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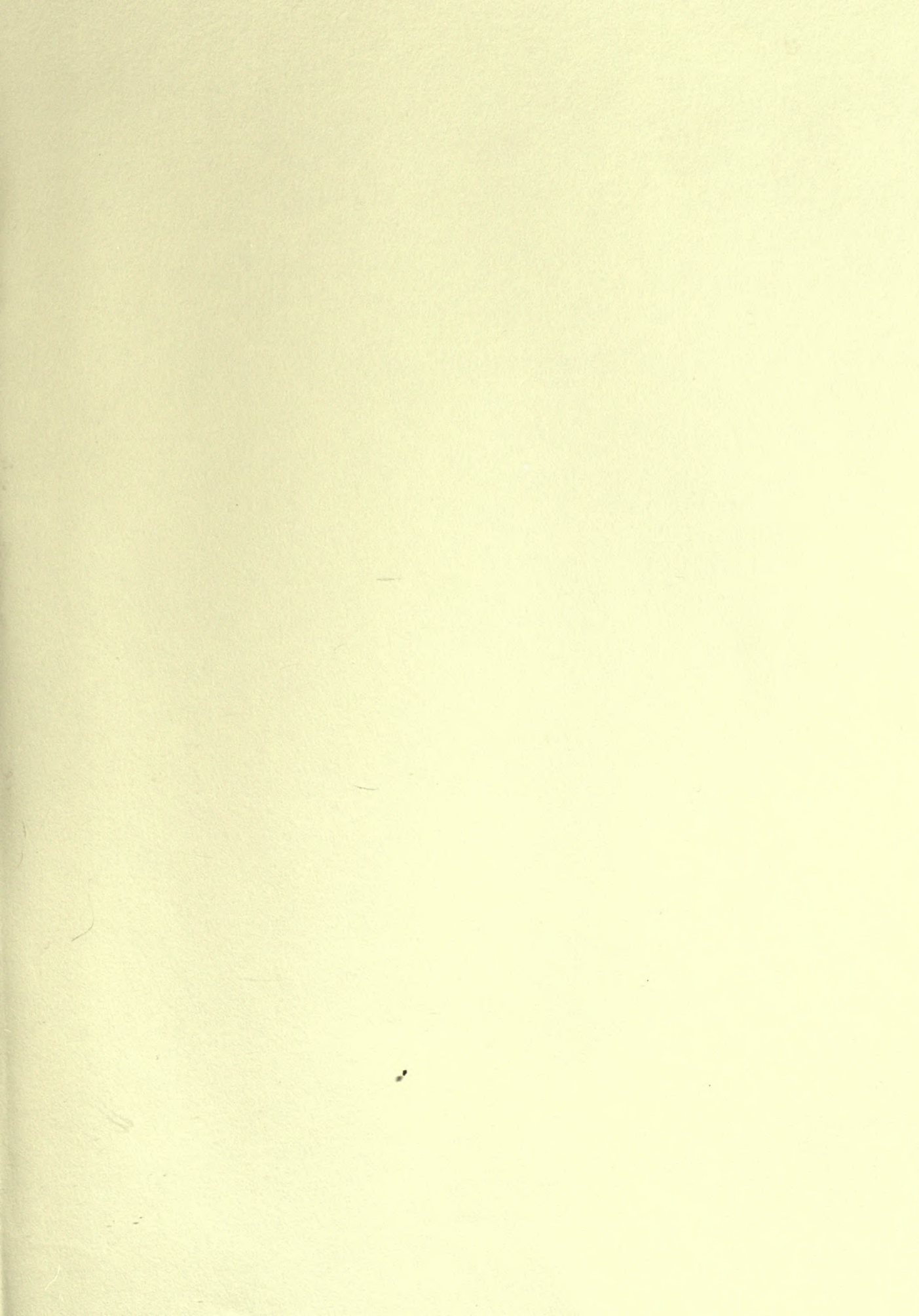


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*Chas. J. Smith*

SYNOPSIS  
OF  
STUDIES IN METAZOAN PARASITOLOGY  
IN THE  
McMANES LABORATORY OF PATHOLOGY  
IN THE  
UNIVERSITY OF PENNSYLVANIA

BY  
ALLEN J. SMITH, M.D.

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SYNOPSIS OF STUDIES IN METAZOAN PARASITOLOGY IN McMANES LABORATORY  
OF PATHOLOGY, UNIVERSITY  
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THE publication of statistical lists such as follows is more common in the journals of special scientific societies than in the usual medical journals; but in the present instance the writer hopes to justify himself by the fact that the UNIV. OF PENNA. MED. BULLETIN is the official organ of the institution in which these studies were made, and, too, by his desire to keep in proximity this list of records with the special descriptions of new parasites included and published in this same journal. For the most part, the parasites submitted for examination have, because of the correspondence of findings with already published descriptions, been merely named without other comment than the numbers of record and a statement of their habitat and host, and an acknowledgment of the person who collected the specimens. For further reference, should this in any case be desired, the reader may consult the books of the laboratory, in which the details of the various examinations are preserved. The value of such synoptical lists lies mainly in the aid they give parasitologists in determining the range of occurrence of parasites, the variety of hosts in which they have been met, and their habitat in the host; and it is for this reason that they should be of public record.



Much of the material has been placed at the disposal of the writer by the Laboratory of Comparative Pathology of the Philadelphia Zoölogical Gardens, the specimens having for the most part been obtained at autopsy of animals which have died in the Gardens during the service of Dr. C. Y. White as pathologist, or of Dr. Herbert Fox, his successor. A number were collected by Dr. J. J. Repp, in Iowa; others were obtained from the hospital of the Veterinary Department of this university; and the remainder, mainly parasites from the human body or from laboratory experiment animals, have been referred by various physicians or were collected by the writer. The list includes studies made since 1903, but is by no means a complete one, as in the early part of the intervening period such parasitological studies were not recorded save occasionally, and since then often no record has been made of common and well-known specimens. The numbers in brackets refer to the accession books of the laboratory ("Path. Hist., —") or museum ("Path. Mus., —"); and, when known, the number of the host in the records of the laboratory of the Zoölogical Gardens ("P. Z. G. Lab., —") is also indicated to facilitate reference.

#### A. VERMES.

##### I. *Trematodes*.

1. *Echinostoma ferox*, Rudolphi (Path. Hist., 1110), from the small intestine of a stork, *Ciconia ciconia* (P. Z. G. Lab., 805). The entire small intestine was invaded, the parasites being quite numerous. The heads of the flukes were embedded in the wall of the gut in small cavities, the tissue about which was swollen and the seat of marked inflammatory reaction, the lesions protruding on the serous side of the wall like miliary tubercles. This mode of attachment varies from that usually stated, which would have the worm attached by its ventral sucker to the interior of the small



cavity in the intestinal mucous membrane and both cephalic and caudal ends protruding above the surface of the lining of the gut. The only other point of difference from the current descriptions of the parasite which was noted was the absence of the cuticular spines from the anterior portion of the worm (not about the mouth, however); but these, according to Dujardin, are very caducous.

This was the second stork of the same species to die in the Gardens since the establishment of the Laboratory of Comparative Pathology with these parasites in the intestine. Both birds were newly arrived in the Gardens, one dying within twenty-four hours after its reception, and the other, the host of the specimens examined, within seventy-two hours.

2. *Paragonimus westermanni*, (Kerbert) (Path. Mus., 39), from the lung of a mouse, presented by Professor Katsurada, of Okayama, Japan, is identical with the lung fluke of man of the same part of the world.

3. *Opisthorchis sinensis*, (Cobbold); three specimens, one from the gall ducts of a human being and the others from the gall ducts of dog and cat; presented by Professor Katsurada, Okayama, Japan.

4. *Monostoma mutabile*, Zeder (Path. Hist., 1132, 1654), has been obtained in one instance from the subpleural air spaces of a coot, *Fulica americana* (P. Z. G. Lab., 885), and in a second case from the liver (this statement is made with uncertainty in the records of the laboratory of the Gardens; it is probably incorrect, and it is more likely that the worms were in the subperitoneal airspaces) of a Carolina rail, *Porzana carolina* (P. Z. G. Lab., 917). The data of identification of both groups of the parasite conform with published descriptions; but the ova were considerably smaller than the measurements given by Dujardin and repeatedly followed in later works upon parasitology. Dujardin (*Hist. Nat. des Helminthes*, p. 351; Paris, 1845) states that the ova are 0.173 mm. in length and 0.084 mm. in breadth; those obtained from the parasites of the first



of the above birds measured 0.110 to 0.120 mm. in length and 0.075 to 0.080 mm. transversely, and those from the parasites of the second bird 0.105 to 0.120 mm. in length and 0.060 to 0.080 mm. transversely.

## II. *Cestodes*.

### (a) *Larval or Bladderworm Stage*.

5. *Cysticercus fasciolaris* (bladderworm of *Tænia erassicolis*, Rudolphi, of cat) is recorded four times: once in the liver of a muskrat, *Fiber zibethicus* (L.), killed at Kennett Square, Pennsylvania, and presented by Dr. I. H. Alexander (Path. Mus., 169); twice (Path. Hist., 1652) in the livers of white experiment rats in the laboratory and in Wistar Institute; and once in the liver of a white mouse, presented by Mr. Howard Crawley. In all cases these bladderworms were present in numbers, the liver of the muskrat containing several hundreds and being enormously enlarged in consequence.

6. *Cysticercus tenuicollis* (bladderworm of *Tænia marginata*, Batsch, of dog) was encountered twice (Path. Mus., 44, 45) in the subperitoneal tissue of the domestic sheep, *Ovis aries*; two examples from the same host having been obtained in Iowa by Dr. Repp; and a third, a single occurrence, from the dressed carcass of a sheep in one of the Philadelphia markets, by one of the veterinary medical students. Recently Professor Joseph McFarland, of the Medico-Chirurgical College of this city, submitted to the writer a fourth example which he had obtained from the subperitoneal tissue of a goat, *Capra hircus*.

7. *Cysticercus cellulosæ* (bladderworm of *Tænia solium*, Rudolphi, of man) was submitted for identification (Path. Mus., 29) in the flesh of a domestic hog, *Sus scrofa*, by Dr. J. W. Nixon, of Gonzales, Texas. Once before, in Texas, pork has been found infested by this larva by the writer. It may be added, however, that, out of some dozens



of tapeworms from the human intestine which the writer has examined in this part of the country and in Texas, none have ever proved to be *Tania solium*, although the belief is common that this species is of frequent occurrence in man in America. Doubtless the parasite occurs in this country, as is indicated by the above experience with the bladderworm stage; but it is much less frequent than is usually believed, specimens of the beef tapeworm, *Tania saginata*, being confused with it by mistake.

8. *Cysticercus pisiformis* (bladderworm of *Tania serrata*, Goeze, of dog), obtained at Galveston, Texas, by Dr. J. J. Terrill from the liver of a common laboratory rabbit, *Lepus domesticus* (Path. Mus., 20).

9. *Hydatid cysts* (bladderworm stage of *Tania echinococcus*, v. Siebold, of dog) have twice been received for study. In one instance several daughter cysts and a portion of the mother cyst wall of a large subperitoneal hydatid (Path. Hist., 1900) from a man, a native Pennsylvanian, a patient in the Scranton State Hospital, at Scranton, Penna., by Drs. J. Cohen and T. O. Williams. The daughter cysts submitted were barren, but showed the remnants of the cestode heads; they were unusually large, being between three and four centimeters in diameter. The second example (Path. Hist., 1717) was met in the lung of a gazelle, *Gazella dorcas* (P. Z. G. Lab., 1145). The cyst and contained daughter cysts in this instance were of the usual type, and numerous examples of echinococci and their hooklets were met in the examination.

10. *Plerocercoids* of an unknown bothriocephalus (Path. Hist., 1691) were obtained from the liver of a wood ibis, *Tantalus loculator* (P. Z. G. Lab., 960). There were five of these larvæ in the host. The usual rule for such larval bothriocephalus worms is that they occur in fish or other habitants of water and later develop to adult stage in another host devouring the fish; but while it is unusual to meet with them in the present type of host, it is neither impossible nor unknown, and it is to be presumed that the free-swimming embryo was obtained by the bird with water swallowed.



(b) *Adult Cestodes.*

11. *Tania serrata*, Goeze (Path. Mus., 31), obtained several times from the small intestine of dogs used in the experimental work of the laboratory, several examples, as a rule, from each host.

12. *Tania saginata*, Goeze (commonly known as *Tania mediocancellata*, Küchenmeister): this, the ordinary "beef tapeworm," from the human intestine, has been brought into the laboratory at least seven or more times within the past few years from this State or from New Jersey (Path. Mus., 27; Path. Hist., 151, 978, 1651), although not all of these are recorded. One example, presented by Dr. David Edsall, was one of six strobiles met at autopsy in the intestine of a Syrian woman who died from tuberculosis in the Phipps Institute of this city. Two entire strobiles were submitted by Dr. P. S. Stout, who obtained them from living patients after the use of a *tæniafuge*. The other instances were fragments found in the dejecta and sent to the laboratory for identification before treatment.

13. *Tania crassicolis*, Rudolphi (Path. Hist., 1106), has been identified from the ileum of an eyra, *Felis eyra*, which died in the Zoölogical Gardens from an intense acute enteritis. Along with it there were also met in the upper part of the intestine a number of examples of *Uncinaria canina*. The single specimen of tapeworm was immature, the strobile measuring 16.5 cm. in length and including no ripe links. The general features of the worm, save in the fact that the measurements of the head and of its hooklets and of the individual proglottides were lower than those usual to this worm, were quite in conformity with the known characteristics of *Tania crassicolis*; but it is possible that in this type of cat a special variety of the parasite in question may develop and may be represented by the present example.

14. *Tania paradoxuri*, n. s. (Path. Hist., 1714), passed



in the dejecta from living paradoxure, *Paradoxurus grayi*, in the collection of the Zoölogical Gardens. For detailed description, see special article in this journal (p. 37).

15. *Tænia eunectes*, n. s.; a number of examples (Path. Hist., 1694) were obtained from the small intestine of an anaconda, *Eunectes murinus* (P. Z. G. Lab. 939). For description, see special article in this journal (p. 39).

16. *Tænia unilateralis*, Rudolphi (Path. Hist., 1681). Along with two species of nematodes there were found in the intestine of a blue heron, *Ardea herodias* (P. Z. G. Lab., 1158), a number of fragments of the strobile of what the writer believes to be Rudolphi's incompletely described *Tænia unilateralis*. The heron, a North American species, died within a week after its reception in the Gardens. The head of the tapeworm was missing from the material obtained, and none of the links examined contained ova. The largest segments measured 2 mm. in width and 0.2 to 0.4 mm. long, were trapezoid in form, with the posterior margin thick, erenulate, and prominent. These proglottides have not as yet been sectioned for microscopic examination; but it may be stated that the genital pores are all on one side, that the cirrus is long and lies coiled in its sheath, extending from the pore (in the anterior part of the lateral border of the link) along the anterior portion of the segment nearly to the median line, and that the vagina opens posteriorly in the genital pore, and its tube is traceable toward the median part of the segment. The details of the rest of the genital apparatus are, however, uncertain without histological examination.

17. *Moniezia expansa*, (Rudolphi), from the intestine of sheep, *Ovis aries*, collected in Iowa by Dr. J. J. Repp (Path. Mus., 25).

18. *Moniezia planissima*, Stiles and Hassal (Path. Mus., 30), from the intestine of sheep, collected in Iowa by Dr. J. J. Repp.

19. *Thysanosoma actinioides*, Diesing (Path. Mus., 26), from the intestine of sheep, *Ovis aries*, in Iowa, by Dr. J. J. Repp.

20. *Ctenotænia leuckarti*, (Rheim) (Path. Hist., 1797),



from the intestine of a cotton-tail rabbit, *Lepus sylvaticus*, killed near Philadelphia, collected by Dr. H. C. Masland.

21. *Dipylidium caninum*, (Linn.), has been met a number of times in the small intestine of dogs in the laboratory, usually two, three or more in a single host (Path. Mus., 32); and once (Path. Hist., 1065) in the intestine of a domestic cat in the hospital of the Veterinary Department of this university (Vet. Hosp., 1330). This last example is by some regarded as a separate species, and described under the name *Tania elliptica*; but aside from the usually smaller size of the strobile and proglottides and the slightly larger size of the ova, does not materially differ from canine examples and is at most a mere variety (*D. caninum*, var. *cati*).

22. *Cotugnia browni*, n. s. (Path. Hist., 1672), from the intestine of a banded parakeet, *Palæornis fasciatus* (P. Z. G. Lab., 1052). For description see special article in this journal (p. 41).

23. *Hymenolepis nana*, (v. Siebold). These specimens (Path. Mus., 5), including in all over a thousand strobiles, were obtained by Dr. L. E. Magnenat from the stools of three children in Amarillo, Texas, after administration of male fern. The hosts were all from the same family, and later Dr. Magnenat found a fourth child in the same family also infested. The ova had been detected in the feces by the physician. Probably many strobiles escaped notice in collection of the material, and the total number in the intestines was surely greater than represented by the material in hand, as Dr. Magnenat subsequent to the medication found numerous ova persisting in the stools of his patients.

24. *Hymenolepis diminuta*, (Rudolphi) (Path. Hist., 1646), from the intestine of a Texas cotton rat, *Sigmodon hispidus texianus* (P. Z. G. Lab., 1096). The material submitted in this instance was fragmentary, and no heads were included; and the identification, therefore, is not absolute. The general features agree closely with those accepted for *H. diminuta* save in the one fact that filaments are to be recognized in the middle layer of the covering of the ova,



arising, as in *H. nana*, from polar tubercles on the inner wall. There is, however, too much divergence in the segments to permit the identification with *H. nana*, and the writer is disinclined to regard the peculiarity of the ova noted as sufficient basis for separating these specimens as a novel species.

25. *Davainea cesticillus*, (Molin); numerous examples in the intestine of domestic fowl, *Gallus gallinaceus*, collected by Dr. S. H. Grant, Rugby, Texas (Path. Mus., 22).

26. *Dibothriocephalus latus*, (Linn). The fish tapeworm of man has been met in the work of the laboratory three times within the past few years. Dr. William Pepper (Path. Mus., 170) obtained, after recognition of the ova in the stool and the administration of an anthelmintic, an entire strobile in the dejecta of a Norwegian sailor in the University Hospital in 1905. Dr. R. N. Willson, in 1906, referred to the laboratory a portion of a strobile of the parasite (Path. Hist., 852) which he had obtained after administration of an anthelmintic from the feces of a young male Polish student in the University of Pennsylvania; and in the spring of 1907, Dr. C. LeR. Griswold, then a fourth-year medical student, obtained a meter or more of the strobile of the same species of tapeworm (Path. Hist., 1822) from another student. The host in this last instance was an American, but had spent his previous summer vacation in European travel; and as all the symptoms suggestive of parasitism had followed this European sojourn, it is possible that this, too, was an instance of the importation of the worm.

