishes. *Pseudœamphistomum damibiense* has been described as a second species parasitic in the cat. It is a smaller form.

**Heterophyæs heterophyæs** occurs in the small intestine and caecum of man, the dog, and the cat in Egypt, Japan, China, Korea, and Formosa. It is a very small fluke (from 1 to 1.7 mm. in length) which occurs in the intestine of the primary host. The intermediate hosts in which this form has been found are mullets (*Mugil cephalus*, *M. japonicus*). Onji and Nishio have recently obtained what is considered by them to be a different form, *Heterophyæs continuæ*, in the cat, after feeding with *Mugil*.

**Heterophyæs acqualis** and *H. dispar*, both very small forms occurring in the small intestine of cats and dogs, were described by Looss in 1902 in Egypt. A form or variety of *H. dispar* was also recognized by Looss under the name of *limatus*. He found it once in a cat.
Rosicottrema venustum occurs in the small intestine of the dog, cat, and Alaskan fox in North America.

Metagonimus yokogawai appears to be rather widely distributed in the Far and Near East. It occurs in the small intestine of man, the dog, cat, pig, and pelican. It has been found in Japan, China, Formosa, Korea, and Roumania. The body is completely covered with scales.

Aschoctyle minuta has been found in the dog, cat, and heron in Egypt and apparently also in Brazil.

The two species Monorchotrema taihoku and M. taichui both occur naturally in the night-heron (Nycticorax) in Formosa, but Faust and Nishigori 'find that they are capable of infecting mammals including man, dog, cat, and laboratory rodents, and believe that they may occur naturally in these hosts.

Paragonimus westermani, the lung-fluke, has a geographical range including Japan, Formosa, Korea, China, the Philippines, North and South America, New Guinea, and possibly Italy. Authorities differ in their opinions as to the validity of the different forms which have been described as distinct species of Paragonimus. The pig is probably the normal host of the fluke, but it, or other very similar forms, occurs also in the lungs, brain, etc. of man, the dog, cat, ox, goat, and other animals, especially wild carnivores. Ward considers P. kellicotti, from the pig, dog, and cat in North America, a distinct form. The first intermediate hosts
of *Paragonimus* in Japan are believed to be numerous species of the genus *Melania*, and the second intermediate hosts various fresh-water Crustacea.

*Echinochasmus perfoliatus* is an intestinal parasite of the dog, cat, and pig in Europe and Asia. In the dog, cases of enteritis have been attributed to infection with this worm. Fishes have been found to be the intermediate hosts of both the European and the Japanese form.

In the Far East *Schistosoma japonicum* occurs in the portal vein and arteries of man, cattle, the goat, horse, pig, cat, and dog.

*Prohemistomum appendiculatum* was obtained experimentally in the intestine of dogs and cats by Ciurca in Roumania.

*Alaria alata* is a fluke which occurs in the stomach and intestine of the dog, cat, wolf, and fox in Europe. In America two closely related species have been described from carnivorous mammals. These are *A. americana* and *A. michiganensis* Hall and Wigler, 1918. The former has been found in the dog, cat, and fox, and the latter in the dog at Detroit, Michigan.

*Pharyngostomum cordatum*, which is similar in structure to members of the genus *Alaria*, is an intestinal parasite of the wild cat in Europe, and, although it does not seem to be of general occurrence in the domestic cat, it has recently been found by Faust in a domestic cat in China.
CESTODES

Diphyllobothrium latum Linnaeus, 1758
Diphyllobothrium decipiens Diesing, 1850
Diphyllobothrium mansonii Cobbold, 1882
Hymenolepis lineatae Coeze, 1782
Cysticercus elongatus, Blumberg, 1882 = Dithyridium bailleti, Railliet, 1885
Diphylidium caninum Linnaeus, 1758
Diphylidium occleyi v. Rätz, 1900
Diphylidium sexcoronatum v. Rätz, 1900
Diphylidium gracile Millzner, 1926
Diphylidium compactum Millzner, 1926
Diphylidium diffusum Millzner, 1926
Diphylidium longulum Millzner, 1926
Diphylidium hali Tubangui, 1925
Joyeuxia chyzeri v. Rätz, 1897
Joyeuxia asculaei Diamarc, 1895
Diplyphylidium trichesii Diamarc, 1892
Diplyphylidium quinquecoronatum Rodriguez and Hamm, 1922
Diplyphylidium nolleri Strjebin, 1924
Cysticercus cellulosee
Taenia taenioformis (Batsch, 1786) Wolffhügel, 1911
Taenia pisiformis Bloch, 1780
Taenia novella Neumann, 1896
Taenia hydatigena Pallas, 1766
Echinococcus granulosus Rudolfi, 1801
Species of the genus *Diphyllobothrium* are, for the most part, ill defined, and it is difficult to find morphological characters which will separate them satisfactorily. According to Baylis, it is impossible, in the present state of our knowledge, to draw up specific definitions which would enable any given adult form met with in a domestic host to be assigned with certainty to its species. He believes it possible that several of the supposed species may ultimately be found to be synonyms. The best-known form is *Diphyllobothrium latum*, the broad or fish tape-worm, whose normal definitive host is probably man. The dog, fox, and cat are also known to serve as hosts of this form. Vergeer (1928), in an article on the dissemination of the broad tapeworm by wild carnivora, states that, because of family relationships, it is safe to assume that the wolf, coyote, and lynx are also capable of serving as hosts. He succeeded in experimentally infesting two bears of the species *Ursus americanus* fallax with *D. latum*, and believes that in nature the bear is a very capable host. All of these animals are, or may be, fish-eaters. Vergeer states also that in cats the broad tapeworm is smaller than in other known hosts, and that in dogs it is always smaller than in man; he concludes that the small size of the host may be a factor limiting the development of the tapeworm.

*D. latum* is probably of world-wide occurrence, although it is mainly known in Europe, and especially in Switzerland and on the shores of the Baltic. It has also been recorded
from various localities in Asia and Africa, and from the region of the Great Lakes in North America.

*Diphyllobothrium decipiens*, which has been found in the cat, dog, and some wild carnivores in Europe, Asia, and America (?) is recognized by some as a distinct species.

*Diphyllobothrium mansoni* was known for many years in the late larval stage, under the name of *Sparganum mansoni*, before the adult form was discovered. The larval form is a large plerocercoid which occurs in the connective tissue of the intermediate hosts, which apparently include, besides man, frogs, snakes, birds, rats, monkeys, etc. It has been found that the adult form is a typical *Diphyllobothrium* occurring in the intestine of the cat and dog. The species probably has a very wide distribution, although it is known mainly from China and Japan.