A number of fragments of what the writer believes to be the same parasite (Path. Hist., 1454) were found in the large intestine of a gray fox, *Canis cinereo argentatus* (P. Z. G. Lab., 1001). The head was not found in this case. The anatomy of the links corresponds closely with the recognized structure of proglottides from man, but the ova are distinctly smaller than those from the worm from human subjects (averaging 0.054 mm. long and 0.030 mm. transversely) and are slightly more pointed toward the operculated end. An



interesting reaction was noted when sulphuric acid was run under the coverglass of a water preparation containing these ova for the purpose of separating the lid, the interior of the eggs invariably assuming a pink to red color, very like the well-known "cholera red reaction" with stools of Asiatic cholera and doubtless due to the same cause, the presence of indol. The absolute identification of the material is, of course, not to be insisted upon, but the writer believes the specimens to be a variety or in very close relation to *Dibothriocephalus latus*. The host was an American fox, but it is not known from what part of the country it originally came.

27. *Bothridium pythonis*, Blainville (= *Solenophorus megalcephalus*, Creplin), has been obtained several times (Path. Mus., 40; Path. Hist., 774) from pythons; once from the intestine of a *Python molurus*, at autopsy, in the Zoölogical Gardens, and again in the dejecta of a living *Python reticulatus* in the collection of the Gardens. Numerous examples were found in the material from each snake (cf. article on *Solenophorus megalcephalus* by Smith and Veeder, *Trans. Phila. Path. Soc.*, 1905). Recently another lot of these same worms have been sent to the laboratory from the Gardens, having been discharged together with a large number of ascarides from a *Python reticulatus*, but as yet these have not been fully studied and recorded, and are not included in the present series.

### III. Nematodes.

28. *Ascaris lumbricoides*, Linn., from the human intestine, has been submitted to the laboratory a number of times (among others, Path. Mus., 38; Path. Hist., 1179), most of which have unfortunately not been recorded. Among those not placed of record was one vomited by a child in the early part of an attack of measles, and in the same family several days earlier another child with the same infectious disease passed several of the worms *via recti*. The voidance

of intestinal parasites in the course of acute infectious fevers is by no means an uncommon occurrence; it is thought to be possibly due to a deleterious action of the toxins of the disease upon the parasites, causing them to lose whatever attachment they may have had to the intestinal wall, or weakening or killing them and thus permitting them to be swept with the discharges from the canal. Some years ago a similar experience was met by the writer in the case of a young man who was known, from the discovery of the ova in his stools, to be the host of *Uncinaria americana*, Stiles. The ova had been repeatedly observed in the feces until an attack of smallpox intervened. Shortly thereafter, and continuously from the time of the variola, no more ova could be detected in the excrement, the presumption being that the parasites had been lost during the febrile period.

29. *Ascaris equorum*, Goeze (= *A. megaloccephala*, Cloquet), was met twice in the present series, once (Path. Hist., 775) passed in the dejecta of a Burchell zebra, *Equus burchelli*, in the collection of the Zoölogical Gardens, and the second specimen picked up in the street by one of the medical students, Mr. O. H. P. Pepper, where, doubtless, it had been deposited by some passing horse.

30. *Ascaris canis*, (Werner) (= *A. mystax*, Zeder), has been repeatedly met in the intestines of dogs used in experimental work in the laboratory (Path. Mus., 33); was referred in one instance (Path. Mus., 14) by Dr. J. J. Repp from a dog in Iowa; was found (Path. Hist., 1447) in the intestine of a chow-dog, the hairless Chinese dog, *Canis domesticus sinensis* (P. Z. G., 1015); and in large numbers from the intestine of a puppy which died in the veterinary hospital of Dr. Horace Hoskins, in this city.

It is generally accepted that the examples of this type of worm met in cats are identical; although it is true that minor differences have been noted and that the feline specimens are often spoken of as constituting a separate variety, *A. canis*, var. *cati*. In the list of laboratory studies specimens are recorded from the domestic cat, *Felis catus*, from Texas



(Path. Mus., 18) and from Philadelphia from the veterinary hospital of this university, and also from a jaguarundi (Path. Hist., 1662), *Felis jaguarundi* (P. Z. G. Lab., 1157), received from a dealer, shortly before its death, into the collection of the Zoölogical Gardens.

31. *Ascaris leptoptera*, Rudolphi. Under the name *Ascaris leptoptera* round worms closely related to *Ascaris canis* have been described from a number of the larger cats, but there has always existed a lack of uniformity of description, which has long given the idea that several varieties and possibly several species have been confused under the name. Two instances of these parasites are included in the present list, both from lions (Path. Hist., 1102, 1148), in one case obtained at autopsy from the stomach and intestines of a lioness (P. Z. G. Lab., 794), and in the other found in the feces of a living lion in the collection of the Zoölogical Gardens. The worms from the two animals are identical, and to the writer's mind present sufficient peculiarity to permit them to be regarded as constituting a new variety. For full description, see special article in this journal (p. 43).

32. *Ascaris aquillæ*, n. s. (Path. Hist., 1637), from the proventricle of a bald eagle, *Haliæetus leucocephalus* (P. Z. G. Lab., 959). For description of these specimens, see special article in this journal (p. 48).

33. *Ascaris serpentulus*, Rudolphi (Path. Hist., 1683), from the intestine of a demoiselle crane, *Anthropoides virgo* (P. Z. G. Lab., 1165), a European crane which had been in the Gardens for about three months.

34. *Ascaris ardeæ*, n. s. (Path. Hist., 1681), from the intestine of a blue heron, *Ardea herodias* (P. Z. G. Lab., 1158). This bird was also the host of the *T. unilateralis*, Dujardin, above mentioned (16) and an undescribed species of dispharagus. For detailed description, see special article in this journal (p. 50).

35. *Ascaris rubicunda*, A. Schneider (Path. Hist., 1677), in large numbers from the intestine of an Indian python, *Python molurus* (P. Z. G. Lab., 1122).

36. *Ascaris anoura*, Dujardin (Path. Hist., 773), passed in large numbers with the feces of a living python, *Python reticulatus*, in the collection of the Zoölogical Gardens.

37. *Heterakis papillosa*, (Bloch) (Path. Hist., 1615), from the ceca of a golden pheasant, *Chrysolophus pictus* (P. Z. G. Lab., 1055).

38. *Heterakis perspicillum*, (Rudolphi) (Path. Mus., 21), from the intestine of domestic fowl, *Gallus gallinaceus*, collected by Dr. S. H. Grant, in Texas. Another, but unrecorded, instance of this parasite was submitted for identification by Dr. L. L. Powell in the summer of 1905, the worm having been found in an egg of a domestic fowl in this city. Such inclusions of intestinal worms in eggs usually creates considerable wonderment, but is no very rare occurrence. The worm, passing by way of the cloaca of the fowl into the oviduct, comes to be mingled with the albumen and encased by the shell of the egg.

39. *Oxyuris vermicularis*, (Linn.) (Path. Mus., 4), is recorded as met in numbers in an appendix vermiformis removed by Dr. J. G. Clark from a woman in the University Hospital, the parasites having very possibly been an important factor in exciting the symptoms of appendicitis leading to operation. In addition to this instance a number of other groups of the same worm have been submitted for identification from time to time, but for some reason, presumably because of their frequency and ease of recognition, were not recorded.

40. *Oxyuris equi*, Schrank (Path. Mus., 8), collected by Dr. J. J. Repp, in Iowa, from the colon of a horse, *Equus caballus*.

41. *Oxyuris megatypylon*, (Rudolphi) (Path. Hist., 776), from the large intestine of an iguana, *Iguana tuberculata*, in the collection of the Zoölogical Gardens.

42. *Oxyuris microtypylon*, n. s. (Path. Hist., 1121), from the large intestine of a Cuban iguana, *Cyclura nubila* (P. Z. G. Lab., 827). For detailed description, see special article in this journal (p. 52).



43. *Oxyuris evoluta*, Linstow (Path. Hist., 1636), from the small intestine of a Canada porcupine, *Erethizon dorsatus* (P. Z. G. Lab., 991). Linstow (*Mith. Mus. Berlin*, i, heft 2, p. 20) has described from *Hystrix brachyura* (?) an oxyuris apparently the same as the specimens here recorded; but so far as is known to the writer the present instance is the only one, aside from Linstow's original observation, in which these parasites have been recognized, and inasmuch as Linstow's record is extremely brief the description entered in the laboratory records from the material in hand seems worthy of full publication. Linstow found his material in the zoölogical collection of the Berlin Museum of Natural History labelled as obtained from *Hystrix brachyura*, but in a footnote to his communication manifests uncertainty as to the correctness of the specific name of the porcupine. He states in brief that only female examples were present, which measured 9.1 mm. in length and 0.47 mm. in thickness; that the esophagus, which ends in a bulb, measured 1 : 11.5, and the long pointed tail 1 : 7.7 of the body length of the worm; that the vagina of the specimens projected as a thick tube 0.22 mm. in length and 0.044 mm. thick; and that the cuticle at the head end was swollen out in a fusiform manner.

The notes of laboratory study (Plate I) of the writer's material, made July 22, 1907, are as follows: From the small intestine of this animal (Canada porcupine) were obtained fifteen small nematodes, all female and non-gravid, the largest (Fig. 1) measuring 8 mm. in length and 0.5 mm. in thickness at thickest level (about 2 mm. from head end), the smallest about half this size. Specimens nearly round in section; tapering anteriorly to the head, which at base of lips measures from 0.07 to 0.09 mm. in diameter; tapering more gradually posteriorly to a long slender tail ending almost effilate, as in oxyuris. Cuticle thin and transparent, finely striated transversely (striæ 0.01 mm.); at head end two cuticular swellings (Figs. 2 and 3) of small size one on either side of base of dorsal lip; and back of lips cuticle of head end slightly swollen in fusiform manner. The body wall, from about the

level of the esophageal bulb, shows two longitudinal ventro-lateral granular bands (apparently not cuticular, but due to the granular muscles showing through the cuticle). Three nearly equal lips (Fig. 3), each with a ridge from base to tip, this ridge at base, near middle of lip, and at the margin, showing special thickenings. Opposite the intervals between these lips and reaching in each case to near the middle of the lips the cuticle extends forward like an outer set of lips, each with five marginal lobes. On either side of dorsal lip, outside the last-named structures, is seen a more or less lobulate but small cuticular swelling. When seen from the side these various lobate protrusions and the lips give a coarsely fringed appearance to the front of the head. The esophagus (Figs. 1 and 4) measuring a little more than 1 mm. in length (including the bulb), is at first nearly uniform in diameter and slender (0.08 mm. in diameter), but gradually thickens in flask-like manner until at a level of 0.8 mm. from the lips it has attained a diameter of 0.17 mm., just back of which it contracts, and from this constriction forms a spheroidal bulb (0.2 mm. long and 0.23 mm. in diameter). Transverse section (Fig. 5) shows a triradiate esophageal lumen; within the bulb a three-toothed (?) armature. For about 1 mm. beyond the bulb the intestine is thick (0.2 to 0.25 mm.), after which it narrows (0.15 to 0.1 mm. or less), running a straight course to the anus. In the rectum it again expands in a fusiform manner; and at the posterior portion of this part of the tube are attached several large monocellular anal glands. Anus situated 1.4 mm. from the tip of the tail. Vulva at one-third of body length from the head (2.5 mm. in an 8 mm. example). In all of the specimens the vagina (Figs. 1 and 6) projects as a thick finger-like tube beyond the body wall, covered on the outside with cuticle and with the central lumen surrounded by what seems to be a layer of circularly disposed muscle cells. In specimen of 8 mm. length, this vaginal extension measured 0.4 mm. in length; and in all the rest of the specimens in hand it bears similar proportions. At the distal end it is subdivided, the lumen opening between



the two lateral lobes. Within the body the vagina extends posteriorly an equal distance (about 0.4 mm.) before opening into the uterus; uterus simple, extending posteriorly (2 mm. in length in the specimen measured), and showing one, two, or three cyst-like dilatations in its course. The dilatations mentioned are variable in size as well as in number, but may reach above 0.2 mm. in width and 0.5 mm. in length. While in the non-dilated parts of the uterine canal (diameter about 0.05 mm.) the wall is thick, rather opaque, granular, and yellowish, and closely crowded with cells, the walls of these cyst-like expansions are very thin, transparent, without appreciable color, and made up of large flat cells very like the endothelial cells of mammals. At its posterior extremity the uterine tube narrows to a blunt point, into which the two ovarian tubes enter. The latter are to be seen passing forward from this point, tortuously plicated along the posterior two-thirds or three-fourths of the uterus, then leaving the uterus to extend forward along the body wall ventrally and dorsally nearly to the level of the vaginal protrusion, and ending in a large geniculate ovarian tube apparently attached to the body wall. No trace of ova or of larval worms were met in any of the specimens (all examined closely for this feature).

At first the peculiar protrusion of the vaginal tube was supposed to be the result of artefact, but careful study soon satisfied the writer that it constituted a constant and specific feature; and no suggestion of similarity to allantonema could be entertained. Tentatively the name *Oxyuris evaginata* was applied in the records to the specimens, but subsequent examination of the literature has fixed the prior recognition of the worm to Linstow, and compelled the retraction of the writer's provisional name and the adoption of that employed by Linstow. The singularity that in both Linstow's material and that of the writer only female specimens were encountered is striking; and it is possible that the virgin state of the specimens may have some bearing, as yet unappreciated by the writer, upon the peculiar vaginal evolution.

44. *Strongylus filaria*, Rudolphi (Path. Hist., 1680), from the bronchial tubes of a bison, *Bison americanus* (P. Z. G. Lab., 289).

45. *Strongylus paradoxus*, Mehlis (Path. Mus., 15), from the bronchial tubes of a domestic hog, *Sus scrofa*, collected in Iowa by Dr. J. J. Repp.

46. *Esophagostoma inflatum*, (A. Schneider), (Path. Hist., 1673), met along with several specimens of an unknown globocephalus in the lumen and in several tiny submucous cysts in the wall of the intestine of a pig-tailed macaque, *Macacus nemestrinus* (P. Z. G. Lab., 508).

The worms, one male and four females, are colorless, cylindrical on section, rigid, opaque; cuticle finely striated transversely. They are of nearly uniform thickness in the greater part of the body length, tapering slightly anteriorly to a head about a quarter as wide as the body of the worm, tapering posteriorly less rapidly to the tail. Mouth terminal, circular, surrounded by a chitinous ring with the cuticle over this elevated into a prominent circular lip. Upon the latter six rather long, pointed papillæ. Posterior to this lip the cuticle of the head is expanded into a collar extending for about one-third the length of the esophagus, sharply defined posteriorly by dorsal and ventral depressed transverse lines. From the level of these on each side a narrow alar cuticular expansion, in which there is situated a pointed papilla (opening of cervical glands). No buccal cavity or capsule, the esophagus beginning immediately back of the mouth opening. Esophagus flask-shaped, relatively short; intestine large, with thick cellular wall, the columnar cells of which show especially distinctly posteriorly. Anus subterminal in both sexes. The largest female measures 16 mm. in length and 0.45 mm. in thickness at middle. Tail obtusely conical, with mucronate tip. Anus 0.2 mm. from tip of tail. Vulva prominent, with thick circular lip, situated 0.35 mm. anterior to anus. Double ovarian tube. Ova yellowish, elliptical, with single, smooth, colorless shell, and with interior often segmented; measures 0.06 to 0.08 mm.



in length and 0.044 to 0.048 mm. in transverse diameter. The measurements of the head structures follow: transverse diameter of circular lip, 0.1 mm.; of chitinous ring underlying this lip, 0.06 mm.; diameter of oral opening, 0.02 to 0.03 mm.; length of collar about neck of worm, 0.26 mm., transverse diameter of same, 0.28 mm.; length of esophagus, 0.7 mm., with a transverse diameter in its posterior portion, 0.2 mm.; lateral cervical papilla 0.17 mm. posterior to this collar.

The single male example included in the material measures 14.5 mm. long, and at middle of length 0.45 mm. in thickness. Tail obtusely conical, ending in a bilobed bursa (with indistinct ventral lobe), not much wider in lateral (0.6 mm.) than in dorsoventral measurement (0.4 mm.). Dorsal ray deeply bipartite, its divisions widely curving from one another, each with a single, simple, small branch near root; dorsomedian ray simple, arising at base of dorsal ray; lateral and ventrolateral rays from a common base, the former divided; ventral ray divided. Just above the level of the cloaca a small ray or papilla from the body wall. Cloaca 0.2 mm. from tip of tail. Two equal, long, pliant spicules, 1.3 mm. long and protruded in the specimen examined 0.9 mm. Anterior end of male as in female.

Comparison of these features with those of known œsophagostomes would indicate a close relation with *Æ. inflatum* (A. Schneider), if not entire identity. In many respects it agrees well with Linstow's *Strongylus aculeatus* (*Württemb. Jahresb.*, 1879, p. 333) from a macaque monkey, but the mouth parts are distinctly different (in the presence of the cervical collar and in the absence of the two lateral teeth in the mouth); and both anteriorly and in the details of the male tail it differs distinctly from Molin's *Æsophagostoma pachycephalum* (*Il sottordine degli Acrofoli*, p. 450) of a cercopithecus. While the host in this case is far removed from the ordinary host of *Æ. inflatum* (large intestine of beef), the correspondence of structure is so great as to make the writer unwilling to regard it as constituting a separate species. This detail of description is here inserted for reference, inas-

much as the occurrence of the worm in such unusual situation may excite question as to the correctness of identification.

47. *Globocephalus macaci*, n. s. (Path. Hist., 1673), met along with the immediately preceding parasite in the intestine of a pig-tailed macaque, *Macacus nemestrinus*. For description, see special article in this journal (p. 59).

48. *Sclerostoma equinum*, (F. Muller) (Path. Mus., 9), from the subperitoneal tissues of a colt, *Equus caballus*, in Iowa, collected by Dr. J. J. Repp.

49. *Syngamus trachealis*, v. Siebold (Path. Hist., 1108), from the trachea and bronchial tubes of a young Reeves' pheasant, *Phasianus reevesi*, killed in the Zoölogical Gardens to prevent development of an epidemic of the "gapes."

50. *Uncinaria duodenalis*, (Dubini) (Path. Mus., 2; Path. Hist., 148), obtained at autopsy from the upper part of small intestine of human being; two cases, both white men and both Europeans, the first in Galveston, Texas, the second in the Philadelphia Hospital.

51. *Uncinaria americana*, Stiles (Path. Mus., 1), obtained after administration of thymol from the dejecta of human being in Galveston, Texas. Two instances of this parasite have been brought to the laboratory from the University Hospital and from the Philadelphia Hospital for identification of the ova, and subsequently for verification of the worms, but neither of these are included in the records of the laboratory.

52. *Uncinaria canina*, (Ercolani), is comparatively common in the intestines of dogs used in the laboratory for experimental purposes, some animals being heavily infested. It is recorded in the laboratory notes also from the dog, *Canis domesticus*, from Galveston, Texas (Path. Mus., 24); from the duodenum and jejunum (Path. Hist., 1106) of an eyra, *Felis eyra*; from the duodenum (Path. Hist., 1662) of a jaguarundi, *Felis jaguarundi* (P. Z. G. Lab., 1157); and (Path. Hist., 1643) from the small intestine of a gray wolf, *Canis mexicanus nubilus* (P. Z. G. Lab., 919).