*Nesocestoides lineatus* belongs to a group which appears to occupy a position intermediate between the Bothriococophalidea and the more typical of the *Taeniidea*. It occurs in the small intestine of the dog, cat, and various wild carnivores in Europe and Africa. The life-history and intermediate hosts are not satisfactorily known. However, the type of larval Cestode known as *Dithyridium* has a scolex which suggests its connection with this genus. Schwartz (1927) obtained an adult *Nesocestoides* in dogs and cats fed experimentally with a *Dithyridium* from a mongoose. *Cysticercus longicollis*, or *Dithyridium bailloti*, is a *Dithyridium* which has been recorded from the pleural and peritoneal cavities of the dog and cat.
Adult cestodes of the genus Dipylidium occur in carnivorous mammals. The cysticercoids, so far as is known, occur in the body-cavity of fleas and lice which are ectoparasitic upon the final hosts. Dipylidium caninum is cosmopolitan in distribution. Its primary hosts are, according to Hall (1920), Canis familiaris, Canis mesoleus, Felis sylvestrius, (Felis catus), Felis catus (Felis catus domesticus), Felis maniculata, and Homo sapiens. The larval form occurs in the fleas (Ctenocephalus canis) of cats and dogs, and in the lice (Trichodectes canis) of the same animals. It has also been recorded as occurring in the common human flea, Pulex irritans. Joyeux (1916) has shown that the fleas become infected during their larval period, and that adult fleas are unable to ingest a tapeworm egg. Chandler (1926) records that children are occasionally infected by this worm, probably by accidentally ingesting ed lice or fleas or by crushing them and then putting the fingers into the mouth.

The common form, *D. caninum*, is extremely variable in size and other characters, and this fact, coupled with the difficulty of counting accurately the rows of hooks, has probably had some influence upon the number of supposed species described. *D. cerleyi* has been found in the small intestine of the cat in Budapest, Hungary. The life-history is unknown. *D. sexcoronatum* occurs in the dog and cat in Europe, India, and North America. *D. gracile* has been reported from the dog and cat in North America, and *D. compact-
um from the cat in North America. *D. diffusum* and *D. longum* have also been described from the cat in North America. *D. halli* was reported from the cat in the Philippines.

The genus *Joyeuxia* Lopez-Neyra, 1927, was erected to contain certain forms which differ from the typical species of *Dipylidium* in the possession of a larger number of crowns of hooks, and in several other morphological characteristics. Both *Joyeuxia chyzeri* and *J. pasqualei* have been reported from the cat, the former in Hungary (?) and the latter in Egypt.

The genus *Diplosomatium* Beddard, 1913, differs only slightly from the two preceding genera. *D. trinchesii*, *D. quinquecoronatum*, and *D. nölleri* have been found in the cat in, respectively, Southern Europe and Egypt, Spain, and Turkestan. Cysticercoids of species of this and the preceding genus have been found in small cold-blooded vertebrates. Apparently the larval forms of both *Joyeuxia chyzeri* and *Diplosomatium trinchesii* occur in various snakes, lizards, and batrachians. One of these intermediate hosts seems to be the common gecko, *Tarentola mauretanica*, which, in countries bordering on the Mediterranean, is said to be considerably preyed upon by cats.

*Cysticercus cellulosae*, the cysticercus of *Taenia solium*, the pork tapeworm of man, occurs chiefly in the connective tissue of the pig, but has been recorded also from a number of other animals, including the cat. However, Baylis concludes that the specific determination of this form must, in many cases, be regarded with suspicion.
A number of species of *Taenia* occur as adults in the cat. *Taenia taeniiformis* seems to be one of the most common forms. Underhill (1920) states that, of the tapeworms harbored by cats, only this species is of importance as affecting their health. The *strobiocercus*, *Cysticerus fasciolaris*, occurs in the liver and abdominal cavity of small mammals, chiefly rats and mice. It is probably cosmopolitan in distribution.

*Taenia pisiformis* is a normal parasite of the dog, but, according to Hall, certainly not of the cat, although it may occasionally occur in the latter. Ackert and Grant (1917) succeeded in developing immature worms of this species in the kitten. Concerning the fact that it is rarely found in the cat, they say: "The larval form of this tapeworm develops occasionally in hares and in mice (Stiles, 1906: 43), but it is well known that its usual intermediate host is the cottontail. Considering the abundance of the latter and the large numbers of cats that have been examined for parasitic worms, it is evident that *T. pisiformis* rarely develops in the cat. However, this may be accounted for in part by the fact that after the young cottontail has eaten the tapeworm oncospheres, from six weeks to two months are required for the cysticerci to develop and by this time the cottontails are usually large enough to evade the cat."

According to Hall, *Canis familiaris*, *C. latrans*, *C. nevadensis*, *Felis domestica*, *F. tigris*, *Urocyon*
cinereocentatus may serve as the primary host, and hares, rabbits, the mountain beaver, and Mus musculus as the secondary host. The form is cosmopolitan in distribution.

**Taenia novella** was described by Neumann from a cat in Europe. The worm was immature, and was probably an accidental parasite. Neumann considers it closely related to *T. pisiformis*.

**Taenia hydatigena** has been reported from the primary hosts Canis familiaris, C. mesomelas, Felis domesticus (?). Hall states that, although Stiles and Hassell (1912) note that this tapeworm has been reported from Felis domesticus, he has not found the reference in question and is not in a position to comment on the matter. The cysticercus occurs in the liver or abdominal cavity of ungulates, and also of primates and rodents. Domestic hosts of the larval form are the ox, sheep, goat, and pig. It has also been recorded in the cat and dog, and, doubtfully, in man. The parasite is cosmopolitan in distribution.

Adults of the genus Echinococcus Rudolphi, 1801, are extremely small, but striking characters are found in the larval stage. This latter is the so-called hydatid, a cyst with a thick laminated wall, which may give rise to daughter-cysts. Inside the cysts brood-capsules are developed, and each of these contains numbers of scolices. This hydatid may attain the size of a child's head. The adult worms occur in the intestine of carnivorous mammals, including the dog and cat, and the larval form in almost every position in the
body of its hosts, which include man and, among the domesticated animals, the ox, sheep, goat, pig, camel, horse, donkey, dog, cat, and rabbit. Infection with the larval stage is acquired by the ingestion of eggs from the feces of an animal acting as primary host. Baylis notes that there is reason for believing that where hydatid disease is common in man it is acquired more often through the direct handling of dogs or cats than by contamination of food or water.

Hall concludes that infection with the adult *E. granulosus* must be comparatively common in dogs in some places in the United States, since the larval worms are not infrequently found, especially in swine, in the meat inspection service of the U.S. Bureau of Animal Industry. He says, however, that it has been reported only by Curtice (1892g), who collected it in a dog from the pound in Washington, D.C., and by Welch (1890a), who developed the adult worm in a dog as the result of feeding experiments. Sheep-dogs and dogs and cats which have access to the offal at slaughterhouses are probably the animals most liable to infection.
NEMATODES:

Toxocara mystax Zeder, 1800
Toxascaris leonina v. Linstow, 1902
Oryuris compar Leidy, 1856
Strongyloides stercoralis Bavey 1876
Strongyloides stercoralis felis Chandler, 1925a
Ancylostoma braziliense Gomez de Faria, 1910
Ancylostoma caninum Ecolani, 1859
Aelurostrongylus abstrusus Reillett, 1898
Ollulanus triquenis Leuckart, 1865
Dirofilaria immitis Leidy, 1856
Cyclicospirura subequalis Molin, 1860
Spirocercus felinus Chandler, 1925
Physaloptera praematiellis v. Linstow, 1899
Physaloptera serina v. Linstow, 1899
Physaloptera necitae Tubangui, 1925
Heterodire oshirenis Jagerskiold, 1904
Entostoma spinigerum Owen, 1836
Trichinella spiralis Owen, 1853
Trichuris serrata v. Linstow, 1879
Trichuris campanula v. Linstow, 1889
Capillaria linearis Leidy, 1356
Capillaria felis-ceti Diesing, 1851
Lucoloeus acrophilus Creplin, 1839
**Toxocara mystax** (-*Dolascaris cati* Schrank, 1768, *Dolascaris mystax* (Zeder, 1800) Leiper, 1909) is a cosmopolitan parasite of the cat and of a number of wild members of the cat family. It may also occur, accidentally, in man. Infection is acquired by the ingestion of the eggs, usually in contaminated food or water.