53. *Physaloptera turgida*, Rudolphi (Path. Hist., 1656,



1660, 1685), from the stomach of the common opossum, *Didelphis virginiana*, from the Wistar Institute of Anatomy and from the Zoölogical Gardens (P. Z. G. Lab., 324, 1166).

54. *Trichuris trichiura*, (Linn.), is recorded from the colon of man (Path. Mus., 3; Path Hist., 148) in the records of the two autopsies above referred to (50) under *Uncinaria duodenalis*. Ova of this worm have also been identified several times in the stools of human beings (unrecorded).

55. *Trichuris suis*, (Schränk) (Path. Mus., 16), from the large intestine of the domestic hog, *Sus scrofa*, collected in Iowa by Dr. J. J. Repp.

56. *Trichuris vulpis*, (Frölich) (Path. Mus., 35), from the large intestine of dog, *Canis domesticus*, in the laboratory.

57. *Trichuris ovis*, (Abildgaard) (Path. Hist., 1901), from the large intestine of an antelope, *Antelope furcifer*, in the Zoölogical Gardens.

58. *Trichinella spiralis*, (Owen), has been met three times (as the encysted larval worms) in human muscle, having been once submitted (Path. Mus., 37) in a portion of the pectoral muscles of a badly infested human cadaver in the dissecting-room by Dr. J. K. Pollock, then a medical student of this school; and twice having been found (Path. Hist., 189, 358) in the muscle of the diaphragm in autopsy material from the Philadelphia Hospital.

59. *Filaria immitis*, Leidy (Path. Mus., 6), from the right heart and pulmonary artery of a dog used in experimentation in the laboratory.

60. *Filaria equina*, (Abildgaard) (Path. Mus., 19), from the peritoneum of a horse, *Equus caballus*, collected in Iowa by Dr. J. J. Repp. A second specimen was presented by Dr. Repp, a single male example, which was taken from the anterior chamber of the eye of a horse in Iowa (Path. Mus., 7). The name *Filaria oculi* has been attached to such examples; but the anatomy of the specimen leaves no doubt in the writer's opinion that this is merely an aberrant example of the species here named.

61. *Filaria labiato-papillosa*, Alessandrini (Path. Mus., 17), was collected by Dr. J. J. Repp, in Iowa, from the peritoneum of a cow, *Bos taurus*. A single example (Path. Hist., 1675) was sent into the laboratory from the Zoölogical Gardens labelled as having been found in the body of a bison, *Bison americanus* (P. Z. G. Lab., 960); but when further data were sought in reference to its precise habitat, there was found no reference to its discovery in the records of the laboratory of the Gardens, and a question existed in the mind of the pathologist as to the correctness of the label. There is therefore an uncertainty as to this specimen, which, however, if correctly labelled, is, as far as the writer knows, the first instance of its occurrence in the American bison.

62. *Filaria gracilis*, Rudolphi (Path. Hist., 1642, 1645), has been identified from specimens found in the peritoneal cavity of two monkeys in the Zoölogical Gardens, the first a white-throated cebus, *Cebus hypoleucus* (P. Z. G. Lab., 955), the second from an unindicated species.

63. *Filaria pungens*, A. Schneider (Path. Hist., 1696, 1716), is recorded as found in the air sacs of a red-headed weaver-bird, *Tondia madagascariensis* (P. Z. G. Lab., 1028), and from the peritoneum of a blue-bearded jay, *Cyanocorax cyanopogon* (P. Z. G. Lab., 404).

64. *Filaria australis*, Linstow (Path. Hist., 1701), was met in the peritoneal cavity of a brush-tailed wallaby, *Petrogale pencillata*, from the Zoölogical Gardens. The writer regards the specimen described as *Filaria spelæa*, Leidy (Pr. Acad. Nat. Sci., Phila., 1875, vol. 27, p. 17), as probably identical, in which case Leidy's name would take preference to that of Linstow's.

65. *Spiroptera incerta*, n. s. (Path. Hist., 1109, 1120, 1453, 1463, 1613, 1616, 1618, 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1626, 1627, 1628, 1629, 1630, 1631, 1644, 1661, 1672, 1675, 1686), has been met in the proventricle and gizzard of several dozen birds. The parasite has been endemic in the bird house at the Zoölogical Gardens, and has appeared particularly among the parrakeets, amazons, conures, and parrots;



but in the list there is also an instance of its occurrence in a valley quail, and quite recently (not included in the present list) it has appeared among the pigeons. For a description and fuller account of the various hosts, see special article in this journal (p. 60).

66. *Spiroptera* (?) *iguanæ*, n. s. (Path. Hist., 1641), from the lung of a Cuban iguana, *Cyclura nubila* (P. Z. G. Lab., 1127). For description, see special article in this journal (p. 66).

67. *Dispharagus ardeæ*, n. s. (Path. Hist., 1681), was met in the alimentary canal of a blue heron, *Ardea herodias* (P. Z. G. Lab., 1158). A single female specimen was found along with a number of ascarides (*Ascaris ardeæ*, *supra* 34) and fragments of *Tænia unilateralis* (*supra*, 16). The entire lot of material was submitted in one bottle, with the statement that the worms were found in the proventricle, stomach, and intestines of the bird, and it is impossible to fix the precise habitat in the canal for the specimen here listed. For description, see special article in this journal (p. 67).

68. *Anguillula aceti* (Path. Hist., 60). Dr. A. F. Coca, in examining a specimen of human urine submitted to the laboratory for diagnostic purposes, met numerous examples of anguillulæ in the fluid; but, inasmuch as the urine was contained in an old wine bottle, and subsequent specimens from the same patient, collected and preserved under careful precautions, showed none of the worms, it was assumed that the examples first observed had been present in acetous remnants in the bottle and were not to be regarded as one of the occasional instances of parasitism by this worm in the urinary or urogenital tract of man.

## B. ARTHROPODA.

69. Larvæ of *Lucilia macellaria*, (Fabricius) (Path. Mus., 10), the common "screw-worms" of the South. The specimens were removed from an ulcerous wound (in which

the ova of the fly had been deposited) upon the forehead of a girl in Galveston, Texas, by Dr. J. J. Terrill.

70. Larvæ of *Hypoderma lineatum*, (de Villers) (Path. Hist., 851), from the subcutaneous tissue of the face of a boy, aged three years, at Glasgow, Montana, a case of Drs. Hoyt and Getty. The child had had a series of swellings located upon the face, thigh, and other parts of the body, dating back to October, 1905; these attaining the size of half of a small apple, each with the appearance at the apex of a small, bluish hemorrhagic point. After the appearance of this apical spot the swellings would diminish and disappear, to be succeeded by similar lesions elsewhere. Finally, in February, 1906, one developed on the face, in which, after it had been well poulticed, the dark spot broke and the single grub appeared, which was submitted for identification. The writer has on one other occasion met a similar occurrence of the larva of this fly in man, in a case of Dr. Herff, of San Antonio, Texas (*Med. News*, December 6, 1902). In neither of these cases was the grub in the last moult.

Here, too, should be listed examples (Path. Mus., 13) of the so-called *Hypoderma ovis* larvæ, collected by Dr. J. J. Repp from the subcutaneous tissue of a sheep, *Ovis aries*, in Iowa. The grubs met in sheep beneath the skin are generally held to be larvæ of *H. lineatum* rather than those of a separate species, as has often been supposed. These are considerably larger than the human specimens just mentioned, and probably represent a more advanced moult than the above.

71. Larvæ of *Cuterebra fontinella*, Clark (Path. Hist., 1798), obtained by Dr. R. C. Rosenberger from the subcutaneous tissue of the neck of a common cotton-tail rabbit, *Lepus sylvaticus*, killed in the vicinity of this city.

72. Larvæ of *Gastrophilus equi*, (Clark) (Path. Mus., 12), obtained by Dr. J. J. Repp, in Iowa, from the gastric mucous membrane of a horse, *Equus caballus*.

73. *Clothilla inquilina* (Path. Hist., 1064). These insects were sent through the Pennsylvania State Health Depart-



ment to the laboratory by Dr. Koch, of Lyons Station, Penna., with the statement that they had infested in great numbers the clothing of one of his patients, a woman, and had caused an irritation similar to that produced by body lice. The same insects swarmed in a mill owned by the patient's husband. This insect has been met a number of times as an insect pest (cf. Railliet, Blanchard et al.). It is very similar to *Clothilla pulsatoria* (one of the "death-watch" insects), which Professor J. B. Smith, of Rutgers College, mentions in the New Jersey State Entomological Catalogue as closely resembling lice and being occasionally mistaken for them, and as sometimes taking practical possession of a whole house and becoming intolerable nuisances to the inhabitants. It is believed to be the same insect which Gay, in 1878, described as a parasite of horses under the name *Trichodectes quadricornis*.

74. *Boöphilus bovis*, Curtice (Path. Mus., 11), the common cattle tick, the carrier of Texas fever of cattle, collected in Iowa by Dr. J. J. Repp.

75. *Pentastoma denticulatum* (Path. Hist., 1640), the larval stage of *Linguatula rhinaria*, (Pilger), from the lung of a gazelle, *Gazella dorcas*, from the Zoölogical Gardens.

76. *Demodex folliculorum*, var. *hominis*, (Simon) (Path. Hist., 210), was encountered in the ducts of the sebaceous glands in a section of a chronic inflammatory lesion of the eyebrow of a woman in St. Mary's Hospital, Philadelphia, submitted for examination by Dr. J. M. Swan. The parasites are probably only coincident with the inflammation, but the inflammatory changes in the walls of the infested ducts suggest that they may have had some part in maintenance of the long-standing irritation producing the lesion.

## PLATE I.

*Oxyuris evoluta*, Linstow: (camera lucida drawings; a line is drawn from each figure to the scale of enlargement employed).

FIG. 1.—Outline of complete worm: *a*, intestine; *b*, vaginal protrusion; *c*, intracorporeal portion of vaginal tube; *d*, *d*<sub>1</sub>, *d*<sub>2</sub>, uterine canal and its expanded portions; *e*, oviduct and ovarium; *f*, anus; *g*, esophagus and bulb; *h*, fusiform cuticular expansion at head end.

FIG. 2.—Frontal view of head end: *a*, dorsal lip; *a*<sub>1</sub>, ventral lips; *b*, one of the three lip-like extensions of cuticle over the lips proper; *c*, one of the two dorsolateral cuticular swellings showing its three papillae.

FIG. 3.—Lateral view of head end.

FIG. 4.—Head end, showing esophagus and bulb: *a*, fusiform cuticular swelling; *b*, esophagus; *c*, esophageal bulb, with its armature.

FIG. 5.—Transverse section of esophagus in its posterior portion, showing its triradiate lumen.

FIG. 6.—Details of genital apparatus: *a*, body wall; *b*, extracorporeal vaginal protrusion; *c*, intracorporeal portion of vagina; *d*, *d*<sub>1</sub>, *d*<sub>2</sub>, uterine canal with its cyst-like expansions; *e*, ovarium; *e*<sub>1</sub>, *e*<sub>2</sub>, *e*<sub>3</sub>, oviduct plicated along uterus and entering posterior end of latter at *e*<sub>3</sub>.

## PLATE II.

*Tania paradoxuri* and *Cotugnia browni*: (camera lucida drawings; a line from each drawing indicates the scale of amplification employed).

FIG. 1.—*T. paradoxuri*: head and first links, showing the conical unarmed rostellum, and the oval suckers with a curved slit-like orifice.

FIG. 2.—Frontal view of head of *T. paradoxuri*.

FIG. 3.—Outline of anterior segments (2 cm. from head) of *T. paradoxuri*.

FIG. 4.—Outline of segment of *T. paradoxuri* near posterior portion of strobile, showing the capacious genital pore.

FIG. 5.—Ovum of *T. paradoxuri*.

FIG. 6.—*C. browni*: frontal view of head, showing depressed rostellum surrounded by row of numerous small hooks, and the globose suckers with circular orifices.

FIG. 7.—Lateral view of head and anterior segments of *C. browni*.

FIG. 8.—Isolated hook from armature of head of *C. browni*.

FIG. 9.—Diagrammatic drawing of fully developed but non-gravid segment of *C. browni* at 8 cm. from head (constructed from sections and from compressed segments): *C*, cirrus; *T*, testicles; *RS*, receptaculum seminis; *OV*, ovary; *Vg*, vitelline gland; *Ut*, uterus.

FIG. 10.—Ovum of *C. browni*.

## PLATE III.

*Tania eunectes*: (camera lucida drawings, except Fig. 4, which is diagrammatic in part, the general outlines, however, being from camera lucida tracings; the scale of enlargement employed is indicated by a line drawn from each drawing).

FIG. 1.—Head and incompletely grown strobile, without gravid links.

FIG. 2.—Frontal view of head.

FIG. 3.—Segments taken from a fully developed strobile from near head, to show the early development of the genital parts. (These were drawn by camera lucida from compressed links, which were originally considerably larger than the first links of the undeveloped strobile in Fig. 1, but which, by the compression, were much increased in both length and width).

FIG. 4.—Fully developed, but as yet non-gravid segment (partly diagrammatic); shows genital parts of segment: cirrus pouch, (*C*); genital pore, (*GP*); vagina, (*V*); receptaculum seminis, (*RS*); uterus, (*U*); testicles, (*T*); ovary, (*OV*), and vitelline gland, (*VG*).

FIG. 5.—Ovum with surrounding amnion.

## PLATE IV.

*Ascaris leptoptera*, Rud., new variety: (camera lucida drawings; a line from each drawing indicates the scale of enlargement employed).

FIG. 1.—Two ova, the one to the right containing a larval worm.

FIG. 2.—Anterior end of worm, to show extent and shape of alar cuticular expansions (*a*).

FIG. 3.—Internal aspect of dorsal lip, showing denticulate border and lobes of pulpa: *a*, denticulate border of lip; *b*, outer paired lobe; *c*, inner paired lobe; *d*, unpaired lobe.

FIG. 4.—External view of head from ventral surface, showing the two ventral lips with their papillae; on either side the first part of alar cuticular expansion.

FIG. 5.—Anterior view of head, showing lips and papillae (dorsal lip above), and beginnings of cuticular expansions laterally.

FIG. 6.—Ventral surface of tail of male; the cuticle, having been cut on the dorsum, is seen spread out laterally; shows the details of the postcloacal papillae: *c*, cloaca.

FIG. 7.—Lateral view of tail of male, showing both postcloacal and precloacal papillae: *c*, cloaca.

FIG. 8.—Tail of female; *a*, anus.

## PLATE V.

*Ascaris aquilla*: (camera lucida drawings).

FIG. 1.—Inner aspect of dorsal lip: *A*, interlabium; *B*, lobus impar; *C*, inner paired lobe; *D*, outer paired lobe. (Same scale of enlargement as Fig. 2.)

FIG. 2.—Outer aspect of dorsal lip, showing papillae, and the deep incision in anterior margin.

FIG. 3.—Frontal aspect of head, showing the lips and interlabia and the papillae of the lips.

FIG. 4.—Lateral aspect of head.

FIG. 5.—Ovum, drawn to show in upper part the tuberculated outer surface of the shell, and in the lower part the segmented interior.



## PLATE VI.

*Ascaris ardeæ* (camera lucida drawings; scale of enlargement is indicated by a line from each drawing).

FIG. 1.—Lateral view of anterior end, showing two of the lips (partly in profile) and two of the interlabia.

FIG. 2.—Frontal view of the head, showing the dorsal lip below and to the left.

FIG. 3.—Internal aspect of dorsal lip and two interlabia, showing details of pulpa of lip.

FIG. 4.—Tail of female.

FIG. 5.—Ovum, above showing the pitted external surface of the shell, and below showing the segmented interior.

FIG. 6.—Ventral surface of male tail. (Note the second pair of papillæ from tip of tail as uncertain.)

FIG. 7.—Lateral view of tail of male.

## PLATE VII.

*Oxyuris microtyphlon* and *Oxyuris megatypylon*: (camera lucida drawings; scale of enlargement is indicated for each by a line).

FIG. 1.—Ovum of *O. microtyphlon*.

FIG. 2.—Ovum of *O. megatypylon* (same scale, drawn in outline for comparison).

FIG. 3.—Frontal view of head of *O. microtyphlon*, showing the three lips and their papillæ.

FIG. 4.—Ventral view of tail of male of *O. microtyphlon* (to the left at the tip of the tail is a lateral view of the same for comparison; dotted lines connect identical structures): *a*, cuticle, showing the transverse striations; *b*, intestine; *c*, anterior lip of cloaca; *d*, posterior lip of same; *e*, postcloacal papillæ; *f*, postcloacal spinous support of tip of tail, bidigitate at its free end; *g*, larger intracuticular spine in tip of tail; *h*, spicule; *i*, body cavity.

FIG. 5.—Female example of *O. microtyphlon*: *a*, anus; *v*, vulva; *o*, ova in uterine canal; *b*, esophageal bulb; *e*, esophagus. The length of the specimen has been indicated by lines drawn into the body of the worm at intervals of 1 mm. from the head posteriorly.

FIG. 6.—Tail of a non-gravid female, showing the closer relation between the anus (*a*) and vulva (*v*) than in the preceding.

FIG. 7.—Male specimen of *O. microtyphlon* (same enlargement as FIG. 5, for comparison of size of male and female): *e*, esophagus; *b*, bulb of esophagus; *i*, intestine; *s*, spicule. (Length marked at millimeter intervals from head posteriorly.)

FIG. 8.—Tail of male *O. microtyphlon* with spicule partly protruded: *i*, intestine; *s*, spicule.

FIG. 9.—Tracing of tail of male *O. megatypylon* from Schneider.

FIG. 10.—Tail of male *O. megatypylon* from author's material.

FIG. 11.—Tail of female *O. megatypylon* (author's material), showing relative position of anus (*a*) and vulva (*v*).

FIG. 12.—Head end of *O. megatypylon* (author's material).

## PLATE VIII.

*Globocephalus ardeæ*: (camera lucida drawings; scale of enlargement indicated for each drawing by a line).

FIG. 1.—Frontal view of head showing mosaic appearance, the mouth and its chitinous ring and intra-oral spines (?), and showing faintly the armature at the base of the mouth cavity.

FIG. 2.—Armature of three curved chitinous plates (*a*) set in the floor of the mouth about the esophageal opening (*c*), and the three-sided chitinous ring (*b*) about the esophageal orifice.

FIG. 3.—Head end, showing (*a*), mouth; (*b*), mouth cavity; and (*c*), armature; (*d*), esophagus and cervical papillæ (*e*); and the cuticular collar (*f*) about the head and first part of neck.

FIG. 4.—Tail of female, showing (*a*) anus and (*b*) vulva.

FIG. 5.—Ova.

## PLATE IX.

*Spiroptera incerta*: (camera lucida drawings; the scale of enlargement is indicated for each drawing by a line).

FIG. 1.—Low amplification of a female worm, showing position of vulva (*V*), the divisions of the esophagus (*O*), position of anus (*A*), and the intestine (*I*).

FIG. 2.—Head end, showing cuticular expansions.

FIG. 3.—Transverse section of anterior end, showing cuticular expansions.

FIG. 4.—Frontal view of head, showing (*a*), lateral toothed lips; (*b*), dorsolateral, and (*c*), ventrolateral (submedian) lips; (*e* and *f*), dorsal and ventral tooth-like structure; and (*g*), outline of oral orifice.

FIG. 5.—Longitudinal view of head end, showing (*a*), lateral lip; (*b* and *c*), submedian lips; (*e*), median dorsal or ventral tooth-like structure; (*f*), mouth cavity; (*g*), first part of esophagus; (*h*), body wall; and (*i*), lateral cuticular expansions.

FIG. 6.—Outline of tail of female to show position of anus.

FIG. 7.—Ova, showing enclosed larvæ.

FIG. 8.—Ventral view of tail of male, showing (*a*), cuticular striations of the general body; (*b*), the quadrilateral cuticular plates within bursa; (*c*), cuticular expansions forming the bursa; (*d*), cloaca; (*e*), spicules, and the papillæ of the tail.

FIG. 9.—Specially enlarged view of the ventral side of tip of tail to show the small papillæ of this portion.

## PLATE X.

*Spiroptera* (?) *iguanae* and *Dispharagus ardeæ*: (camera lucida drawings; scale of enlargement indicated by line drawn from each figure).

FIG. 1.—*Spiroptera* (?) *iguanae*: ventral surface of tail of male, showing tip of tail and arrangement of papillæ about the cloaca.

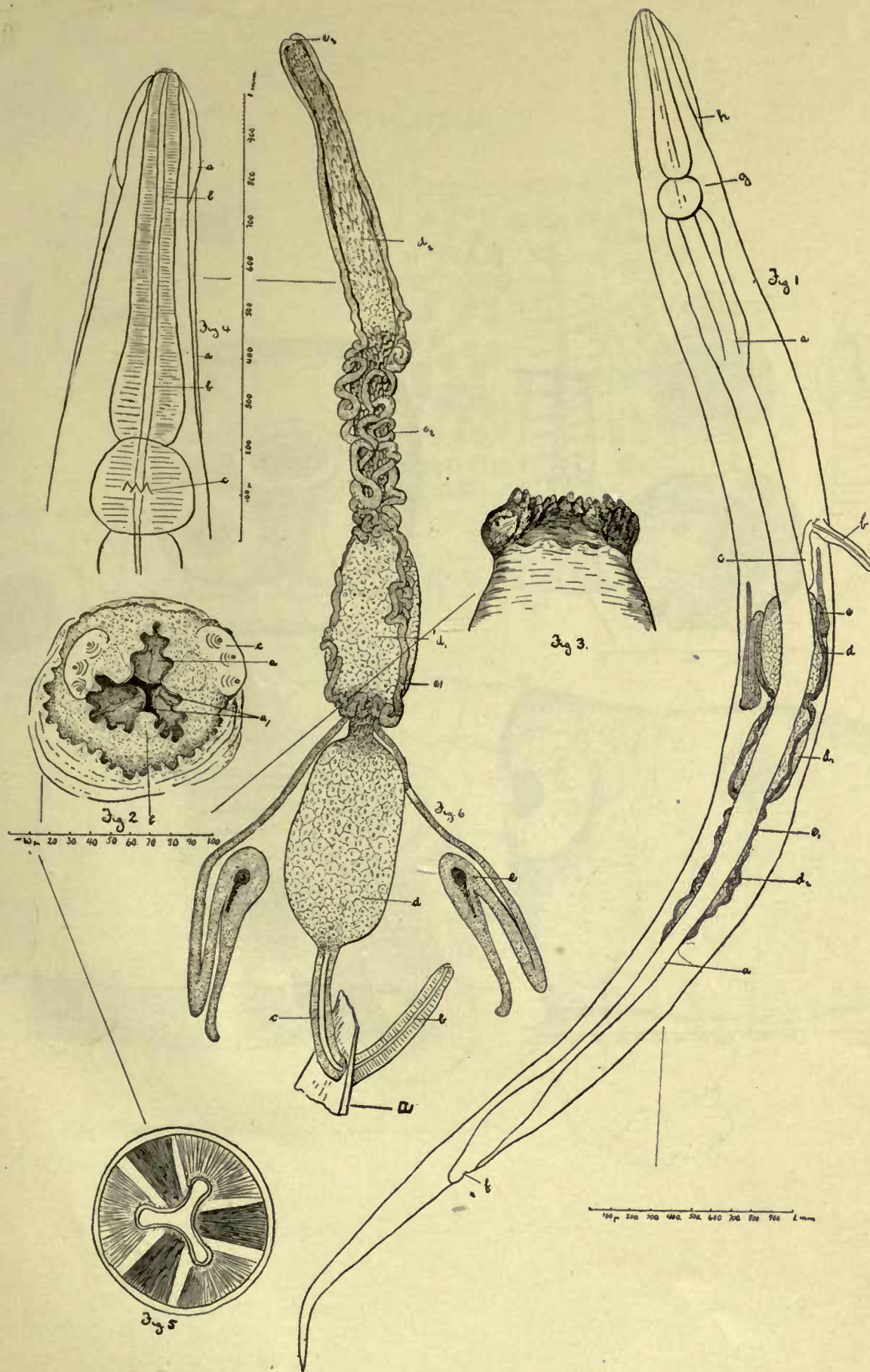
FIG. 2.—*Spiroptera* (?) *iguanae*: lateral view of tail of male, showing (*a* and *a*<sub>1</sub>), the principal and accessory spicules and (*b*) the cloaca.

FIG. 3.—*Spiroptera* (?) *iguanae*: head end, showing (*a*), mouth and (*b*), esophagus (structure of lips uncertain).

FIG. 4.—*Dispharagus ardeæ*: anterior end viewed laterally, showing (*a*), one of the lateral lips; (*b*), the "cordons;" (*c*), the anterior narrow, and (*d*), posterior wider portions of the esophagus.

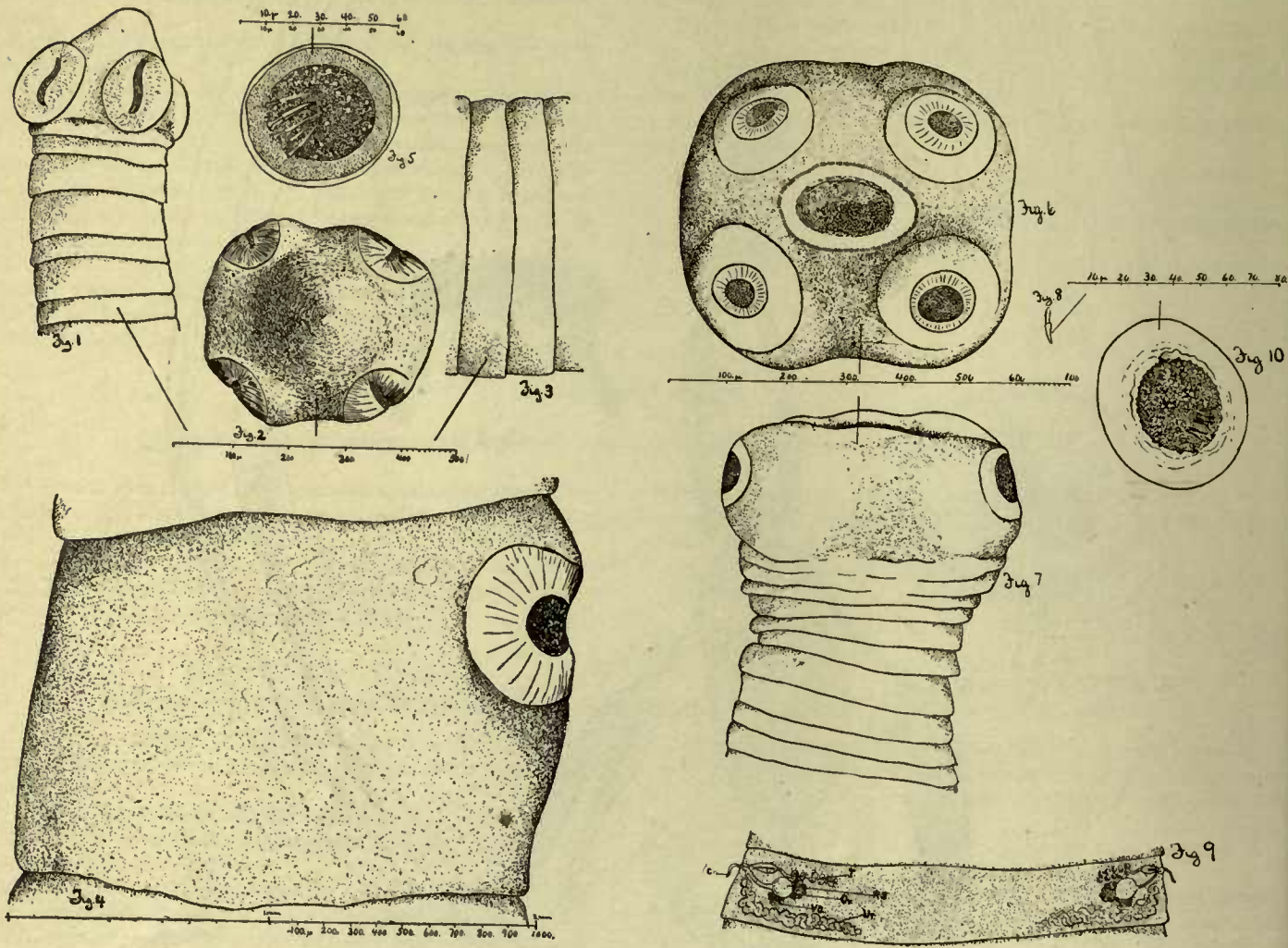
FIG. 5.—*Dispharagus ardeæ*: frontal view of head (lips bent to one side by pressure of coverglass), showing (*a*), the two lateral lips and (*b*) the beginnings of the lateral cords at bases of lips. (Scale of enlargement below, same as for Figs. 4 and 6.)

FIG. 6.—*Dispharagus ardeæ*: tail of female, showing position of anus (*a*), and the mammillary eminences (*b*) alongside of anus.



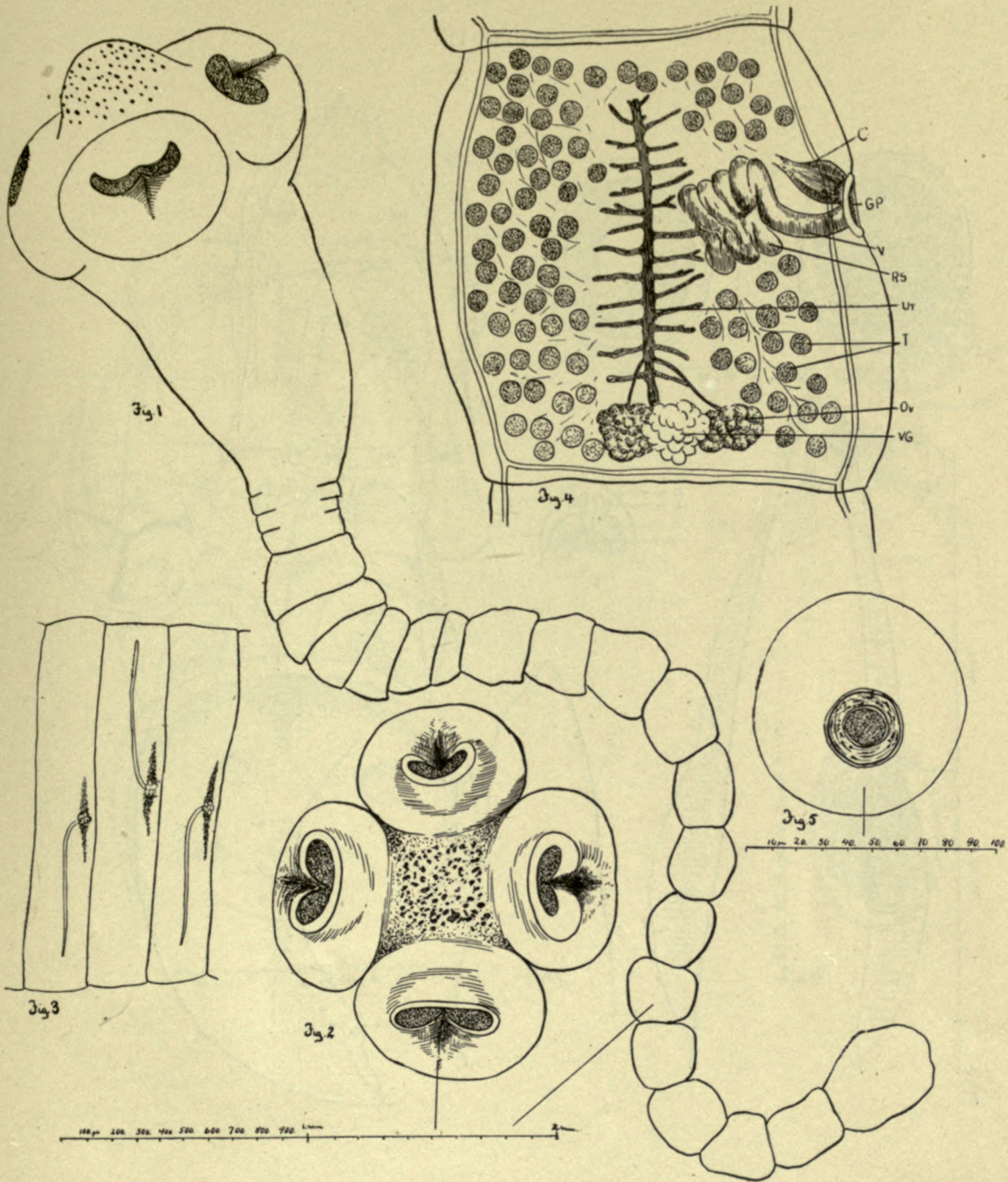


# PLATE II



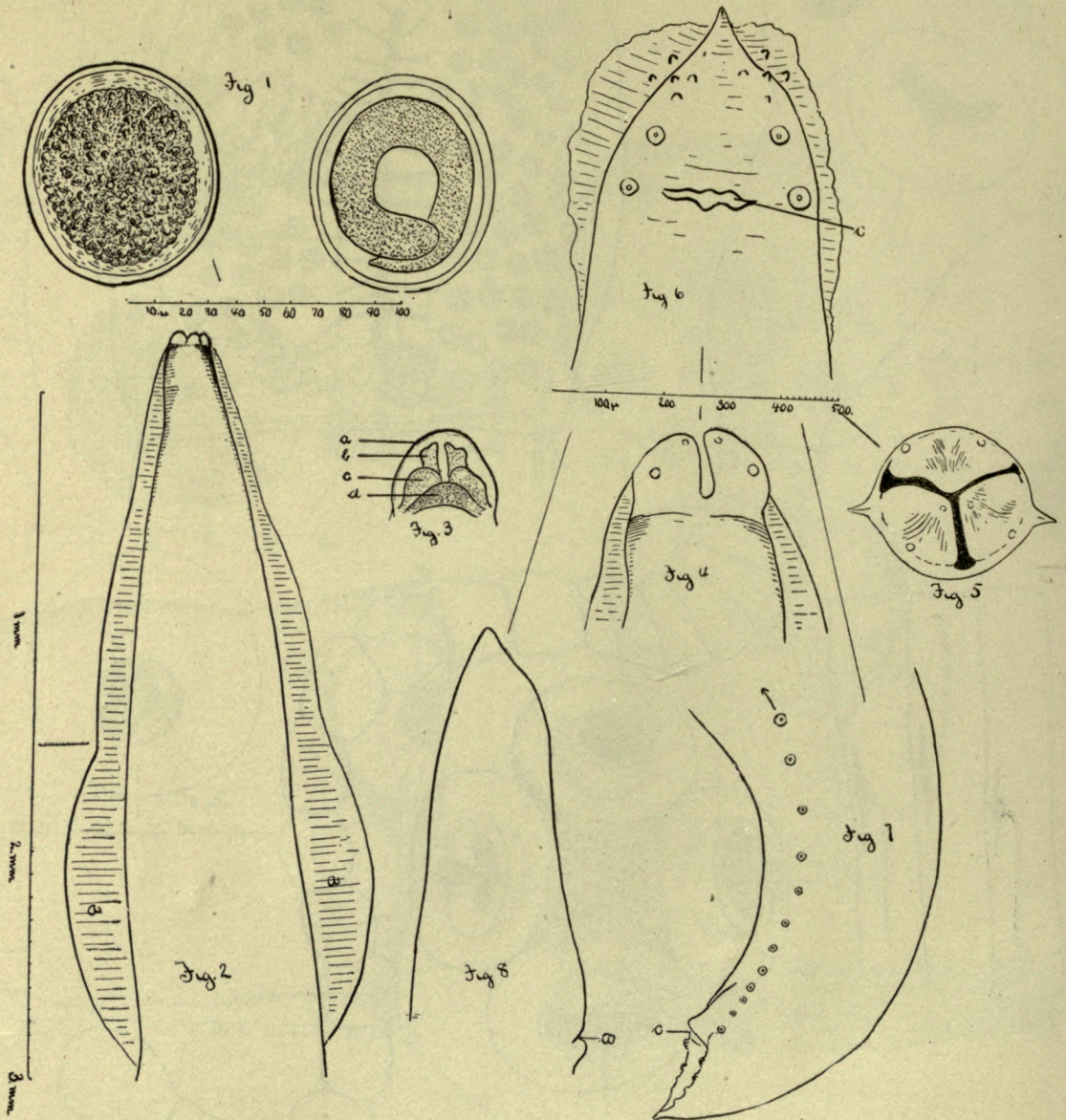


# PLATE III



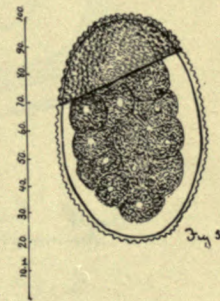
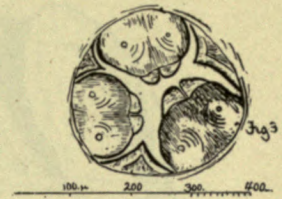
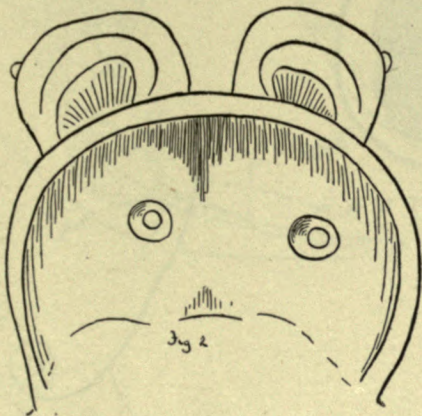
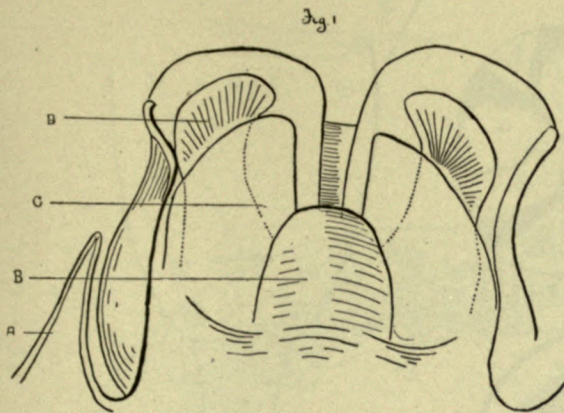