**Toxascaris leonina** occurs chiefly in wild Felidae. However, it has been observed occasionally in the domestic cat in England, and it is possible that it may be more common in that animal than is generally supposed. Some authors would divide the Toxascarids of the lion, dog, and cat into three species, *T. leonina*, *T. limbata*, and *T. microp-tera*, respectively. Taylor (1924) states his belief that the three are identical, and that they should be known as *T. leonina*. Baylis and Daulnay (1922) mention as other hosts the tiger, leopard, oence or snow leopard, fishing cat, leopard cat, hunting leopard, and Indian fox.

**Oxyuris comper**, recorded from the small intestine of the cat in the United States, is a species of doubtful status. It may, according to Baylis, be a pseudoparasite derived from some animal which the cat had eaten. Hall believes that Leidy's specimens were probably examples of *Passalurus (Oxyuris) ambiguus* (Rudolphi, 1819), normally a parasite of rabbits.

Members of the genus *Strongyloides* normally have alternating and quite dissimilar free-living and parasitic generations. The parasitic forms occur in the intestine
of vertebrates, and the free-living stages in the feces of the hosts or in the soil. Infective larvae have the power of penetrating the skin of suitable hosts. At least three species occur in man and domestic animals. *S. stercoralis* has been found in man, dog, and cat. Chandler (1925), who found the parasite in cats, created for it a new subspecies or variety, *S. stercoralis felis*. According to his report, it differs from the human form in several respects.

*Ancylostoma braziliense* and *A. caninum* are the hookworms commonly found in cats, as well as in dogs. Both species may occur in man, although infection with the latter form seems to be very rare. *A. duodenale*, a normal parasite of man, has been experimentally transmitted to young dogs and cats, but is not, as a rule, found in older individuals. Both *A. braziliense* and *A. caninum* are widely distributed.

Baylis states that, so far as is known, the life-history of all the hookworms is similar. If this is true, cats and dogs become infected through active penetration of the infective larvae into the skin or mucous membrane.

*Aelurostrongylus abstrusus* (formerly included in the genus *Synthetocaulus*) is a parasite of the lungs of the cat. It is the cause of a form of broncho-pneumonia. Cameron (1927, 1928) has investigated the life-history of this species. He finds that the adults live in the pulmonary blood-vessels, and the eggs are carried into the capillaries of the lungs. They hatch here, and the larvae penetrate through the tissues into the alveoli, pass up the
trachea, are swallowed, and pass out with the feces. They must then be ingested by mice, in the muscles and subcutaneous tissue of which they reach the infective, encysted form. The cat becomes infected by prey ing upon the mouse.

_Eullulenum triquervis_ is a minute form which occurs in the stomach of the cat. The worms are viviparous. Leuckart believed that mice acted as intermediate hosts for this parasite, but Cameron finds that the larvae develop in the stomach of the cat up to the third stage, and believes that they may be transferred to other cats in the vomit. If ingested by another cat they develop into fourth-stage larvae and finally into adults.

Adults of the genus _Dirofilaria_ occur in the heart, blood-vessels and air-passages, or in the connective tissue, of various mammals. The female is viviparous, and the larvae, without sheaths, are found in the blood-stream of the host. _Dirofilaria immitis_, which is widely distributed in the warmer countries of the world, occurs in the dog and cat, and in various wild carnivores. It inhabits chiefly the right ventricle of the heart and the pulmonary artery. It may form dense masses, and has been known to cause death in dogs. The microfilariae show some degree of nocturnal periodicity in the peripheral blood. Certain mosquitoes are apparently capable of acting as vectors of this parasite.

_Cyclicospirura subacqualis_ occurs in the stomach of various wild Felidae, and, according to Baylis (1929), is
the same form as that recorded by Chandler (under the name of *Spirocerca folincus*) from the domestic cat in India. Chandler found the worms in purulent cysts in the stomach wall of five out of about 250 cats examined.

Species of the genus *Physaloptera* Rudolphi, 1813 occur in the alimentary canal, usually in the stomach, of various vertebrates. Six species have been recorded from man and domestic animals. According to Baylis (1929) nothing is yet known about the life-history of any of these species, although it is presumed that an intermediate host, probably an insect or some other invertebrate, is required for the development of the larvae. *P. vomitialis* occurs in the stomach of the cat, and also of the leopard and other wild Felidae, in Africa, the East Indies, and South America. Chandler found the parasite in about 2 per cent of the cats he examined in Calcutta. He says, "It appears to be a distinctly pathogenic parasite, for every one of the seven cats we have found infected, and also the leopard, showed an inflamed and eroded stomach wall, and distinct evidence of gastro-intestinal irritation. There seems to be little doubt but that a histolytic substance is excreted by the worm. In most cases the worms are very firmly fixed to the wall of the stomach by their powerful lips, but numerous additional bites which had been deserted by the worms were also in evidence."

*Physaloptera cormae*, which was originally recorded from the stomach and intestine of the cat in Egypt, has also been recorded from the fowl by Railliet. *P. pacita* was recorded
from the stomach-wall of the cat in the Philippines.

Dictyococcus cebiricus occurs in the intestine of the
cat and dog in Egypt and Turkestan. It has also been
recorded from a civet cat in India and from the South
American Azara's fox in captivity in England. The
cuticle, for part of the body length, is armed along the sides
with two subventral series of large, flattened, comb-
lifted spines, which lend a very characteristic appearance.

Members of the genus Gnathostoma Owen, 1836 occur as
adults in carnivorous mammals. Their usual habitat is the
wall of the stomach. Gnathostoma spinigerum occurs in the
stomach of the cat, dog, and various wild carnivores, and
has been recorded from various parts of the world, includ-
ing China, India, Siam, North and South America, and the
Philippines. A few cases of accidental occurrence in man,
where the parasite was found in the subcutaneous tissue,
have been recorded. In its normal hosts the worm burrows
in the stomach-wall, where it causes the formation of
tumors. Not infrequently an opening into the abdominal
cavity is acquired, and the death of the host from periton-
itis may follow. Hepatic lesions are caused by the burrow-
ing of the larvae. Chandler (1925) thinks the parasite
exhibits a very definite seasonal incidence. In connec-
tion with its effect upon the host, he says, "I do not hesitate
to consider G. spinigerum by all odds the most deadly
parasite to which the cat is subject. In fact I know of
no other parasite in the whole realm of helminthes which can
be as consistently injurious to its host in a short period of time."

The life-history of Gnathostoma spinigerum is not yet known. Larvae of the same genus have been found encapsulated in the mesentery of snakes, and others in birds. Chandler reports that feeding of cysts from snakes resulted in infection of cats in every case. However, the species relationships have not been demonstrated. According to Baylis, there is a possibility that the first larval host may be a molluse, or at least some invertebrate.

The well-known Trichinella spiralis occurs in a large number of mammals besides man. According to Baylis, it is probable that almost all kinds of mammals are susceptible to infection with this worm. It has been recorded, at least experimentally, in the pig, ox, sheep, horse, dog, and cat. It also occurs in rabbits, rats, and in a number of other mammals. The pig, rat, and man are probably its chief hosts.