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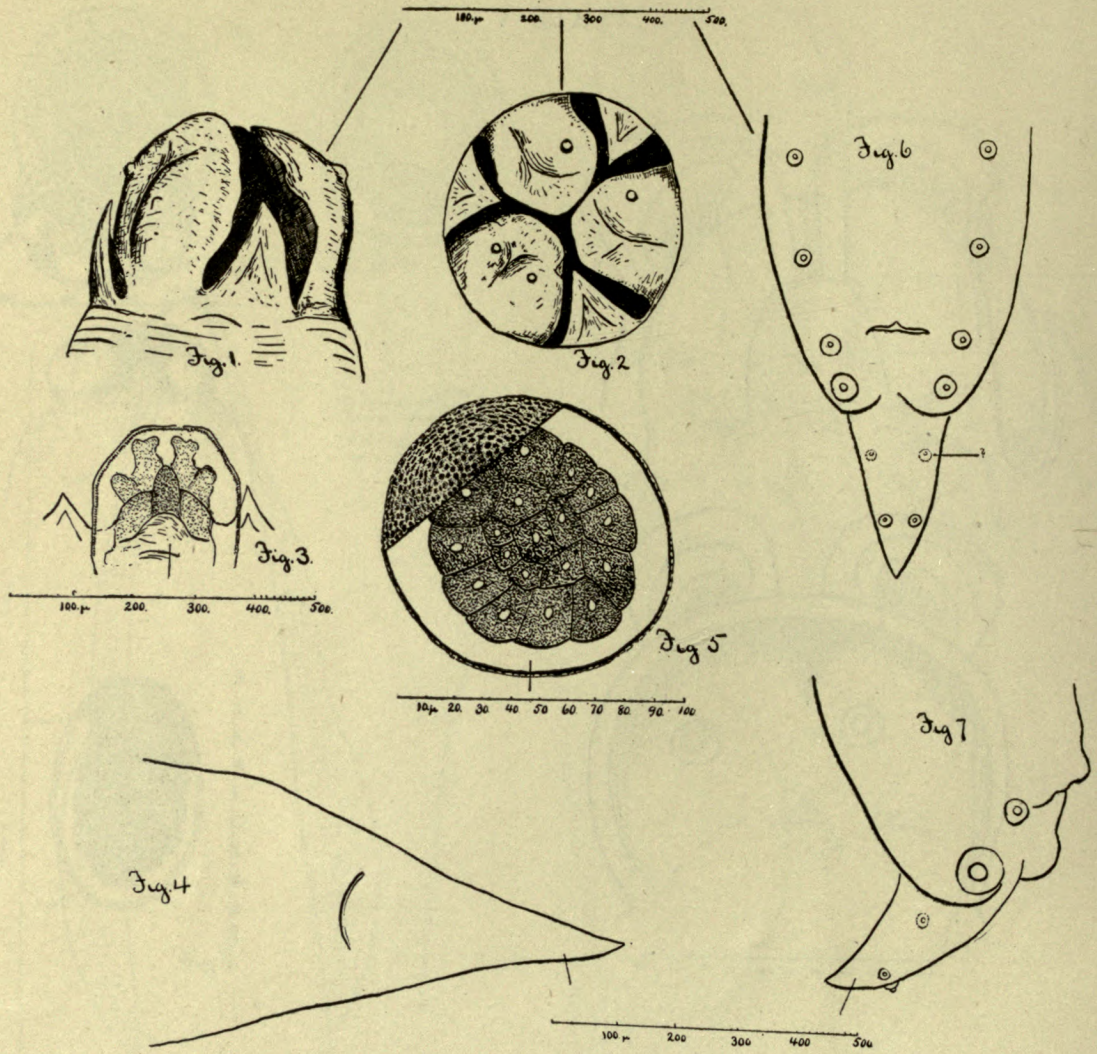


# PLATE V



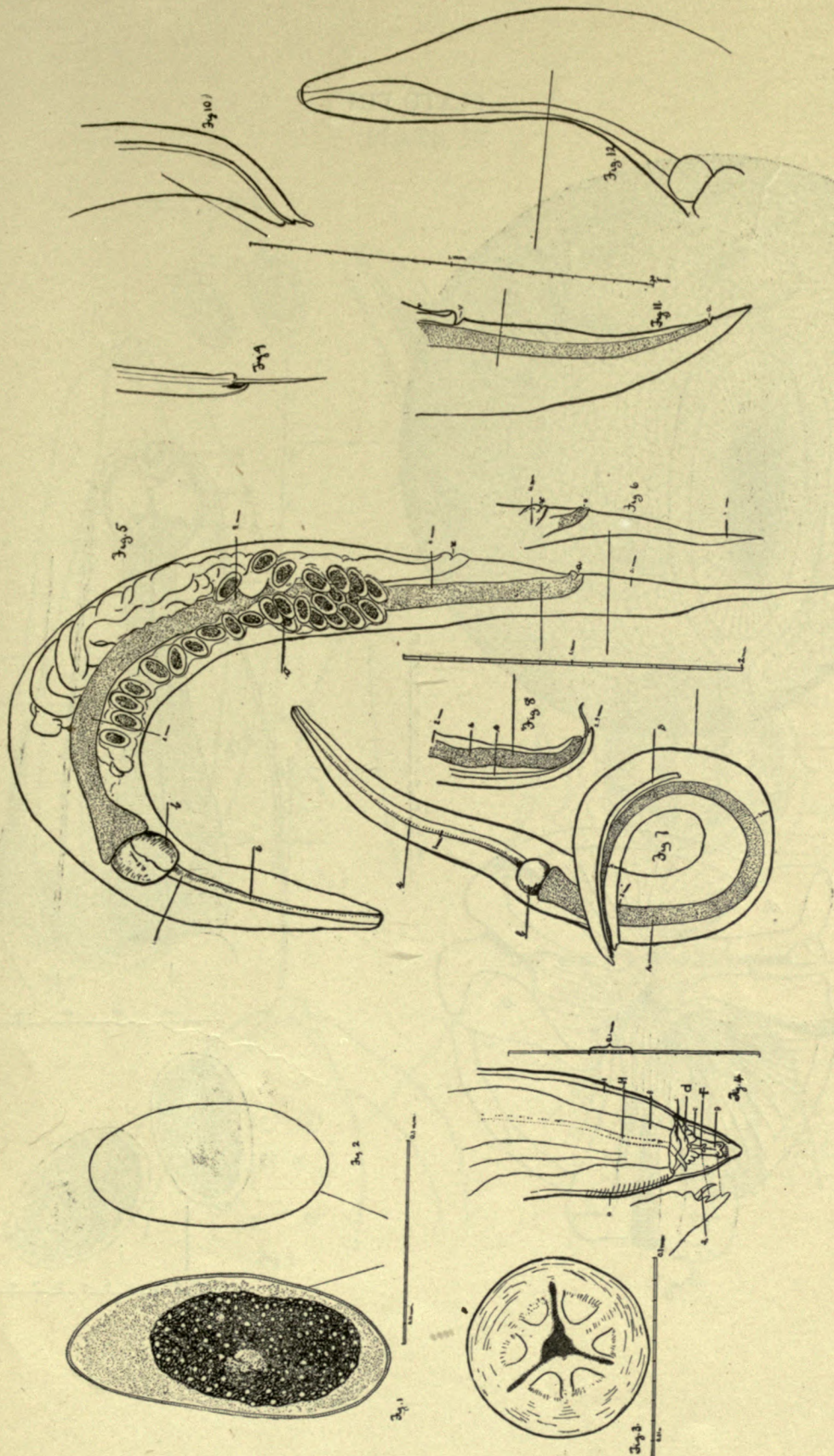


# PLATE VI



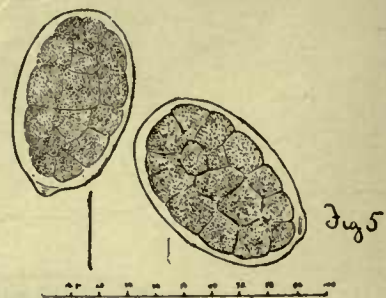
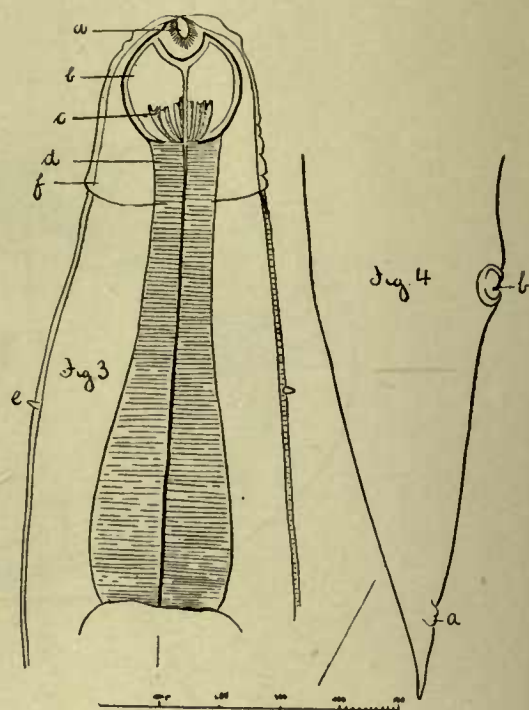
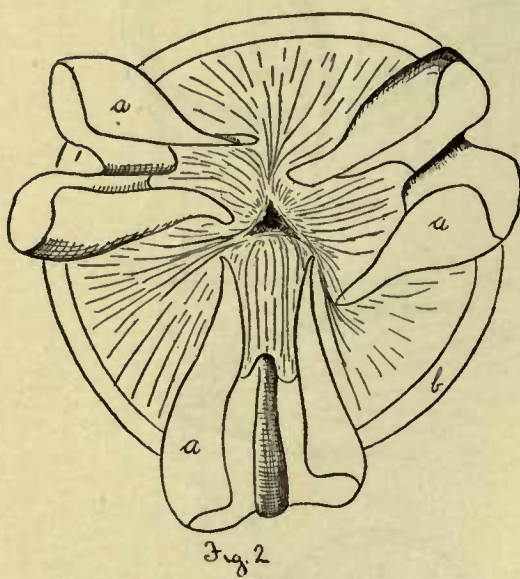
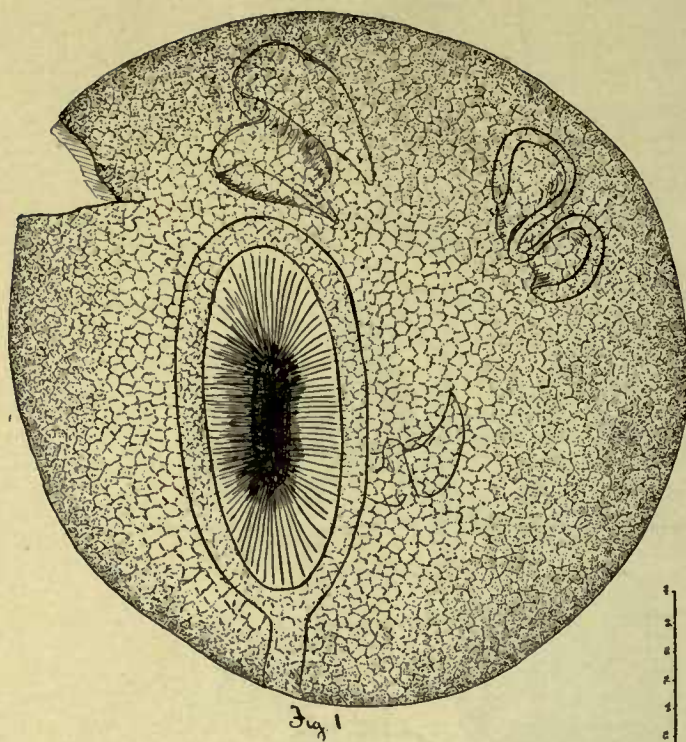


# PLATE VII



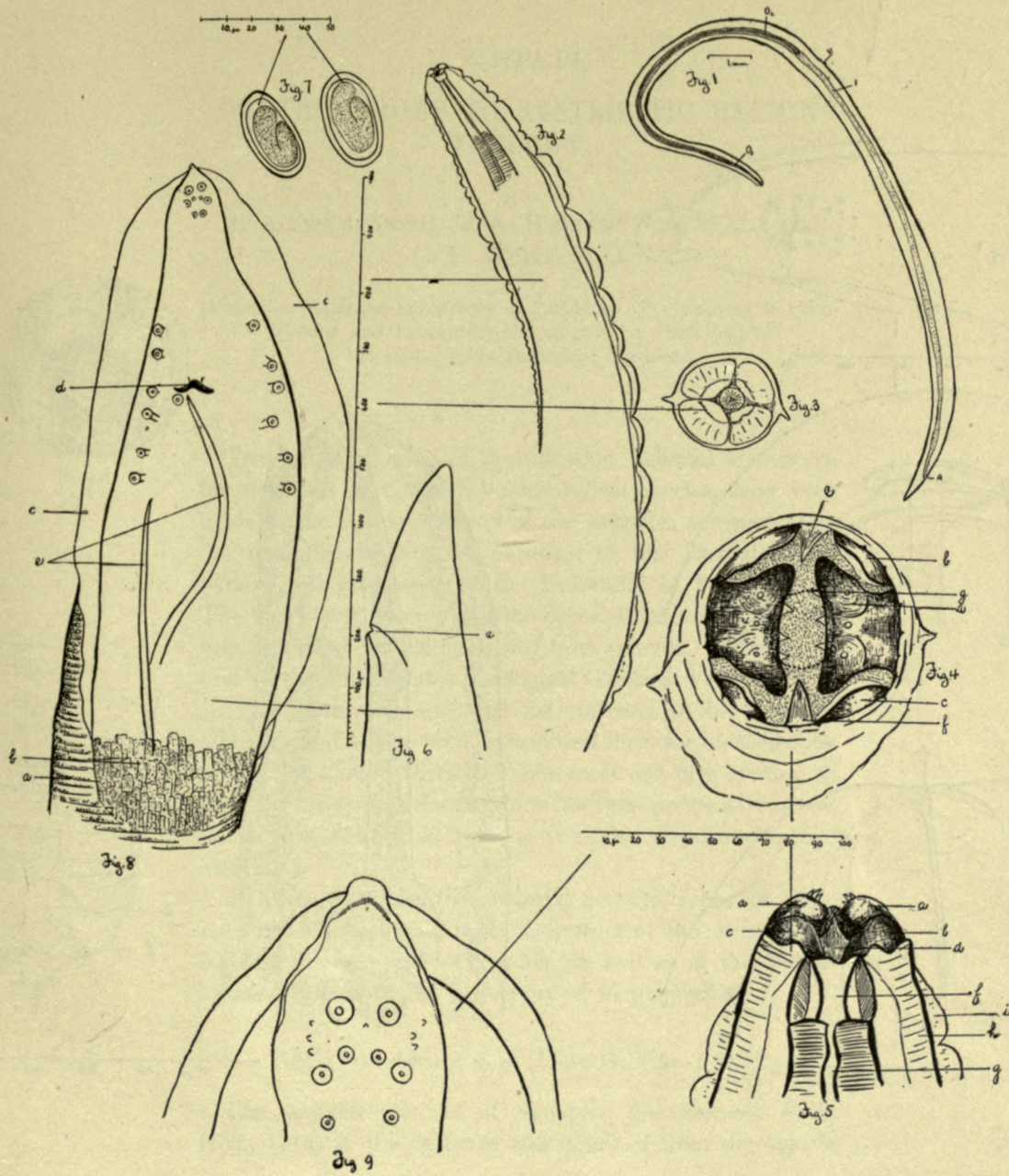


# PLATE VIII



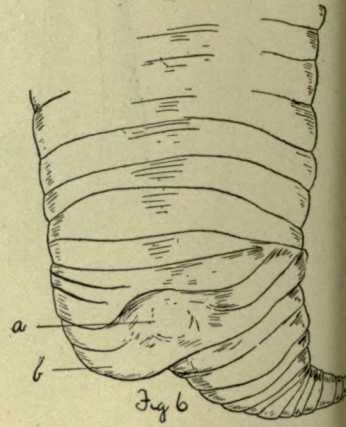
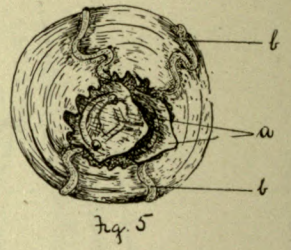
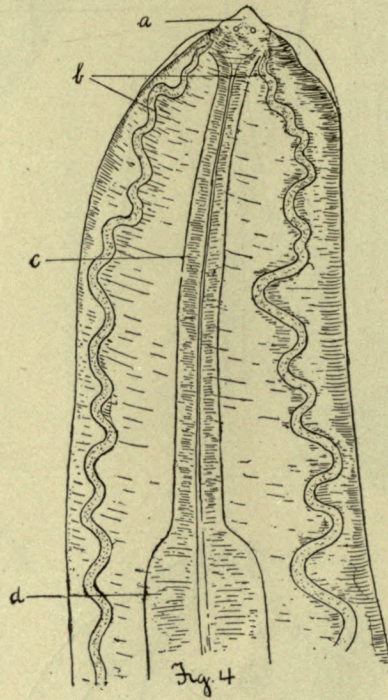
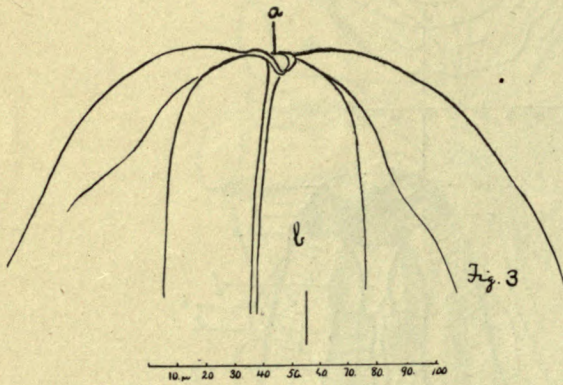
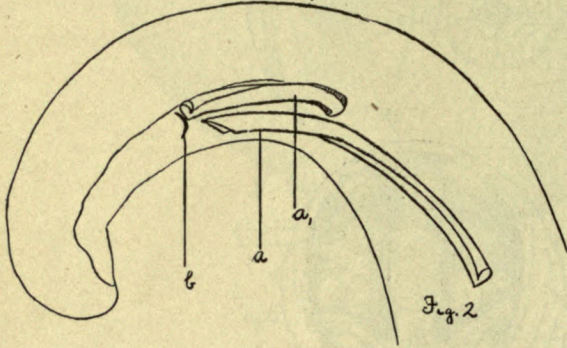
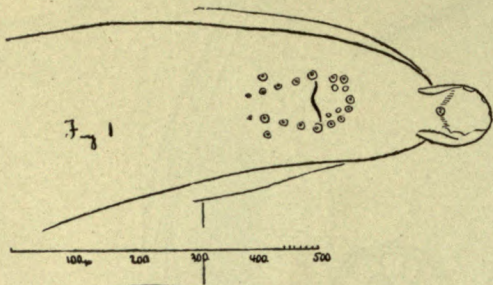


# PLATE IX





# PLATE X





## CONTRIBUTIONS TO SYSTEMATIC HELMINTHOLOGY.

BY ALLEN J. SMITH, M.D., HERBERT FOX, M.D., AND  
C. Y. WHITE, M.D.

(From the McManes Laboratory of Pathology of University of Pennsylvania and Laboratory of Comparative Pathology of the Philadelphia Zoological Gardens.)

THE following notes of identification, believed to concern for the most part new helminthological species, have been made in the course of study of the parasites enumerated in the synoptic article upon parasites in this journal in the pathological laboratory of the University of Pennsylvania. The specimens upon which the descriptions are based have been obtained for the most part from animals of the collection of the Philadelphia Zoological Gardens which came to autopsy in the laboratory of the Gardens at the hands of Drs. Fox and White, who transmitted them for identification to the first-named writer. While most are new species, at least one has been included which has been previously known, but is here considered because it seems to present special variations.

In all cases where the material permits, types of these parasites will be placed in the collection of the Academy of Natural Sciences in Philadelphia, as well as in the Pathological Museum of the University of Pennsylvania.

*Tania paradoxuri*, n. s. (Plate II, Figs. 1 to 5).

The material (No. 14 of Synopsis, this journal; Path. Hist., 1714) in this instance was obtained from the dejecta



of a living animal, a Gray's paradoxure, *Paradoxurus grayi* (habitat, India), and includes one well-developed strobile of the tapeworm together with fragments of several more, one of these fragments consisting of a second head and some of its anterior segments. All of the material was unfavorable for study, both because of the close adherence of extraneous (fecal) matter, which it was impossible to safely dislodge either by mechanical means or by various solvents employed, and because the tissue of the worms was more or less disintegrated when received and poorly adapted to section and staining methods of study.

The complete strobile measures 160 mm. in length, and is made up of over three hundred segments. It attains its greatest width in the level between 120 and 140 mm. from the head, where the links (Fig. 4) are 3 mm. wide and 1 mm. long; thence posteriorly it narrows to a terminal link slightly more than 1 mm. wide and 2 mm. long. The anterior links (Fig. 3) are decidedly wide in proportion to their length, measuring at 20 mm. from the head 0.45 mm. wide and 0.04 to 0.06 mm. long. There is no neck, the first segment being clearly outlined immediately back of the head, being 0.25 mm. wide and 0.03 mm. long. Viewed laterally the head (Fig. 1) is slightly wider than the first segments, and is provided with four suckers and a low, broadly conical, retractile rostellum devoid of armature. The retractile character of the rostellum is inferred from the fact that in one of the heads the frontal region between the suckers was practically flat, while in the other the conical appearance described was definitely present. Viewed from the front (Fig. 2) the outline of the head is a quadrilateral, with the dorsoventral diameter slightly greater than the lateral (dorsoventral, 0.35 mm.; lateral, 0.25 mm.). The suckers are prominent, oval in shape, with their long axes in the long axis of the strobile; and open by a curved, slit-like orifice extending in the longitudinal direction of the worm. Suckers measure 0.15 by 0.13 mm.

Genital pores (Fig. 4) marginal, irregularly alternating; marked by very large orifices and prominent lips; are situated toward the anterior part of the margin of the link. Ova (Fig. 5) spheroidal, with thin, smooth, colorless external wall (outer diameter 55 to 60 micromillimeters), enclosing a colorless, finely granular albuminous layer; within the latter a yellowish embryophore, 40 mm. in diameter, coarsely granular, hexacanthous. Embryonal hooklets measure 18 to 20 micromillimeters in length.

*Tænia eunectes*, n. s. (Plate III).

In the small intestine of an anaconda, *Eunectes murinus* (P. Z. G. Lab., 939), there were encountered seven small cestodes, apparently entire, together with a half-dozen undeveloped strobiles and several fragments of other strobiles of the same parasite (Path. Hist., 1694; No. 15, Synopsis, this journal). The largest of the entire strobiles measured between 9.5 and 10 cm. in length and was made up of between two and three hundred proglottides. The worm reaches its greatest width of segments at about 7 cm. from the head, where it is 2 mm. in width. All the larger specimens were marked at various positions with one or more knot-like swellings (probably due to contraction of the worm in life). The head (Fig. 2) viewed from the front presents a crucial appearance from the prominence of the suckers, measuring transversely across two opposed suckers 1.5 mm. and laterally across two adjacent suckers 1.3 mm. The transverse diameter of the square front between opposed suckers measures 0.4 mm. The suckers, thus prominent, form the rounded arms of the crucial frontal picture, each sucker being globose in shape and having a lateral diameter of about 0.7 mm. The orifice of each sucker is a rather wide slit, running laterally; and as a peculiarity, common to all the heads included in the material obtained, the outer wall of each sucker is depressed and its margin turned in, forming an



angular intrusion into the cavity of the sucker. The central part of the front of the head, between the suckers, forms a broad and low cone (Fig. 1); and is unarmed in all the specimens, but the cuticle here contains numerous small, granular, non-polarizing bodies, which in life probably projected slightly above the surface to give it a slight roughness. Back of the suckers the head is prolonged as an inverted truncated cone for a little over 0.1 mm., narrowing from 0.9 mm. at the level just behind the suckers to somewhat over 0.3 mm. in width at the posterior portion where the segments begin (the level of truncation of the inverted cone).

In the young and incompletely formed strobiles (Fig. 1) the proglottides are all small, those next the head somewhat broader than long, but soon becoming square to ovoid in outline and more loosely attached to each other (moniliform) than is seen in any part of the adult strobiles. These seem all to be neuters, and, judging from their shape and appearance, never become developed, and are pushed along in the growth of the strobile by the formation of efficient links as the head becomes older. In the fully developed strobiles the neck segments are at first about a millimeter wide (wider than the terminal part of head) and 0.1 mm. long; in their fullest development (at widest part of strobile) they remain somewhat wider than long (2 mm. wide and 1 to 1.8 mm. long); thence to the end they diminish in width, becoming square and finally longer than broad (1.5 to 1.8 mm. long and 1 mm. or less in width). The links in these fully formed specimens are not sharply defined from each other, the anterior margins of a given proglottis being of almost the same width as the posterior margin of its predecessor, thus not permitting much overlapping of the former by the latter. Without staining the lines of separation between the proglottides are inconspicuous, the first impression being of a continuous surface. One of the surfaces of the larger links is usually somewhat convex, the opposite side showing a longitudinal concave depression along the middle of the link. Genital pores

irregularly alternate. The uterus in efficient but as yet non-ovigerous links (Fig. 4) shows as a median longitudinal tube, with about a dozen lateral branches extending toward the margins of the link, these when filled with ova showing as thick, round-ended, club-like branches. The two ovaries and vitelline gland lie along the posterior margin of the link, much as in *Tænia saginata*, the vitelline gland directly back of the uterine tube, the ovaries spreading out on either side, their oviducts joining the uterine canal a little in front of its posterior end. Between the uterus and the genital pore there is a thick plicated tube, regarded by the writers as a receptaculum seminis. The cirrus is slender; cirrus pouch thick and muscular; the testes in non-gravid links numerous seen in the lateral fields.

The ova (Fig. 5), when obtained without tearing it, show a delicate colorless outer sac (amnion?), within which lies the ovum proper; this sac is spheroidal and measures 85 to 90 micromillimeters in diameter. The ovum is spherical, double walled, colorless, with a coarsely granular and somewhat laminated material between the walls; the enclosed embryo granular and provided with six hooklets. Outer diameter of ovum, 28 to 30 micromillimeters; diameter of embryophore, 16 to 18 micromillimeters.

Examination of helminthological literature at command of the writers has thus far failed to show any *tænia* having comparable features to the above, and for this reason it is believed to constitute a new species, for which the name *Tænia eunectes* is proposed.

*Cotugnia browni*, n. s. (Plate II, Figs. 6 to 10).

From the tapeworms of the type of the dipylidium group, with two sets of genital organs in each segment, the genus *Cotugnia* was framed to include those cestodes having such arrangement of the genital apparatus met in birds and provided with a rostellar armature of numerous hooklets,



by Diamare (*Boll. soc. di naturalisti in Napoli*, 1893, ser. i, vol. vii, p. 10), with *C. digonopora* of fowls as the type. The following specimens (Path. Hist., 1672) are believed by the writers to constitute a new species of this genus, to which provisionally they would assign the name *Cotugnia browni*.<sup>1</sup> The material was obtained at autopsy from the intestine of a banded parakeet, *Palæornis fasciatus* (P. Z. G. Lab., 1052), along with a number of specimens of *Spiroptera incerta*, n. s. There were included four strobiles, the largest 140 mm. in length and apparently entire; two two-thirds to three-fourths the length of the first and lacking the terminal links; and the fourth only 5 cm. long and possessing no ripe segments. In addition there were several fragments made up of ripe links, evidently broken from one or other of the shorter strobiles. The largest example attained its greatest width 100 mm. from the head, where the segments were 4 mm. wide, diminishing thence posteriorly, so that the terminal links were but 3.5 mm. in width. The strobile included a few more than two hundred segments. The head was small and short, with quadrate front (Figs. 6 and 7); measured 0.3 mm. in length, and over the front dorsoventrally 0.55 mm., laterally 0.6 mm. Four prominent suckers, globose in shape, with full diameter of 0.2 mm., and circular orifice 0.05 mm. in diameter; suckers unarmed. Rostellum of all the heads depressed, provided with a circle (Figs. 6 and 8) of numerous (over two hundred) small hooklets (0.012 to 0.014 mm. in length). Neck short. First links (Fig. 7) much wider than long (0.4 mm. wide, 0.03 to 0.05 mm. long); immature links showing the developing genital organs (60 to 80 mm. from head) from 2.5 to 3 mm. wide and 0.5 to 1 mm. long; largest ripe links (100 to 110 mm. from head), 4 mm. wide and 1.5 mm. long; terminal links, 3.5 mm. wide and 1.5 mm. long. Double genital apparatus (Fig. 9); a genital pore on each lateral margin of link at first

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<sup>1</sup> Named for Dr. Arthur Erwin Brown, Secretary of Philadelphia Zoölogical Society.

third of its length, the cirrus usually protruded for 0.1 or 0.2 mm., smooth, with slightly curved end. Cirrus pouch thick and flask-shaped, anterior; a half-dozen or more small testes in anterior portion of link, sessile upon the vas deferens. Vagina thick-walled, opening into a spheroidal receptaculum seminis about midway between anterior and posterior margins of link and external to testes; ovary rosette-shaped and lying to median side of receptaculum; vitelline gland posterior to receptaculum. Uterine tube, with egg sacs, extends along the posterior margin of link toward median line, the tubes of the two sides not meeting. In ripe links the uterine tubes fill nearly the entire link, the ova being held in the reticulately distributed tubes and freed therefrom with difficulty on tearing the segments, each being held by some surrounding adherent material. Ova (Fig. 10) colorless, spheroidal, with a thin, pliant outer membrane, within which is a granular and slightly laminated material separating the outer membrane from the embryo. The latter has no distinct membrane separating it from the surrounding granular matter, is yellowish in hue, hexacanthous, coarsely granular, and its outer surface rough with irregular elevations. Outer wall of ovum measures 66 to 70 micromillimeters in length by 56 to 60 micromillimeters transversely.

*Ascaris leptoptera*, Rudolphi (*ex parte*), new variety (Plate IV).

The ascarides of the larger members of the cat family have been the source of no little confusion from the first in the endeavor to separate them from the common *Ascaris canis* (Werner) of the cat and dog; and there is little constancy of description of the ascarides derived from lions alone, not to speak of the differences announced between those of lions, tigers, and other of these larger cats. Rudolphi (*Entozoa*, II, i, p. 140) created a new species of the group for an ascaris from a lion in the Zoölogical Gardens of Leipsic, the verity of which has at one time been affirmed and again



denied by nearly every writer since then. Much stress was originally laid upon the precise appearance of the alar cuticular expansions, and probably much of the confusion has arisen from the apparent fact that these are by no means constant in size and shape, and seem to be at times entirely absent. That there are several closely allied species, and that there may be a number of more or less distinct variations, can scarcely be denied, and until breeding experiments are added to the existing morphological observations it is not likely that the difficulties of classification will be entirely removed.

To illustrate the confused status of the question, these outlined descriptions may be here quoted. Schneider (*Nematoden*, p. 39; Pl. I, Fig. 5), accepting Rudolphi's specific name, *Ascaris leptoptera*, but declaring that his original specimens were but *Ascaris canis* (Werner), describes, from material including several hundred specimens from a lion born in London and examined after death at nineteen months of age in Berlin, a parasite having the following characteristics: Females, 65 mm. long; males, 46 mm. long. Lips equal, digitate, with rather pointed anterior margin and broader base. Denticulation poorly developed and inconspicuous, only showing along the lateral borders. Lobes of pulpa of dorsal lip long, undivided. Lateral alar membranes extend from head 4 mm. posteriorly, rounded at posterior termination. The head, even in the youngest examples, is deeply retracted between the salient cuticular expansions. Vulva 25 mm. from anterior end of worm. Shell of ovum thick, unmarked or only with irregular, trabecular reticulation. Tail of male lancet-shaped, slightly broadened, and with the ventral side flattened. Thirty-five pairs of papillæ, six postanal, the terminal and adjacent ones with conical base; the rest all raised, with pointed tips; all in uniform row.

Chatin (*Mém. de la Soc. de Biol.*, 1877, p. 266) records from a lion a number of ascarides without alar cuticular expansions, buccal lobes deeply divided, straight esophagus

with ventricle (bulb); males reaching 25 mm. in length and having long double genital spicules; females attaining a maximum length of 80 mm. and with the vulva anterior to the first third of the body length. Ova 0.08 mm. (stated by Chatin 0.8 mm.—evidently a mistake) in length and 0.074 mm. transversely, without reticulation of the shell. For this material the author argues identity with Rudolphi's original *Ascaris leptoptera*.

On the other hand, Linstow (*Arch. mik. Anat.*, lx, p. 217; Pl. XII, Fig. 1) differentiates from *Ascaris canis* (Werner) and *Ascaris leptoptera*, Rud., an allied species, under the name *Asearis leonis*, having the following characteristics: Lips with rather broad base, finely denticulated borders, without interlabia. Dorsal lip broader than long, anteriorly rounded, its papillæ relatively posteriorly situated; pulpa with two lobules projecting anteriorly, each showing two rounded anterior prolongations. A lateral alar expansion on each side of head, attaining a width of 0.18 mm. anteriorly and diminishing gradually and uniformly as it extends backward (those of *A. canis* and *A. leptoptera* are narrow anteriorly and increase in width posteriorly to reach the body wall in their posterior positions by a sharp and almost rectangular curve). Males attain a length of 34 mm. and a thickness of 0.99 mm.; esophagus 1: 12 of body length; male tail acutely conical, with small digitate tip; the feebly developed, small genital spicules, 0.83 mm. in length; 21 pre-anal and 4 postanal papillæ in uniform lines, the anterior ones 3.04 mm. in front of tip of tail. Females attain 53 mm. in length and 1.38 mm. in thickness; caudal end lanceolate; vulva at 5: 8 of body length. Ova with thick, smooth shell, without markings; ova measure 0.086 mm. long and 0.062 mm. in transverse diameter, and (a rare feature in genus *Ascaris*) contain a fully developed larval worm.

In the material from the Philadelphia Zoölogical Gardens there were included ascarides from two lions. At autopsy of the first (P. Z. G. Lab., 794), a lioness about



ten years of age and a resident of the Gardens for nine years, dead from acute peritonitis following puncture of the intestinal wall by a spicule of bone, 36 specimens (Path. Hist., 1102), of which 23 were females and 12 males, with one badly damaged example undetermined, were obtained from the stomach and intestines. In addition to these a single male specimen (Path. Hist., 1148) was subsequently submitted, having been passed in the dejecta of a lion now living in the collection. On examination it was found to present precise identity with the first examples. The following notes of description were made from the study of the specimens from the first animal: There is considerable variation in size from age and state of development. The largest female measures 76 mm. in length; the largest male 62 mm. Worms cylindrical in section, with thickest level near middle of body length; and taper delicately anteriorly and posteriorly. Preserved specimens colorless (but with a reddish tinge in some, especially toward the posterior extremity, suggesting that in life they were of reddish hue), rigid. In both sexes the head end is inflexed. Cuticle finely striated transversely, expanded at head end into a semilanceolate alar extension (Fig. 2, a), beginning anteriorly close to base of lips and in the larger specimens extending posteriorly 3 mm., its widest portion at about its posterior fourth, where it attains a width of nearly 0.3 mm., its free border from this level to its coalescence with the body cuticle becoming thick and somewhat rounded (not as large or as cordate in outline as the wings of *Ascaris canis*, and not crenulate). Mouth terminal, provided with three nearly equal lips, the dorsal lip a little wider than the others (base of dorsal lip, 0.16 mm. transversely; of inferior lips, 0.13 mm.). Diameter of face of cephalic end, 0.25 mm. Each lip bears two papillæ on external surface. Dorsal lip broader than long (0.12 mm. from base to anterior border; base, 0.16 mm. transversely); anterior border convex and poorly defined from lateral borders, which are also convex. Poorly marked

denticulation along both anterior and lateral borders (somewhat variable in the clearness of denticulation in different individuals). Pulpa (Fig. 3) shows an unpaired median lobe arising from base for one-third the length of lip; the paired lobes lobulate (anterior and lateral, each broad and subdivided as in drawing). Saddle-groove fairly deep. Inferior lips narrower and more digitate (Fig. 4), and more closely following Schneider's description for dorsal lip (*Nematoden*, Berlin, 1866, p. 39).

Tail of male (Fig. 7) incurved or often tightly enrolled, without cuticular expansions, terminating in a short cone (as wide at level of cloaca as it is long from this level), ending in a small cuticular spicule. Cloaca 0.18 mm. from tip of tail. Ventral surface of tail of male slightly flattened. Twenty-seven pairs of caudal papillæ (Fig. 6), of which 7 are postcloacal. Of the postcloacal, 3 are lateral, small and conical, and likely to be overlooked, near the end of the tail; Nos. 4 and 5 are also small conical ones, at border of flattened ventral surface; Nos. 6 and 7 and all the precloacal papillæ appear as small tips set upon a rounded eminence. They gradually increase in size anteriorly and are set in a regular row, succeeding Nos. 4 and 5 along the margin of the flattened ventral surface of tail. Spicules of male equal, small.