Two species of the genus Trichuris (commonly known as whipworms) have been recorded from the cat in South America. These are T. serrata and T. campanula, both described by von Linstow. Urioste, who has examined material from cats in Brazil, believes that the latter is a synonym of the former. However, the measurements which Urioste gives in description of T. serrata agree very closely with the original description of T. campanula.
The genus *Camillaria* Zeder, 1800 consists of very slender, hair-like worms closely related to *Trichuris*, but with the oesophageal region of the body usually shorter than the posterior portion, and with the latter not conspicuously thickened. The worms occur in the alimentary canal, or occasionally in the urinary bladder, of all groups of vertebrates. The determination of species is often a matter of some difficulty, partly on account of the small size and lack of striking specific differences of the parasites. Two species have been recorded from the cat. *Camillaria linearis* was recorded from the small intestine of the cat in North America. A species which Rolleston had found in the bladder of a wild cat in Ireland was named *Camillaria felis-cati* by Dicke in 1881. In 1885 Well recorded the occurrence of what he presumed to be the same species in the bladder of a domestic cat in Egypt. More recently, the species has been recorded in Russia.

*Enocles* aerophilus was found in the trachea of the fox, and has been recorded also from the cat, dog, wolf, and badger. York and Maplestone have suggested that *Enocles* Dujardin, 1845 should be regarded as a synonym of *Hematoloe Hall, 1916.*
ACANTHOCEPHALA

Corynosoma strumosum Rudolphi, 1802

Centrorhynchus erraticus Chandler, 1925

Centrorhynchus aluconis Miller, 1760

Echinocordalis pardalis Westrum, 1821

The Acanthocephala are worms all of which, as adults, are parasitic in the alimentary canal of vertebrates. Their affinities are rather obscure. Perhaps the most striking characteristic of the group is the absence of an alimentary canal of any kind. The only external aperture is that of the genital organs. At the anterior end of the body there is a proboscis, a cylindrical, oval or rounded, hollow structure, armed (save in one genus) with posteriorly-directed hooks. This serves as an organ of attachment to the tissues of the host. Between thirty and forty genera are at present recognized.

Corynosoma strumosum is normally a parasite of seals and of cormorants. The larval form occurs in fishes. The adult has been recorded once, probably as an accidental infection, in the stomach of the cat.

Chandler (1925) found three specimens of an Acanthocephalan of the genus Centrorhynchus in the small intestine of a cat in India. The specimens were all immature. He presumed that, since this group had hitherto been found parasitic in birds only, the parasites had been freed from the intestine of a bird eaten by the cat and that they had established themselves temporarily in the intestine of the cat. In consider-
ation of the unusual location of the parasite, Chandler proposed the name *Centrorhynchus erraticus*.

*Centrorhynchus aluconis* is a species normally parasitic in owls, hawks, and other birds. The larval form is found in amphibia and reptiles. Kostylev, in 1926, referred to this species immature forms found in a cat. The infection was probably accidental.

Adults of the genus *Echinorhinalis* Travassos, 1913, occur in the intestine of Felidae. *E. mandelis* (= *Echino-

rhynchus cennaealus* Diesing, 1851; *E. oxyclus* Leidy, 1851, not Zeder, 1800) occurs in various wild Felidae in America, and was recorded once from the domestic cat in the United States. The worm is 30 to 40 millimeters long and has a stout proboscis armed with five or six rows of hooks.
HELMINTHIC PARASITES OF CATS IN CALCUTTA, AS REPORTED BY CHANDLER

Asa C. Chandler, in 1925, reported in the Indian Journal of Medical Research the results of helminthological observations on about 250 cats at Calcutta, India. This report is especially valuable in that it records the results of one of the few comprehensive studies that have been made of the parasites of a considerable number of cats in a rather restricted locality.

The following table, which lists the parasites found and the approximate percentage of incidence, is taken from Chandler's report.

PREMATODES

<table>
<thead>
<tr>
<th>Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Onisthorchis felineus</em></td>
<td>61.0 per cent</td>
</tr>
<tr>
<td><em>Echinochasmus perfoliatus</em></td>
<td>2.0 per cent</td>
</tr>
</tbody>
</table>

CESTODES

<table>
<thead>
<tr>
<th>Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Diphyllobothrium decipiens</em></td>
<td>0.5 per cent</td>
</tr>
<tr>
<td><em>Taenia taeniaformis</em></td>
<td>42.0 per cent</td>
</tr>
<tr>
<td><em>Diphyllidium caninum</em></td>
<td>43.0 per cent</td>
</tr>
</tbody>
</table>

NEMATODES

<table>
<thead>
<tr>
<th>Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Strongyloides stercoralis felis</em></td>
<td>20.0 per cent</td>
</tr>
<tr>
<td><em>Belescaris mystax</em></td>
<td>63.0 per cent</td>
</tr>
<tr>
<td><em>Ancylostoma braziliense</em></td>
<td>70.0 per cent</td>
</tr>
<tr>
<td><em>Gnathostoma spinigerum</em> (adult)</td>
<td>31.4 per cent</td>
</tr>
<tr>
<td></td>
<td>00.0 per cent</td>
</tr>
<tr>
<td></td>
<td>Aug. to Feb.</td>
</tr>
</tbody>
</table>
Feb. to April 10.0 per cent
(larvae) Jan. to March 12.0 per cent
Physaloptera praemutualis 3.0 per cent
Spiroceca felineus 2.0 per cent

ACANTHOCEPHALA

Centrorhynchus erraticus (one case) .5 per cent

Chandler notes that Opisthorchis felineus seems to be one of the most common parasites of cats in Calcutta. He believes that a large number of these flukes, up to 50 or more, can be harbored without serious ill effect to the host. The fluke Echinochasmus perfoliatus was found only twice in 100 individuals which were examined for it.

A new description and specific diagnosis is given for Diphyllolothrium decipiens. Only one cat in 200 examined was found to harbor this parasite, and only a single specimen was present. Taenia taeniacformis, as might be expected, was very common. Dipylidium caninum was even more common than Taenia taeniacformis, and in some cases infection was very heavy, from 50 to 75 or more worms being found in one host.

Strongyloides; Chandler says, had not previously been recorded from cats. The form differs slightly from that which occurs in man, and for it a new subspecies or variety was created.

Although Belascaris mystax was found in 65 per cent of the Calcutta cats, no very heavy infections were observed. Usually not more than five or six worms were present, and in no case more than twenty. Chandler points out that the
relative lightness of this infection (which, of the twelve infections observed, is the only one acquired through the ingestion of eggs with contaminated food or drink) speaks very highly for the cleanliness of cats as regards their food habits, and for the effectiveness of their habit of covering up their feces when possible.

Chandler considers the occurrence of *Ancylostoma braziliense* in 70 per cent of the cats, to the total exclusion of *A. caninum*, the most interesting and unexpected observation made in his study.

*Gnathostoma spinigerum*, Chandler believes, has a definite seasonal occurrence. He also observes that, if this is true, the parasites must be "consistently lethal" to their hosts. He considers this parasite the most deadly one to which the cat is subject.

*Physaloptera praecutialis*, like *Gnathostoma spinigerum*, is a stomach parasite, and seems to be distinctly pathogenic.

*Spirocerca felineus* was found in purulent cysts in the stomach wall in five out of about 250 cats. The specific diagnosis given by Chandler is new.