Tail of female (Fig. 8) a slender cone more than twice as long as the transverse diameter at level of anus; anus 0.7 mm. from tip. Tail straight or occasionally lightly enrolled. Vulva 5 m. from anterior end (length of worm used for measurement, 7.4 cm.); vagina short, dividing into two uterine canals with long plicated ovarian tubes, ranging posteriorly and anteriorly (anterior to vulvar level). Ova nearly spherical to oval in shape, smooth externally, and without markings on shell, thick-shelled, containing larvæ, measuring from 65 to 80 micromillimeters in diameter for the spheroidal examples, and for the oval ones from 75 to 85 in length and from 55 to 75 micromillimeters transversely



(one very large example out of several hundred observed measured 105 by 55 micromillimeters). The ova here described were taken from the uterine tube of a damaged female, the genital tubes and intestine being protruded through the broken body wall and hanging freely exposed in the 4 per cent. solution of formaldehyde used as a preservative for twelve days before the study was made. Nevertheless, in many of the ova active vermicular movements persisted in the enclosed larval worms.

From comparison of the above data with the descriptions quoted in the early part of the article it is clear that the present specimens are to be classified as an intermediate variety between *Ascaris leptoptera* and Linstow's *Ascaris leonis*. Whether, in view of the marked variations which seem possible in these leonine ascarides, it is justifiable on purely morphological grounds to accept their specific separation is of course an open question; and to the writer it seems doubtful whether the matter can be determined short of careful feeding experiments. It is true the specimens here described seem more nearly related with Linstow's *Ascaris leonis* than with *Ascaris leptoptera*, Rud., as described by Schneider; but in view of the existing uncertainty it has seemed best to adhere tentatively to the older specific name and relate our specimens as a variation thereof.

*Ascaris aquillæ*, n. s. (Plate V).

There were obtained from the proventricle of an American bald eagle, *Haliæetus leucocephalus* (P. Z. G. Lab., 959), two nematode worms (Path. Hist., 1637; No. 32, Synopsis, this journal) at autopsy. Both were females and one was badly damaged, the head lost and the esophagus protruding from the broken end. It is stated that in addition to these specimens from the proventricle, larval filarial worms had in life been found in the blood of this worm, but at autopsy no adult filariæ were encountered.

The following description is based upon a study of the single perfect specimen. The worm is cylindrical in section, 50 mm. in length and 1.5 mm. in diameter at its thickest level (in third fourth of the body length), tapering anteriorly gradually to a rather bluntly rounded head 0.25 mm. in diameter at base of lips, and tapering posteriorly more rapidly to terminate in a straight, acutely conical tail. When received the specimens were colorless, with brownish lines of the intestine showing through the relatively opaque and thick body walls. Cuticle transversely striated; no alar expansions or other cuticular peculiarity. There are three thick and prominent lips (Fig. 3), each with two papillæ; well-marked interlabia. Lips free from denticulation, nearly symmetrical and equal. Dorsal lip (Figs. 1 and 2) four-sided, the anterior border deeply divided; groove of saddle deep and prolonged well to base. Anterior border projecting well beyond the pulpa on each side of saddle (like a finger-nail), its anterolateral angles auriculate (the lateral border being infolded and causing the angle to project slightly forward and laterally). Lateral border a double curve, concave anteriorly and convex posteriorly; apparently the entire margin infolded. Base about equal to anterior border of lip. Median unpaired lobe of pulpa extends from base about half-way to anterior margin of lip; two paired lobes, the inner large, its inner border straight and parallel with saddle-groove, its outer border broadly rounded to the tip, which is directed forward and slightly medianly. The outer lobule, more slender, extends further anteriorly, is undivided, and is directed anteriorly and toward the median line. Interlabia large, the margins infolded. Width of dorsal lip at base, 150 micromillimeters; width of anterior margin, 140 micromillimeters, distance from base to anterior margin, 110 micromillimeters. Esophagus long and slender, provided with a small and inconspicuous bulb at its posterior end, this latter with a posteriorly directed, finger-like diverticulum. Intestine at its beginning provided with a large, anteriorly directed,



cecum-like diverticulum. Intestine and esophagus brown. Intestine large, straight, with numerous irregularities (like the haustra of the human colon), terminating at subterminal anus. Vulva small, inconspicuous, anterior to middle of body length. Vagina long, slender, muscular, opening into a capacious uterine canal with thin walls, which soon divides into two uterine tubes. Ovarian tubes very long and plicated tortuously about uterus and intestine. The ova (Fig. 5) are very variable in appearance (taken from both specimens). The best examples are elliptical to ovate in shape, with a thin, colorless, pliant shell-membrane, the external surface of which is thickly beset with small tubercle-like projections; the interior yellowish and coarsely granular, often segmented, and many examples containing larval worm met. They range from 80 to 90 micromillimeters in length and from 50 to 60 micromillimeters in width (one very large example measuring 100 by 70 micromillimeters was seen). In the absence of the male no full description is possible, but the above features are, as far as the writers at present know, unique. The parasite approaches *Ascaris spiculigera*, Rudolphi, and *Ascaris nasuta*, Schneider, both from pelicans and similar birds, and *Ascaris granulosa*, Schneider, from *Tachypetes aquilus*; but differs sufficiently in the details of the lip structure to permit specific differentiation.

*Ascaris ardeæ*, n. s. (Plate VI).

In a group of helminths obtained from the alimentary tract of a North American blue heron, *Ardea herodias* (P. Z. G. Lab., 1158), there were found twelve ascarides (Path. Hist., 1681; No. 34 of Synopsis, this journal), 8 females and 4 males. The host from which they were obtained died within a week after its reception in the Gardens, and unfortunately the precise records of the part of the alimentary tract inhabited by these worms were not made. There were also found fragments of a tapeworm (*T. unilateralis*, Dujardin) and a single

example of an undescribed dispharagus; the autopsy protocol stating for the entire material that the parasites were found in the proventricle, stomach, and intestine. Presumably, inasmuch as the tapeworm fragments are much more likely to have been in the intestine and because the dispharagus was a solitary example, some of these ascarides were found in the upper portion of the tract.

The specimens are colorless, rigid, round in section, thickest posterior to middle of body length, tapering attenuately to the anterior and less finely posteriorly. Cuticle finely striated transversely, without alar expansions; longitudinal lateral lines well-marked.

The largest female measures 80 mm. in length, and at thickest level (about third fourth of length) 1.8 mm. in diameter. Head (Fig. 1) at base of lips 0.4 mm. in diameter; head rounded, with three prominent lips and well-marked interlabia (Fig. 2). Lips nearly equal, the superior provided with two and each ventrolateral lip with one papilla. Superior lip (Fig. 3) four-sided, the angles rounded, anterior and lateral borders finely denticulate, lateral borders convex.

Lip deeply grooved; unpaired lobe of pulpa prominent; lateral lobes provided with anteromedian, anterior, and lateral lobules. Esophagus with triradiate lumen, slender, expanding posteriorly in clavate fashion, without bulb, but with a valve-like opening into the intestine. Intestine simple, straight, terminating at anus 1.1 mm. from tip of tail. Tail (Fig. 4) acutely conical. Vulva 30 mm. from head end. Ova (Fig. 5) taken from uterus measured 105 to 110 micromillimeters in length, 96 to 100 micromillimeters transversely, spheroidal in shape, with colorless shell marked by thickly set pits (giving at first impression the appearance of fine spines over the surface but really pitted, and the walls of the uterus where these ova lay having elevations corresponding with the pits); interior in advanced segmentation, brownish. The females in the posterior half of the body usually closely coiled.



The largest male measures 72 mm. in length and at thickest level (about the posterior third) 1.5 mm. in diameter. Anterior end as in female. Tail rigidly incurved, and at level of cloaca narrowed to 0.4 mm. in diameter, from which level it becomes bluntly rounded with a small acutely conical tip projecting 0.25 mm. beyond and curved dorsally, giving an ungulate appearance to the end of the tail (Figs. 6 and 7). Cloaca 0.15 mm. anterior to level of truncation. Genital spicules double, equal, curved, brownish, 1.3 mm. in length. Details of caudal papillæ determined with difficulty because of the rigid curving of the tail and the opacity of the specimens. On the small conical tip there are two pairs, No. 1 at posterior third of tip; No. 2 at anterior third of tip; No. 3 close to level of truncation, large and conical; No. 4 conical and smaller than No. 3, at level of cloaca; anterior to cloaca five or more pairs of smaller papillæ, more widely separated than Nos. 3 and 4.

Compared with *Ascaris serpentulus*, Rudolphi, these worms present many common features, and were at first regarded as probably identical. They differ however, very clearly in a number of characters. Among other points the absence of alar cuticular expansions at the anterior end, the more marked division or lobulation of the paired lobes of the pulp of the lips, the broader anterior margin of the lips, the smaller size and more spherical shape of the ova seem sufficient justification for regarding the worms in hand as of separate species. Differentiation from Linstow's *Ascaris reticulata* from *Ardea crocoi* (*Mith. aus d. Zoöl. Samml. f. Naturk. in Berlin*, i, heft 2, p. 7) is readily made by the absence of interlabia and denticulation of the lips in the latter, as well as by other striking differences.

*Oxyuris microtyphlon*, n. s. (Plate VII).

Rudolphi (*Synopsis*, p. 285; No. 45) originally described under the name *Ascaris megatyphlon* certain small nematode

parasites obtained from the ceca of two iguanas (*Iguana tuberculata*) preserved in alcohol, giving the specific name from the size of the intestine just back of the esophageal bulb. His general description is brief: "Hæ dimidiam ad tres lineas longæ, crassiusculæ, flaccidæ, quam plurimæ femine. Caput valvulis tribus acutiuseulis. Corpus feminæ retrorsum incrassatum tandem longe subulatum; *maris* obtuso truneatum, *genitali* longo recto tenui in altero ante apicem exserto." His further discussion concerns the appearance of the esophagus and first part of the intestine, and his interpretation of its parts by analogy with the divisions of the alimentary canal of higher animals. Dujardin (*Hist. Nat. des Helminthes*, p. 146, Paris, 1845), identifying material from the same host with the above, erected a new genus, *Ozolaimus*, of which the worm in question formed for him the single species. His description follows: "Corps blanc fusiforme plus ou moins recourbé, long de 5 à 8 mm., 10 à 12 fois plus long que large; tête à deux lobes latéraux plus écartés vers le haut; bouche verticale; pharynx rétréci obtus, par les lobes internes, à travers lesquels on voit l'orifice triangulaire du canal œsophagien; œsophage brunâtre, long de 2.8 mm., traversé par un canal triangulaire, dont les arêtes sont occupées chacune par une petite gouttière tubuleuse; première partie de l'œsophage longue de 1.14 mm. large de 0.08 mm. au milieu, et renflée en un fuseau large de 0.16 mm. avant de se joindre par une sorte d'articulation avec le suivante; deuxième partie de l'œsophage longue de 1.66 mm., d'abord aussi large, puis rétrécie jusqu'à n'avoir que 0.05 mm., et séparée, par un étranglement du ventricule large de 0.18 mm. turbiné; cavité interne du ventricule triangulaire, et revêtue par une membrane striée transversalement; intestin très-gonflé en arrière du ventricule, plus étroit en approchant de l'anus; tégument strié transversalement, et muni de deux bandes opposées granuleuses, larges de 0.05 mm.; stries écartées de 0.0045 mm. à 0.007 mm.

"*Mâle* long de 5 mm., large de 0.5 mm., recourbé en arrière;



queue obliquement tronquée et comme onguiculée, ou terminée obliquement par un appendice déprimé, arqué; anus près de l'extrémité; spicule simple, presque droit, très-aigu, long de 1.25 mm., large de 0.025 mm. près de sa base, contenu dans une gaine fibreuse et musculeuse qui le fait saillir en se contractant, retractile au moyen de deux muscles symétriques insérées à sa base.

"*Femelle* longue de 7.5 mm. à 8.2 mm., large de 0.66 mm. à 0.70 mm.; queue droite, amincie peu à peu et terminée en point mousse; anus situé à 0.25 mm. de l'extrémité; vulve saillante et boursoufflée, située au quart postérieur de la longueur, à 1.5 mm. de l'anús; uterus et oviductes repliés et comme pelotonnes au-dessus de la vulve; œufs elliptiques longs de 0.096 mm. à 0.1 mm., larges de 0.053 mm."

Later, Schneider (*Monographie der Nematoden*, Berlin, 1866, p. 120) properly placed the worm in the genus *Oxyuris* and from poorly preserved material described the female as 3.5 mm. in length and the male 2.3 mm. "Mund mit (?) Lippen. Oesophagus mit einem Bulbus, darin ein Zahnapparat Bursa wie ein Fingernagel gestaltet. Afterende kegelförmig weit nach hinten vorragend. Spiculum sehr lang. Papillen?" Schneider gives a plate of the tail of the male (Taf. VII, Fig. 9), which we have reproduced in outline (Fig. 9).

In 1905, Dr. C. Y. White, then pathologist to the Philadelphia Zoölogical Gardens, referred about 200 small nematodes, of which only 6 were males, which he had obtained at autopsy from the large intestine of an *Iguana tuberculata*, to the senior writer for identification. They followed closely the description of Dujardin, save that the ova were larger (118 x 53 to 133 x 68 microm.) and ellipsoidal rather than elliptical; there were three nearly equal lips to the mouth without apparent papillæ, and with the mouth-opening appearing triradiate between the lips instead of a vertical mouth with two lateral lobes. As in Dujardin's description, the anus was subterminal in the female, tail did not terminate

finely, the vulva occupying the same relative position and presenting the same prominent appearance as described by this author. The tail of the male was unfortunately not studied in its details at the time, and the unused males were lost by a student to whom they were entrusted for histological study; but the general features of shape and size as well as the appearance and size of the spicule were noted. Lateral calcareous bands, as described by Dujardin, were constant in the specimens, and, too, scattered granules in the walls of the alimentary and genital tubes. Believing with Schneider that there is doubt as to the correctness of Dujardin's description of the mouth, we regard this material as identical with the oxyuris of the writers quoted.

Some months later (1906) Dr. Fox, the present pathologist to the Zoölogical Gardens, obtained at autopsy from the large intestine of another species of iguana (*Cyclura nubila*) numerous specimens of a smaller nematode, which on superficial examination was believed to be *Oxyuris megatryphon*; but subsequent study has shown differences of structure constant and sufficient in character in our view to require reference of our specimens to a new but closely allied species, for which we propose the name *Oxyuris microtyphon*. The notes of study, made October 30, 1906, follow: "Several hundred specimens of a small nematode worm obtained from the cecum of an iguana which had died in the Philadelphia Zoölogical Gardens (P. Z. G. Lab., 827) were submitted for identification, a very large proportion being quite small and undeveloped, the majority of the developed examples being non-gravid females. Of the developed specimens, the largest, females, measure 5 to 6 mm., or slightly more, in length, the males attaining a maximum length of 4.5 mm. The worms in transverse section are round; viewed in length are delicately fusiform, tapering anteriorly from the thickest part near the middle (0.3 to 0.5 mm.) to a rounded head which measures roughly between 0.05 and 0.1 mm. in diameter. Posteriorly the females (Figs. 5 and 6) taper gradually to the anus, where



they measure about 0.2 mm. in thickness, the tail continuing about a millimeter beyond, straight and almost effilate, to a fine point. The tail of the male (Figs. 7 and 8) ends obliquely, closely resembling the tail of *Oxyuris megatyphlon* in general appearance, and presenting an unguilate tip as in the latter worm; the tail of male examples widely curved to ventral side. The worms are colorless, the cuticle transparent, delicate, and finely striated transversely. The longitudinal granular bands seen in *O. megatyphlon* are absent.

Mouth small, provided with three nearly equal lips (Fig. 3), each with two fairly prominent papillæ; esophagus (Figs. 5 and 7) long and straight, without the fusiform widening characteristic of *O. megatyphlon*, and showing a well-marked spheroidal ventricle (bulb) at the junction with the intestine proper. Compared with *O. megatyphlon* (Fig. 12) it presents a more slender esophagus; in fully developed females occupying from one-sixth to one-third the body length (being proportionately shorter and thicker in larger and gravid specimens, in which it seems crowded anteriorly), and in several males measured, nearly half of the full length. The esophageal bulb, like that of *O. megatyphlon*, contains a three-pieced armament; and in large females is about 0.2 mm. in diameter. The beginning of the intestine (the part called the cecum by Rudolphi) is generally smaller than in *O. megatyphlon*, but rather variable; the intestinal tube straight. In the female the anus is about a millimeter from the tip of the tail (from 0.8 to 1.4 mm. in different examples measured), and is guarded by two rather prominent transverse lips. Just within, upon the walls of the intestine, are several small rounded structures, probably anal glands. The anus of the male opens subterminally in a cloaca with the genital organs. Esophagus and intestine of both sexes brownish. The calcareous granules seen so numerous upon the walls of the intestine and generative tubes in *O. megatyphlon* are absent.

The generative apparatus (Fig. 5) of the female consists of two ovarian tubes and their oviducts, closely plicated along

the intestine, which unite into a single uterine tube, this continuing as a thick-walled vagina to open at a vulvar orifice, guarded by two prominent transverse lips, a short distance (0.4 to 0.8 mm.) anterior to the anal orifice, the vulva being thus relatively more anterior than in *O. megatyphlon*. The fully formed ova (Fig. 1) are ellipsoid in shape, usually slightly flatter on one side than on the opposite, and range from 145 x 62 to 170 x 85 microm. in size (from measurements of a dozen or more, obtained from several females). The shells are smooth, delicate, simple, somewhat pliant, and colorless; the vitelline substance yellow and granular; and with development a colorless, finely granular embryo takes its place. It is to be remarked further that the writer found several large females among the preserved material which contained well-formed larval worms in their interiors, these showing the general structural features of the adults. From one example as many as five of these larvæ were dragged in the dissection. It is not known whether these may not have developed within the parent from the ova after death of the worm (but this is suspected because developed ova and free larvæ were in no instance found together in any of the female worms) or whether the worm is ovoviviparous.

In the male the two tubular testes are disposed as the oviducts in the female, terminating in a sperin sac. The spicule (Figs. 4, 7 and 8) is single, long, and often double-curved, the distal curve directed dorsally (is sometimes straight). The cuticular tip of the tail (Fig. 4) of the male is straighter than that of *O. megatyphlon*, its sides infolded. It is supported ventrally by a median intracuticular spine which ends in four small prominences on the ventral side of the tip of the tail, and which shows in the median line of its base a second, smaller spine, bipartite at its free end. At the base of the latter, just back of the cloacal margin, there are on each side three small papillæ, the largest next the small median spine, the other two diminishing in size. The posterior lip of the cloaca is bilobed, the anterior trilobed, the median lobe the largest.