The occurrence of *Controrhynchus erraticus* was thought to be a case of pseudoparasitism in which worms from the intestine of a bird eaten by the cat had temporarily established themselves in the intestine of the cat. Chandler considers it a new species.
In his discussion of the relation of cat parasites to those of man, Chandler points out that six of the forms he found are known to be more or less rare human parasites, while one, *Strongyloides stercoralis foliis*, is merely a variety of a very common human parasite, and may be only a hostal strain of it. The two flukes, he says, are not likely to occur in the Indian peoples, since they do not eat raw fish. It is not yet known whether *Diphyllobothrium dendriticum* can infect man as a Sparganum. *Diphylidium caninum* has been recorded from man, but Chandler believes that for practical purposes it can be ignored. He records that there are nine records of parasitism of man by *Doloresacer mystax*, but concludes that man is a highly unsuitable host. He considers it possible, however, that the early development, including invasion of the lungs, may take place in man, and that the lesions produced may serve as a focus of bacterial infection. He considers *Ancylostoma braziliense* not rare as a human parasite, but believes it not sufficiently common to be of much more than academic interest. In his discussion of *Ancylostoma spinigerum*, he says, "In view of the extreme pathogenicity of this worm it is fortunate, whatever its usual path of infection to the final host, that this path only rarely leads to human beings." In the few known cases of human infection the worm was found not in the stomach wall, but in subcutaneous and mammary tumors. It is pointed out that the eating of snakes, in which some of the wilder Indian and Malay tribes indulge, may be very dangerous.
In conclusion, Chandler says, "To sum up we may conclude that the domestic cat in Calcutta, while serving as a reservoir for a considerable number of occasional human helminthic parasites, is not involved in the spread of any common human helminthic infection with the possible exception of Strongyloides stercoralis. Infection experiments are necessary to determine what relation the Strongyloides of cats has to the human infection."
II. MATERIALS AND TECHNIC

The alimentary tracts of 50 cats were used in the study. All cats, except those numbered 1, 2, 3, and 4, were killed by excessive etherization. Those numbered 6 to 47, inclusive, had been used for previous studies by Dr. H. B. Latimer, and the digestive tracts and contents were obtained from him. In the case of cats numbered 6 to 26 inclusive, and 36, 38, 39, 40, 41, 42, 45, 46, and 47, the material was examined as soon as possible after the death of the animal. In such cases the helminthes were alive and quite active. The digestive tracts of cats numbered 23, 29, 30, 31, 32, 33, 34, 35, 37, and 44, since they could not be examined at once, were preserved for several weeks, each in a separate glass jar, in 4 per cent formalin. All of these cats were apparently normal and healthy adults.

Numbers 1, 2, 3, and 4 were cats which had been sent to Lawrence from Parsons, Kansas. All were immature. The death of all four, apparently from exposure and from malnutrition of long standing, occurred within several days after their arrival in Lawrence. (Number 4, when apparently near death, was given chloroform.) The bodies were examined and the helminthes of the digestive tract were removed for study.

Cats numbered 100 to 105 inclusive had been used for dissection in the comparative anatomy laboratory, and the
digestive tracts were obtained from the preserved animals. The cats were all mature specimens.

In the examination of fresh non-preserved material, the digestive tracts were placed in a dissecting pan and carefully cut open from end to end, care being taken to keep the point of the scissors close to the wall of the intestine in order to avoid injury to any parasites which might be encountered. The walls and the contents of the entire tract were then examined, and all the helminthes found were removed and placed in physiological salt solution for subsequent observation.

Living parasites were examined with the aid of a binocular dissecting microscope. The Hemitodes were especially transparent when alive, and helpful observations as to their structure could be made. In the case of Cestodes, examination of the scoleces, with the actively-moving acetabula and rostella, often gave valuable aid in identification.

Tapeworms were killed and fixed in a warm solution of mercuric chloride. In some cases portions of the worms were compressed between two slides and kept in this condition during fixing. The fixing solution contained 7 grams of mercuric chloride and .75 gram of sodium chloride in 95 c.c. of distilled water, with 5 c.c. acetic acid added immediately before use. The worms were allowed to remain in this solution from 1 to 12 hours, the time varying with the size. They were then washed and placed for 24 hours in 50 per cent alcohol containing a small amount
of iodine. They were then washed in clear 50 per cent alcohol, and stored in 70 per cent alcohol.

When it was not possible to identify the tapeworms by study of the unmounted specimen, in toto mounts of the scolex, mature proglottids, and gravid proglottids were made, or serial sections were prepared. In toto mounts were, for the greater part, prepared according to the method outlined by Shaw (1928). Serial sections were stained with Heidenhain's iron-alum hematoxylin.

Nematodes were killed and fixed either in 4 per cent formalin or in boiling 70 per cent alcohol, and were stored in the respective fluids.

Helminthes collected from the material which had been preserved in formalin were examined under the dissecting microscope and later stored in 4 per cent formalin. If necessary, in toto mounts and serial sections were prepared; although they sufficed for purposes of identification, the staining was not satisfactory.

Measurements of parasites were made macroscopically after fixation.

In all cases in which it was possible, records were kept as to the following points:

1. Physical condition of host.
2. Sex of host.
3. Date cat was taken.
4. General locality in which cat was taken.
5. Number and species of helminthes found.
6. Approximate measurements of helminthes, usually length only.
7. Regions of digestive tract in which parasites occurred.
8. Pathological conditions of host's tissues apparently due to injury by parasites.
9. Counts of male and female hookworms found.
10. Length and body weight of eff cat (data furnished by Dr. Latimer).
III. RESULTS AND DISCUSSION

The helminthes which were found belonged to four species of Cestodes and Nematodes. Table I gives the names of the parasites, the number of cats infected with each, and the percentage of incidence of each.

Table I

<table>
<thead>
<tr>
<th>Name of Parasite</th>
<th>No. of Cats Infected</th>
<th>Incidence of Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cestodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taenia taeniaeformis</td>
<td>20</td>
<td>40 per cent</td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td>1</td>
<td>2 per cent</td>
</tr>
<tr>
<td>Nematodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancylostoma caninum</td>
<td>42</td>
<td>34 per cent</td>
</tr>
<tr>
<td>Toxocara mystax</td>
<td>44</td>
<td>83 per cent</td>
</tr>
</tbody>
</table>

In addition to these there were found in one case (Cat no. 16) two organisms which have not yet been identified with certainty. They are quite small, one being about 2 millimeters and the other about 4 millimeters in length, and are probably evacuating larvae of some Cestode. The smaller form is cyst-like in appearance, while in the larger an armed head is protruded and two tail-like structures extend from the opposite end of the body. They were found quite near to each other in the small intestine of the cat, the smaller form, of course, unattached, and the larger one with its armed head deeply and firmly
embedded in the intestinal wall.

Table II indicates the largest number of specimens of each parasite found in any one host, and gives the average number per host.

Table II

<table>
<thead>
<tr>
<th>Name of Parasite</th>
<th>Largest No. per Host</th>
<th>Average No. per Host</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taenia taeniaeformis</td>
<td>15</td>
<td>1.28</td>
</tr>
<tr>
<td>Dipylium caninum</td>
<td>1</td>
<td>.02</td>
</tr>
<tr>
<td>Ancylostoma caninum</td>
<td>37</td>
<td>9.28</td>
</tr>
<tr>
<td>Toxocara mystax</td>
<td>31</td>
<td>5.06</td>
</tr>
</tbody>
</table>

Table III shows the frequency of occurrence of different species of parasites in the same host.