From the above description the general similarity to *O. megatyphlon* is apparent. The differences briefly stated in *resumé* are as follows: The adult worms are considerably smaller in size than *O. megatyphlon* (according to our measurements of *O. megatyphlon* and those of Dujardin; equal according to Rudolphi's, considerably larger according to Schneider's data); and the head is relatively smaller than in *O. megatyphlon* (our measurements). The papillary eminences on the lips are clear and constant; but these are not apparent in *O. megatyphlon*. The calcareous granules of the cuticular bands and in the walls of the alimentary and genital tubes are constant in *O. megatyphlon*, but are uniformly absent in the case of the present specimens. The fusiform swelling of the esophagus, regarded by Rudolphi as a proventricle, is constant in our specimens of *O. megatyphlon* (Fig. 12); is uniformly absent from *O. microtyphlon*. The size of the first part of the intestine (Rudolphi's cecum) is usually smaller than in *O. megatyphlon*. The vulva is relatively closer to the anus and considerably more anterior to the tip of the tail in the female of *O. microtyphlon* (cf. Figs. 5 and 11); and the tail is invariably long and finely drawn out instead of being slightly blunt as in *O. megatyphlon* (in the larval forms of the latter the tail is quite as in *O. microtyphlon*, and the larvæ are practically indistinguishable). The shape and general appearance of the ova are very similar, but the invariably larger size of those of the smaller worm (compare Figs. 1 and 2) is clear from the material examined by us (and they exceed by one-half to three-fourths the measurements given by Dujardin). Apparently (from camera lucida tracings) the unguulate tip of the tail of *O. megatyphlon* is slightly larger and is less straight than that of *O. microtyphlon*, but the failure to note the finer details of structure of the former prevents close comparison (compare Figs. 4 and 10). The difference from the tail of *O. megatyphlon* as depicted by Schneider (Fig. 9) is striking.

The iguana from which the examples in question were

obtained was one purchased by the Zoölogical Gardens from an animal dealer, and no record as to its precise original habitat exists save that it was a Cuban ignana. It had been in the Gardens from June 29, 1906, until its death, September 11, 1906. The cause of death was not determined.

*Globocephalus macaci*, n. s. (Plate VIII).

In examining the intestine of a pig-tailed macaque, *Macacus nemestrinus* (P. Z. G. Lab., 508), there were found free in the lumen and in several tiny submucous cysts of the wall seven small nematodes (Path. Hist., 1673), which from their gross appearances were at first believed to be identical, but which upon careful examination proved to include five esophagostomes and two examples of a globocephalus. It is impossible at this time to indicate which of the specimens inhabited the cysts and which were free in the intestinal tube. Both specimens of the globocephalus were females and of nearly the same size. The larger measured 16 mm. in length, and at its thickest level, near the middle of the body length, 0.5 mm. in diameter. Cuticle delicate, transparent, distinctly striated transversely. The worm tapered regularly and gradually anteriorly to a rounded head measuring 0.25 mm. in transverse diameter; and posteriorly tapered to a finely conical, straight tail. No cuticular expansions or swellings. Head (Fig. 3) rounded and provided with a prominent spheroidal cavity, 0.17 mm. in transverse diameter, with an elliptical chitinous ring about the mouth and a triangular chitinous ring (sides convexly curved) at its base about the esophageal opening, these connected by a lateral longitudinal piece. Over the head the surface presents a peculiar mosaic appearance (Fig. 1) given by certain prism-like cells (feebly polarizing; are they crystalline?), whose ends underlie the cuticle about the buccal cavity. Mouth terminal, elliptical, its long axis dorsoventral, the chitinous ring about it measuring



in long axis 0.14 mm., and in short axis 0.06 mm. Looking into the mouth, it seems to be surrounded by a row of fine spines, directed inwardly and toward the centre (the appearance may, however, be given by the bordering prism-like cells). Within the mouth cavity (Figs. 2 and 3), springing from the base and apparently set in the chitinous ring about the esophageal opening, is an armature of three complexly curved chitinous plates. Esophagus 0.75 mm. long, flask-shaped, 0.25 mm. in diameter in its posterior and thicker part. At level of second third of esophagus, 0.65 mm. from front of head, on each side a pointed papilla projects above the cuticular surface (opening of cervical glands). No esophageal bulb. Intestine straight. Anus (Fig. 4, *a*) subterminal (0.14 mm. from tip of tail). Vulva (Fig. 4, *b*) prominent, provided with thick circular lip, 0.65 mm. anterior to tip of tail. Ova (Fig. 5) slightly yellowish, segmented, oval, with thin, colorless, unmarked wall, each with a slight thickening or tubercle at one pole; measure 0.064 to 0.07 mm. in length and 0.038 to 0.04 mm. in width.

*Spiroptera incerta*, n. s. (Plate IX).

Among all the types of verminous parasites derived from animals in the Zoological Gardens in the series studied by the writers by far the most numerous group has been made up of a small nematode obtained from the proventricles of a number of the inhabitants of the bird house, in which it would seem that a well-marked and strictly localized endemic has been for the past year or two, and is now, prevailing. The material studied (Path. Hist., 1109, 1120, 1453, 1463, 1613, 1616, 1618, 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1626, 1627, 1628, 1629, 1630, 1631, 1644, 1661, 1672, 1675, 1686) includes examples obtained at autopsy from twenty-five birds, the parasites invariably occupying the proventricle and some times also being found in small numbers in the gizzard. The specimens, while often found free in the mass

of mucus and food occupying the proventricle, were commonly found with the head end embedded in the more or less disintegrated lining membrane of the proventricle; the resulting mass often completely obstructing the tube and preventing the passage of food. The parasites varied much in the number found in each bird, the smallest number in the series being two in a valley quail, and the largest one hundred and thirty-four in a Rosehill parrakeet; commonly the grade of infestation was represented by twenty to forty worms; and generally the females outnumbered the males by about three or four or more to one. As a rule, in the case of infestation by larval or immature worms the number of parasites found ranged high, nearly a hundred or more than a hundred; from which it is suggested that ordinarily in the course of parasitism a number of the worms are dislodged from the proventricle, passed through the host's intestine and discharged. There is no evidence leading to the supposition that the adult parasites may locally produce the young forms; and in the few instances in which larval and partially developed or mature forms were encountered together the probability is that there took place repeated infestation. Six of the birds were infested by larval worms. One of these showed both larvæ and fully developed and gravid adults, the rest either larvæ alone or larvæ and immature adult forms. All of the latter birds were relatively recent admissions to the Gardens at time of death, having been in the collection from one or two to six or eight weeks. The one host having both gravid adult worms and larvæ had been in the collection over a year prior to its death; and, with the exception of three birds mentioned below as possibly introducing the parasites into the collection, the hosts were all inhabitants of the Gardens for several months to several years. From this it is suggested that the period required from the development from the egg to the mature adult stage is somewhere within six or eight weeks.

There is no positive information as to the time when first the parasites appeared in the collection; and their source



is not clear. The first record (Path. Hist., 1109; August 28, 1906) concerned a Guatemalan amazon (P. Z. G. Lab., 790) and contains the statement that this was one of three birds showing the same parasites and same anatomical findings; that the three birds had been recently purchased for the collection, and that one died within two days after its reception; that they were placed in separate cages on their arrival, and that no other birds in the same portion of the house presented the same features of disease as these; that bunches of mucus containing the worms were found in the lower third of the distended esophagus in all three, acute enteritis in two, chronic enteritis in one, and parenchymatous degeneration of all the organs in all three. From this time forward the records of discovery have been numerous, including all twenty-five birds here referred to, as well as four or five more received since the present series was completed. The earlier examples and the greater number have been obtained from parakeets and allied birds; but, evidently from unusual conditions prevailing in the bird house for the dissemination of the parasites, they have been found distributed in a variety of species, in several genera, and even in several families of hosts. The birds thus far found infested include the following; *Conurus pertinax*, two birds (P. Z. G. Lab., 1125, 1042); *Conurus leucotis*, one bird (P. Z. G. Lab., 1076); *Chrysotis guatemalæ*, one bird (P. Z. G. Lab., 790); *Chrysotis leucoccephalus*, one bird (P. Z. G. Lab., 1131); *Chrysotis auripalliata*, one bird (P. Z. G. Lab., 910); *Chrysotis ochroptera*, one bird (P. Z. G. Lab., 891); *Platycercus eximius*, five birds (P. Z. G. Lab., 843, 850, 862, 867, 889); *Platycercus barnardi*, one bird (P. Z. G. Lab., 1004); *Platycercus palladiceps*, two birds (P. Z. G. Lab., 876(?), 877); *Bolborhynchus monachus*, two birds (P. Z. G. Lab., 1049, 1164); *Bolborhynchus lineola*, one bird (P. Z. G. Lab., 871); *Palæornis fasciatus*, one bird (P. Z. G. Lab., 1052); *Protogerys virescens*, one bird (P. Z. G. Lab., 422); *Eelectus roratus*, one bird (P. Z. G. Lab., 1152); *Pæocephalus senegalus*, one

bird (P. Z. G. Lab., 823); and *Lophortyx californicus*, one bird (P. Z. G. Lab., 997). Recently, but not included in the present series, several of the pigeon family have also been found similarly infested.

From the very serious alterations found in the proventricle there can be no doubt of the serious importance of these parasites to the host, which unquestionably may by a serious grade of infestation be killed by the worms. In their earlier studies of the matter the writers searched, but in vain, for the presence of larvæ in the blood on the supposition that the parasites were true filariæ; but later determined the fact that the larva-laden ova are passed through the alimentary canal and are to be found in numbers in the fecal discharges. Search for an intermediate host has thus far been unavailing, the roaches, mice, and rats in the bird house having been repeatedly examined without success. Tentatively, therefore, the idea has been adopted that the ova with their enclosed larvæ, protected by the thick and firm walls of the eggs, are mechanically distributed, as by air currents, with dust from one cage to another, and in this manner get into the food or water of each bird and are swallowed therewith and develop from the egg within the mouth, esophagus, or proventricle of the new host. Based upon this view, it has been urged to the keepers of the collection that the cages are to be kept scrupulously clean, and, after the death of a bird or its transference, that the cages be sterilized. Apparently under such precautions there is some diminution of the occurrence of the parasites; but the interval has been too brief to permit certainty in this direction at the present time.

The structural characteristics of the worms are constant; but there is considerable variation in size of the mature specimens as obtained from different hosts, and often among the examples obtained from a single bird. The average maximum length of fully developed females was a little over 14 mm.; thickness, 0.45 mm.; average maximum length of males, 8 mm.; thickness, 0.31 mm. The smallest adults were



occasionally but little more than half the size of the average; the largest female observed in the entire material was 20.5 mm. long and 0.6 mm. in diameter; the largest male observed, 12 mm. long and 0.35 mm. in diameter. The largest examples were found in the conures and in the Senegal parrot. The worms are of filarial shape (Fig. 1), long and slender, cylindrical in section, rigid and colorless. Thickest level of females at about two thirds of length from head; of males, near middle of body length. From these levels the specimens taper anteriorly in delicate manner to the head end, which at base of lips in a female of 12 mm. length measured 0.08 mm. in diameter (0.06 mm. in male somewhat over 8 mm. in length). Posteriorly the females taper uniformly and finely to an acutely conical straight tail (Fig. 6), with the tip slightly inclined dorsally; the tail of the male a little less acutely conical and curled ventrally. Cuticle finely striated transversely, transparent; and on each side at the head end the cuticle is raised into an uncertain and asymmetrical expansion (Fig. 2) with crenulated margin (in the female used for measurements reaching 1 mm. backward from head on one side and less than half this distance on the other). The head (Figs. 4 and 5) is small and is provided with six lips. Of these, two are large, thick lateral lips (Fig. 4, *a*), with broad and nearly straight anterior border, the sides incurved and the base about half the length of the anterior free border. These lips are armed with three prominent conical teeth on the anterior border; on their external surface, from base to anterior border, extends a depressed median line, on each side of which the lip substance rises in a rounded elevation. Midway between the free border and base on the external surface is a horizontal row of three small and easily overlooked papillæ. On either side of these lateral teeth is a smaller submedian lip (Fig. 4, *b* and *c*) with rounded margin and broad base, unarmed. Dorsally and ventrally between the two adjacent submedian lips is a sharp-edged prominence projecting into the oral cavity (Fig. 4, *e* and *f*) looking from

the outside like an interlabial tooth. About the bases of the lips the body cuticle rises into a collar of small and irregular eminences. There is a well-marked oral cavity (Fig. 5, *f*), the base lying about the same distance back of the base of the lips as the lateral lips rise in height above their base; base of cavity horizontal, its lateral walls rising from it at nearly right angles. The esophagus (Figs. 1, 2, and 5, *g*) is long and slender (in male of over 8 mm. length it measures 2.5 mm. in length; in female of 12. mm. length, 3.5 mm.); for a short distance from the base of the oral cavity it is thin-walled and narrow, thereafter widening and becoming thicker-walled and definitely muscular. It opens into the intestine by a rather prominent valve-like arrangement. The intestine is straight and opens in the female subterminally (0.2 mm. from tip of tail); and in the male a little more anteriorly (0.35 mm. from tip of tail) in a cloaca. Caudal end of male (Fig. 8) provided with lateral alar cuticular expansions (not quite symmetrical) supported at base by irregular and small rays from the body wall, enclosing a bursa. The cuticle within this bursa is arranged in long rectangular plates, running in the long axis of the worm and contrasting sharply with the transverse striæ of the rest of the cuticle. Within this bursa are ten pairs of papillæ and one unpaired precloacal papilla. These are arranged as follows from tip of tail forward: Nos. 1, 2, 3, and 4 (Figs. 8 and 9) are quite small and situated just in front of tip of tail, No. 2 (smaller than No. 3) and No. 3 nearly on same level (No. 2 median to No. 3); equal distances between Nos. 1, 3, and 4. No. 5 is about half-way between tip of tail and cloaca, larger than the above; No. 6 about half-way between No. 5 and cloaca, this pair not entirely symmetrical; No. 7 at or just in front of cloaca; Nos. 8, 9, and 10 in row anterior to No. 7, and separated from No. 7 and each other successively by uniformly increasing distances. Nos. 5, 6, 7, 8, 9, and 10, and the unpaired precloacal papilla, considerably larger than Nos. 1, 2, 3, and 4. Male spicules unequal. Testicular tubes plicated along the intestine.



In the female there are two ovarian tubes, anterior and posterior, which with their oviducts lie densely folded along the intestine, nearly hiding the latter in the greater part of the length of the worm. These unite into a short and inconspicuous uterine and vaginal tube, which opens ventrally at an easily overlooked vulvar orifice (Fig. 1, *v*) within the first third of the length of the worm. Ova (Fig. 7) are colorless, elliptical in shape, with thick walls, each containing a more or less well-developed larval worm. They measure as an average 38 micromillimeters in length and 18 micromillimeters in transverse diameter (small examples as low as 34 x 16; largest examples as high as 42 x 20 micromillimeters).

The larval forms met were, as a rule, but 2 or 3 millimeters in length, and often showed some appearance as of undergoing moult, the old cuticle separating about the tail end of the worm. The mouth parts were less complex than in the adults. In the young sexual forms about the only feature of importance noted was the fact of the lack of development of the bursa by the formation of the lateral caudal expansions, the papillæ being, however, seen as in the older examples.

*Spiroptera* (?) *iguanæ*, n. s. (Plate X, Figs. 1 to 3).

From the lung of a Cuban iguana, *Cyclura nubila* (P. Z. G. Lab., 1127), a single specimen of a nematode worm (Path. Hist., 1641) was submitted for identification, in bad state of preservation, and for this reason mainly permitting only the following features to be determined. The worm, a male, measured 30 mm. in length and at its thickest level (near middle of length) 0.6 mm. in thickness. It was colorless, rigid, subcylindrical, nearly uniform in thickness for the greater part of its length, but anteriorly tapering to a rounded head end (which at 0.02 mm. back of the mouth measured 0.14 mm. in diameter), and posteriorly terminating in a bluntly conical, enrolled tail with rounded tip. Cuticle finely striated transversely; worm polymyarial. Mouth

very small (0.02 mm. in diameter), the tissue about the head end rather badly broken, and the details of mouth structure uncertain. (Apparently there are three minute lips, four sided, with broad base, the anterior margin nearly straight and not as wide as base, the lateral margins convex; each lip with a single median prominence.) No buccal capsule. Esophagus long and slender, with triradiate lumen, without bulb, but widening posteriorly in delicate clavate manner before opening into intestine. Ventral surface of tail flattened to concave; uncertain from cuticular damage as to existence of cuticular expansions here and the formation thereby of a definite bursa. Tail tightly enrolled; tip of tail rounded, slightly constricted from the body of the tail, with several uncertain papilla-like prominences along its border as shown in drawing (Fig. 1). Cloaca 0.3 mm. from caudal end. Genital spicules (Fig. 2, *a* and *a*) unequal (0.27 and 0.55 mm.), grooved, the accessory piece relatively broad and flared out at distal end into a coarse barb. Eleven pairs of papillæ, of which six are precloacal; all closely set about the cloacal orifice, the most posterior being 0.21 and the most anterior 0.39 mm. from the tip of the tail.

The uncertainty of specific classification is seriously increased by the poor condition of the specimen and the fact that no female examples were obtained. The fact of the existence of six pairs of precloacal papillæ would render doubtful the propriety of regarding it among the filariæ or spiropteræ; but until further information is had the writers feel that the general features warrant a tentative retention among the spiropteræ, and would propose the specific name of *Spiroptera iguanæ*.

*Dispharagus ardeæ*, n. s. (Plate X, Figs. 4 to 6).

The following description is based upon a single female specimen (Path. Hist., 1681; No. 65, Synopsis, this journal) obtained from a North American blue heron, *Ardea herodias*,



(P. Z. G. Lab., 1158), the same bird from which were also obtained the examples of ascarides above described under the name *Ascaris ardeæ*. The precise part of the alimentary tract from which the specimen was derived cannot be stated, inasmuch as the notes of autopsy merely mention the fact that the parasites, including the ascarides, fragments of a tapeworm (*T. unilateralis*, Duj.), and the present specimen, were "found in the proventricle, stomach, and intestine." Presumably the worm was a solitary example of its species in the host, being found alone and, although apparently fully developed, having no ova in its genital tubes. The specimen measures 17 mm. in length and 0.7 mm. in diameter at thickest level, near the middle of the body length; slightly attenuate anteriorly, tapering very much less posteriorly until close to the end of the tail, where it suddenly contracts into a conical tip bent strongly upon the dorsum. Specimen rigid, colorless; cuticle rather coarsely striated transversely. At the head end, beginning at the base of the prominent lateral lip on each side, there pass two raised sinuous lines, submedian, backward to nearly the middle of the body length, extending then dorsally and ventrally respectively to join similar lines upon the opposite side of the worm. The head at base of the lips measures 0.15 mm. in transverse diameter. Two lateral lips, each with double papillæ. Esophagus 2 mm. in length, made up of two portions, an anterior narrow portion 0.8 mm. long and 0.05 to 0.09 mm. in diameter, which suddenly enters a second wider portion 1.2 mm. long and about 0.2 mm. in diameter. Intestine simple and straight. Anus 0.35 mm. from tip of tail. At level of anus the body suddenly narrows to form the conical end of the tail, presenting on each side of the anal orifice a marked ventrolateral rounded (mammary) prominence. Vulva near middle of body length. Specimen non-gravid.





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