Table III

<table>
<thead>
<tr>
<th>Parasites</th>
<th>No. of Cats Infected</th>
<th>Per Cent Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taenia taeniaeformis alone</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Dipylium caninum alone</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ancylostoma caninum alone</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Toxocara mystax alone</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Taenia taeniaeformis and Dipylium caninum</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Taenia taeniaeformis and Ancylostoma caninum</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
Table IV gives the number of the cat, the sex, the date on which the animal was taken, the locality from which it came, the body weight in grams, nose to anus length in millimeters, remarks as to the condition of the cat, and the number of parasites of each species found in the digestive tract. In some cases it was impossible to obtain data on all these points. In the case of cats numbered 6 to 47 inclusive, the author is indebted to Dr. H.B. Latimer for data as to the sex, locality, body weight, and body length, as well as remarks as to the physical condition.

In the case of *Taenia taeniaeformis* an indication of the
size of the parasite is given. The following size-ranges have been arbitrarily set:

4 to 20 mm. (length)  
20 mm. to 4 cm.  
4 cm. to 12 cm.  
12 cm. to 33.5 cm.

very small  
small  
medium  
large

The measurements were taken after the Cestodes had been killed and fixed, and are, of necessity, only approximate. However, measurements of living Cestodes are even more difficult to take with any degree of uniformity and accuracy, since the strobila possesses extreme powers of contraction and extension.
<table>
<thead>
<tr>
<th>Number</th>
<th>Sex</th>
<th>Date Taken</th>
<th>Locality</th>
<th>Body Weight</th>
<th>R.A. Length</th>
<th>Remarks</th>
<th>L. min.</th>
<th>T. max.</th>
<th>R. con.</th>
<th>T. mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>11/7/31</td>
<td>Parsons</td>
<td></td>
<td></td>
<td>Immature, very thin</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>5 (small)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>11/8/31</td>
<td>Parsons</td>
<td></td>
<td></td>
<td>Immature, very thin</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>5 (small)</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>10/27/31</td>
<td>Paradise</td>
<td>1504.0</td>
<td>450</td>
<td>Good condition</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>10/29/31</td>
<td>Paradise</td>
<td>1852.0</td>
<td>450</td>
<td>Good condition</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>10/30/31</td>
<td>Paradise</td>
<td>1556.5</td>
<td>495</td>
<td>Good condition</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>11/5/31</td>
<td>Paradise</td>
<td>4585</td>
<td>604</td>
<td>Good condition</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Female</td>
<td>11/6/31</td>
<td>Paradise</td>
<td>2147.3</td>
<td>493</td>
<td>Good condition</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Female</td>
<td>11/7/31</td>
<td>Paradise</td>
<td>1720</td>
<td>492</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Male</td>
<td>11/8/31</td>
<td>Paradise</td>
<td>4529</td>
<td>605</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>Female</td>
<td>11/9/31</td>
<td>Paradise</td>
<td>2574.0</td>
<td>505</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>Female</td>
<td>11/10/31</td>
<td>Paradise</td>
<td>2466.5</td>
<td>511</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>Male</td>
<td>11/11/31</td>
<td>Paradise</td>
<td>1655</td>
<td>448</td>
<td>Young cat</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td>Male</td>
<td>11/12/31</td>
<td>Paradise</td>
<td>2476</td>
<td>561</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Male</td>
<td>11/13/31</td>
<td>Lawrence</td>
<td>2131</td>
<td>561</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>Male</td>
<td>11/14/31</td>
<td>Lawrence</td>
<td>2402</td>
<td>551</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>Female</td>
<td>11/15/31</td>
<td>Lawrence</td>
<td>2456.5</td>
<td>600</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>17</td>
<td>Female</td>
<td>11/16/31</td>
<td>Lawrence</td>
<td>2454</td>
<td>520</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>Female</td>
<td>11/17/31</td>
<td>Lawrence</td>
<td>2566.5</td>
<td>500</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>19</td>
<td>Male</td>
<td>11/18/31</td>
<td>Lawrence</td>
<td>3017</td>
<td>512</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>Female</td>
<td>11/19/31</td>
<td>Lawrence</td>
<td>3017</td>
<td>509</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>21</td>
<td>Male</td>
<td>11/20/31</td>
<td>Lawrence</td>
<td>2025.5</td>
<td>600</td>
<td>Only two teeth left</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>22</td>
<td>Female</td>
<td>11/21/31</td>
<td>Lawrence</td>
<td>2495</td>
<td>504</td>
<td>Only two teeth left</td>
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<tr>
<td>47</td>
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<td></td>
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<td>Female</td>
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<tr>
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<td>Female</td>
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<td>Lawrence</td>
<td></td>
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</tr>
<tr>
<td>53</td>
<td>Female</td>
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<td>7</td>
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</tbody>
</table>

Table IV: Data on the growth and condition of chickens from 11/7/31 to 12/31/31. The table includes columns for number, sex, date taken, locality, body weight, R.A. length, and remarks. The remarks column indicates the condition and status of each chicken, with terms such as 'Immature, very thin', 'Good condition', and 'Only two teeth left'.
<table>
<thead>
<tr>
<th>Female</th>
<th>Date</th>
<th>Location</th>
<th>Condition</th>
<th>Fat Description</th>
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<tr>
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<td>Lawrence</td>
<td>Young, fairly fat</td>
<td>Young, good condition</td>
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</tr>
<tr>
<td>12/19/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
</tr>
<tr>
<td>12/20/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
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<tr>
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<td>Fat, very small</td>
<td></td>
</tr>
<tr>
<td>12/24/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
</tr>
<tr>
<td>12/25/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
</tr>
<tr>
<td>12/26/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
</tr>
<tr>
<td>12/27/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
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<tr>
<td>12/28/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
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<tr>
<td>12/29/31</td>
<td>Valley Falls</td>
<td>Fat, old</td>
<td>Fat, very small</td>
<td></td>
</tr>
</tbody>
</table>

Note: Fat descriptions are generally indicative of the general state of health and condition of the animals. The table above provides a summary of the fat conditions observed on different dates and locations.
TAENIA TAENIAEFORMIS

Synonyms:

Vermis vesicularis muris Hartmann, 1695 b
Fasciola muris hepaticae Roederer, 1762a
Taenia hydatigena Pallas, 1776, in part
Vermis vesicularis taeniaeformis Bloch, 1780a
Taenia collo brevissimo Bloch, 1782a
Taenia serrata Goeze, 1782a
Hydatigena taeniaeformis Batsch, 1786
Cysticercus fasciolaris Rudolphi, 1808a
Taenia crassicollis Rudolphi 1810a

It is not surprising that Taenia taeniaeformis was found to be the most common Cestode of the cats examined, since it is a cosmopolitan parasite of quite general occurrence. Underhill (1920) states that it is the only Cestode harbored by cats that is important as affecting their health. He gives the following description of symptoms of heavy infection: "There is at first a diminution of appetite which gradually passes to refusal to take any food whatever. Diarrhoea, at first slight, later severe, is succeeded by constipation; there is salivation, and in some cases vision and hearing are seriously affected. Colic is a frequent accompaniment, during the attacks of which the animal may rush about in a frantic manner, apparently heedless of or unable to see objects with which it may come in contact. Finally, as a manifestation of the nervous disturbance, there are convulsions; there is
much prostration and emaciation, and the animal dies, usually during or shortly after an epileptiform attack."

It is doubtful whether any of the cats studied harbored a number of *Taenia taeniaeformis* sufficiently large to have any very great effect upon their health; however, there is always present the factor of appropriation of food material by the parasite, and the possibility of harmful effects produced by toxins. It is conceivable, but not likely, that the scolex of the parasite might effect an opening through the intestinal wall into the peritoneal cavity, an event which would probably be followed by the death of the host.

Table IV has shown that no more than four large *Taenia taeniaeformis* were ever found in one cat. In cats numbered 104 and 105, in which were found, respectively, 8 and 15 of these Cestodes, the latter were very small, measuring in the first case from 10 to 20 millimeters in length, and in the second case from 4 to 10 millimeters. Probably these small worms represented a recent and rather heavy infection. An interesting question arises as to how many Cestodes from any infection will be able to reach maturity in the intestine of the host, and as to what factors play a part in determining this number.

The largest Cestode of this species found was 33.5 centimeters in length. Other fairly large ones had attained the following lengths (in centimeters): 30, 25.5, 21.25, 24.75, 24, 23.5, 23, 22.5, 21, and 20.
It is difficult to make any generalizations as to the part of the digestive tract apparently preferred as a habitat by any of the species of parasites found. However, *Taenia taeniaeformis* was found more frequently in the ileum than in any other region of the tract. In a number of cases active gravid proglottids which had become detached from the strobila were found in the large intestine.

Hall (1920) states that the following animals may serve as primary hosts of *Taenia taeniaeformis*: Felis catus (*F. domestica*), *F. maniculata*, *F. macroura*, *F. concolor*, *F. melivora*, *F. onca*, *F. mitis*, *F. tigrina*, *F. cory*, *F. sylvestris* (*Catus sylvestris*), *Lynx uinta* (*Lynx venta*), and *Mustela erminea* (*Eutisherus erminea*). He gives as possible secondary hosts the following animals: *Mus musculus*, *Erimys norvegicus*, *Erimys rattus alexandrinus*, (*Mus rattus alexandrinus, Mus tectorum*), *Erimys rattus rattus*, *Microtus arvalis* (*Arvicola arvalis*), *Arvicola amphibius* (*A. amphibia*), "*Lemmus terrestris*", *Ondatra zibethica* (*Fiber zibethicus*), *Talpa europaea*, and *Plectus auritus*.

The secondary host ingests the eggs of the parasite in contaminated food or water. The escaped embryos make their way to the liver, where they develop into the larval stage known as *Cysticercus fasciolaris*. Infection of the primary host results from ingestion of this *cysticercus*. In this
region, infection of a cat with *Taenia taeniaeformis* is probably most often acquired from the ingestion of a mouse or rat harboring the larval form of the parasite.

**DIPYLEDIUM CANINUM**

Synonyms:

*Taenia canina* Linnaeus, 1758a

*Taenia moniliformis* Pallas, 1781, not Batsch, 1786a

*Taenia cucumerina* Bloch, 1782a

*Taenia cateniformis* Goeze, 1782a

*Taenia elliptica* Goeze, 1782a

*Taenia ellyptica* Batsch, 1786a

*Taenia cateniformis canina* Linnaeus of Gmelin, 1790a

*Taenia cateniformis felis* Gmelin, 1790a

*Alydeenius ellypticus* (Batsch, 1786a) Zeder 1800a

*Taenia cuneiceps* Zeder, 1800a

*Halysia ellyptica* (Batsch, 1786a) Zeder 1803a

*Taenia canina* (Linnaeus, 1758a) van Beneden, 1861a

*Tenia cucumerina* (Bloch, 1782a) van Beneden, 1861a

*Taenia (Dipylidium) cucumerina* Bloch of Leuckart, 1863

*Cryptocystis trichodectis* Villot, 1882

Only one specimen of *Dipylidium caninum* was found in the fifty cats examined. This is rather surprising in view of the fact that the parasite is a cosmopolitan one of rather common occurrence, and that the intermediate hosts are the common fleas and lice of the cat and dog.

Chandler (1925) found *Dipylidium caninum* even more common
than Taenia taeniaeformis in Calcutta cats. It occurred in 43 per cent of about 250 cats examined, and in some cases the infections were quite heavy, from 50 to 75 or more specimens being present in some cats. Shaw (1923) in a study of the parasites of dogs at Lawrence, Kansas, found Dipylidium caninum in numbers ranging from 2 to 50 in 23 of the 35 dogs examined, or, in about 65.7 per cent of them.

According to Hall, the primary hosts of Dipylidium caninum are Canis familiaris, C. mesomelas, Felis sylvestris (F. catus), F. catus (F. catus domesticus), F. mani culata, and Homo sapiens. The secondary hosts are Trichodectes canis, Ctenocephalus canis, and Pulic irritans.

Joyeux (1916) showed that only larval fleas can ingest the eggs of this Cestode. The tapeworm embryo develops in the visceral cavity of the flea, and becomes a very small larva called Cryptocystis trichodectis. The primary host becomes infected from swallowing these larvae.

Baylis states that the Dipylidia are often troublesome parasites of dogs and cats, and that they may cause great digestive disturbance, emaciation, and weakness.

Dipylidium caninum has occurred occasionally in man. Chandler (1926) says, "Children who play with dogs are occasionally infested by this worm, probably by accidentally swallowing lice of fleas or by crushing them and then putting infected fingers into the mouth."
ANCYLOSTOMA CANINUM

Synonyms:
Uncinaria trigonocephala (Z.-canina) (Rud., 1818)
Railliet, 1885a
Schlerostoma caninum Ercolani, 1859a
Uncinaria vulpis Froelich, 1799a
Strongylus tetragonocephalus Rud., 1809a
Anchylostoma caninum (Ercolani 1859) Loeb and Smith, 1904a

Ancylostoma caninum occurred in 42 cats, or in 84 per cent of the total number examined. The largest number found in any one host was 37, and the average number per host was 9.28. This average is higher than for any of the other helminthes found, although Toxocara mystax occurred in a larger percentage of the cats. No other species of hookworm was found.

The greater number of these parasites occurred in the middle region of the small intestine. Quite often the intestinal wall around the points of attachment was bloody and inflamed, and sometimes bloody and congested areas that seemed to be deserted sites of attachment were observed. Occasionally considerable areas of the mucosa near the points of attachment were covered with blood.

Six pairs of copulating hookworms were found. All were free in the lumen of the intestinal tract. In several cases the pairs retained the position during and after fixation.
The number of females found exceeded that of males. The average length of the males was 8.3 mm, and that of the females about 10.4 mm.

*Ancylostoma caninum* is said to occur very rarely in man. In dogs it may be the cause of epidemic "kennel anemia". Cats are rather generally thought to be less susceptible to the effects of the parasites than are dogs; however, it may be possible that the worms occur in smaller numbers in cats than they do in dogs. Shaw (1928), in connection with parasites of the digestive tract of dogs, says, "The number of individual hookworms found in one dog ranged from four to hundreds, or more than could readily be picked out and counted." The largest number found in any one cat was 37. However, the number of hosts examined is probably, in both cases, too small to permit the formulating of generalizations.

Chandler, in his study of parasites of Calcutta cats, found *Ancylostoma braziliense* in 70 per cent of the cats, to the total exclusion of *A. caninum*. He considers this "perhaps the most unexpected and interesting observation made", and states that he does not know how to account for the complete absence of the latter species. He has frequently found the latter in dogs in Calcutta.

It has already been pointed out that the life-history of *A. caninum*, so far as is known, is similar to that of other hookworms. Apparently cats acquire infection by the
active penetration of the infective larvae into the skin or mucous membrane.

**TOXOCARA MYSTAX**

Synonyms:

- *Fusaria mystax* Zeder, 1800
- *Ascaris cati* Schrank, 1788, in part
- *Ascaris leptoptera* Rud., 1809, in part
- *Ascaris alata* Bellingham, 1839

*Belascaris mystax* (Zeder, 1800) Leiper, 1907

*Belascaris cati* (Schrank, 1788) Railliet and Henry, 1911

As noted in the tables, this parasite occurred in 44 cats, or in 88 per cent of the total number. As regards incidence of infection, it is the most common parasite encountered. The largest number of the worms found in any one host was 31, and the average number per host was 5.06. The worms varied in length from 8 mm. to 9 cm., and the average length was about 6.57 cm.

*Toxocara mystax* occurs also in a number of wild members of the cat family, and, accidentally, in man. According to Chandler, there are records of nine cases in which the parasite succeeded in establishing itself in man. Apparently man is not at all suitable as a host. Dickinson (1925) reports one case in which it was suspected that the patient, a girl aged three years, had become infected from a very thin and sickly cat.

It is interesting to note that, of the four species of
helminthes encountered in this study, *Toxocara mystax* is the only one that gains entrance into the host's body by way of food or drink contaminated with eggs of the parasite. As Chandler says, the relative lightness of the infection speaks highly for the cleanliness of the food habits of cats. Infection in the Calcutta cats was even lighter than in the cats concerned in this study; Chandler says that in most instances not more than five or six worms were present, and never more than twenty.

*Toxocara mystax* of the cat is quite similar to *T. marginata* of the dog. According to Taylor (1924) the most striking difference is seen in the spicules, which are relatively much longer in the former. He points out also that in *T. mystax* the cervical alae are broad and terminate abruptly at their posterior extremities, while in *T. marginata* they are long and narrow and terminate gradually.

*T. mystax* was found usually in the duodenum. Occasionally a few specimens were found in the stomach. In several instances the parasites were found in groups or knots of such size as to suggest the possibility of mechanical occlusion of the intestinal canal.
DISCUSSION AND COMPARISONS

The study has shown that, so far as can be judged from the number of hosts examined, cats in this locality are rather lightly parasitized by helminthes of the digestive tract, both as to number of species and as to number of individuals.

Comparison with the results of Chandler's study of Calcutta cats has shown that the latter are, in general, the more highly parasitized.

Comparison with the study of the parasites of dogs made by Shaw (1928) indicates that dogs of this locality are more heavily parasitized than cats. The following table gives the common name of the parasites found and the incidence of infection in both dogs and cats.

<table>
<thead>
<tr>
<th>Common Name of Parasite</th>
<th>Per Cent of Dogs Infected</th>
<th>Per Cent of Cats Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tapeworms</td>
<td>83</td>
<td>42</td>
</tr>
<tr>
<td>Hookworms</td>
<td>83</td>
<td>84</td>
</tr>
<tr>
<td>Belworms</td>
<td>14</td>
<td>68</td>
</tr>
<tr>
<td>Whipworms</td>
<td>11</td>
<td>0</td>
</tr>
</tbody>
</table>

It is interesting to note that, while the percentage of hookworm infection of both dogs and cats were about the same, the percentage of tapeworm infection was much higher.
in the dogs, and that of cestworm (Toxocara mystax) infection was much higher in the cats. No whipworms were found in the cats.

The number of individual hookworms found per dog was apparently greater than the number per cat; Shaw says they "ranged from four to hundreds, or more than could readily be picked out and counted". As to the numbers of cestworms (Belascaris marginata) Shaw says that in one dog only one cestworm was found, but that in the others the number ranged from four to nineteen; it has already been pointed out that the largest number found in any one cat was 31. Tapeworms occurred in much greater numbers in the dogs than in the cats. The following table, which will illustrate this fact, is copied from Shaw's paper.

<table>
<thead>
<tr>
<th>Name of tapeworm</th>
<th>Number of dogs infected</th>
<th>Range in Nos. of worms per dog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipylidium</td>
<td>23</td>
<td>2-50</td>
</tr>
<tr>
<td>Taenia pisiformis</td>
<td>11</td>
<td>1-46</td>
</tr>
<tr>
<td>Taenia hydatigena</td>
<td>3</td>
<td>1-16</td>
</tr>
<tr>
<td>Multiceps</td>
<td>8</td>
<td>2-17</td>
</tr>
<tr>
<td>Unclassed ones (very small)</td>
<td>5</td>
<td>2-200</td>
</tr>
</tbody>
</table>
None of the parasites found in the cats are, as a rule, considered to be distinctly non-seriously pathogenic when occurring in moderate numbers. It is doubtful whether any of the cats studied harbored a number of parasites sufficiently large to have any serious effect upon the health of the host.

The possibility of human infection with the various parasites has already been considered. (In addition, it may be mentioned that Baylis has made a statement which indicates his belief in the possibility of infection of man with *Taenia taeniaeformis*; he records that a tape-worm found in a five-year-old child at Buenos Aires and described by Bacigalupo (1922) does not seem to be distinct from *Taenia taeniaeformis*, the only characteristic not normal for the latter being the large size of the scolex. The parasite was given the name *Taenia infantis*.) It would seem that the danger of infection of man is slight, since (1) the cats examined harbored no parasites of which man is the normal host, (2) the two (possibly three) species (*Ancylostoma caninum*, *Toxocara mystax*, and *Taenia taeniaeformis*) which can infect man have have been known to do so only very rarely, and (3) *Diphylidium caninum*, the only species which has been reported any considerable number of times from man, is, if one may judge from the results of the study, rather rare in the cats of this locality.
IV. SUMMARY AND CONCLUSIONS

1. A study was made of the helminthes of the digestive tract of 50 cats.

2. The following four species of helminthes were found: *Taenia taeniaeformis*, *Dicylidium caninum*, *Ancylostoma caninum*, and *Toxocara mystax*.

3. Percentages of infection were:

   - *Taenia taeniaeformis*: 40 per cent
   - *Dicylidium caninum*: 2 per cent
   - *Ancylostoma caninum*: 84 per cent
   - *Toxocara mystax*: 88 per cent

4. The average numbers of parasites per cat were:

   - *Taenia taeniaeformis*: 1.28
   - *Dicylidium caninum*: .02
   - *Ancylostoma caninum*: 9.28
   - *Toxocara mystax*: 5.06

5. Cats of this locality are probably rather lightly parasitized both as to number of species of helminthes of the digestive tract and as to number of individual parasites.

6. Probably none of the cats examined harbored enough helminthes to have any serious effect upon their health.

7. The possibility of human infection from cats in this locality, so far as can be determined from the results of the study, is very slight and is of little or no practical importance.
BIBLIOGRAPHY


7. Fox, Herbert, 1923. Disease in Captive Wild Mammals and Birds.


