

# A SYNOPSIS OF THE TREMATODE FAMILY SCHISTOSOMIDAE, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES

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The family Schistosomidae is composed of a number of genera of diecious trematodes parasitic in the blood-vascular system of warm-blooded vertebrates. The manner in which the free-swimming larval forms gain access to the body (skin penetration by the cercaria) is correlated with the fact that many of the species are parasitic in aquatic birds, as these birds are naturally exposed to attack in cercaria-infested waters. Several species are of considerable medical and veterinary importance; three species are parasites of man, and several species occur in ruminants and other domesticated animals. The forms found in man may produce severe lesions in the liver, bladder, and intestine, frequently resulting in death; those occurring in the domesticated animals produce similar lesions, but as these forms have not received as much study as the human species, less is known of their medical and economic importance.

Little is known of the distribution of schistosomes in the United States. Tanabe (1923) described a new genus for a new species which he succeeded in rearing in white mice following exposure to infection with cercariae obtained from *Lymnaea palustris* in Boston, Mass.; Chapin (1924) reported a blood fluke from *Marila affinis*; and more recently Linton (1928) described an *Ornithobilharzia* species from water birds at Woods Hole, Mass. Several cercariae of the schistosome type have been described from snails in this country and it appears probable that these trematodes are not uncommon but have been overlooked because of their peculiar location in the body.

In this paper three new genera and species are described from North American hosts, and *Bilharziella polonica* is reported from this continent, apparently for the first time. As a result of the study of these forms, it became apparent that a synopsis of this group would be useful, as the descriptions of many species have been given in

publications having a more or less limited circulation. The writer has, therefore, attempted to assemble descriptions of all the genera and species, and has prepared keys which will aid in the identification of these trematodes. Unfortunately many of the descriptions are inadequate as they have been based in many instances on the study of a limited number of specimens. Unless stated to the contrary the descriptions of known species have been compiled from original sources.

A few changes have been made in the classification of this group, which appear necessary for proper coordination. A new subfamily, Bilharziellinae, is proposed for those species resembling *Bilharziella polonica* in form or organization. The genus *Macrobilharzia* Travassos is regarded as a synonym of *Ornithobilharzia* Odhner, the type species, *M. macrobilharzia*, apparently being congeneric with *Ornithobilharzia intermedia* Odhner. *Schistosoma bomfordi* Montgomery and *S. turkestanicum* Skrjabin have been transferred to the genus *Ornithobilharzia*, as neither of these species are congeneric with *Schistosoma haematobium* (Bilharz) type of *Schistosoma*, and both of them have characters of the genus *Ornithobilharzia*.

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#### Family SCHISTOSOMIDAE Looss, 1899

*Synonyms*.—Schistosomatidae Poche, 1907, p. 126; Bilharziidae Odhner, 1912, p. 58.

*Family diagnosis*.—Trematoda: Sexes separate, Pharynx absent; esophagus short, terminating posteriorly in a bifurcation to form intestinal branches or ceca which join caudally at the cecal union to form a single, slender intestinal cecum terminating near the posterior end of the body. Suckers present or absent; acetabulum, when pres-

ent, cephalad of the genital pore. Body of male may be widened caudad of the acetabulum and have the sides incurved ventrally, forming a gynaeophoric canal in which the female lies. Testes consist of four or more follicles. Cirrus pouch present or absent. Female more slender than male. Ovary elongate, sometimes spirally curved, and lying cephalad of the cecal union. Laurer's canal present or absent. Vitellaria extensive, extending from the distal pole of the ovary to the posterior end of the body. Parasitic in the blood vessels of birds and mammals.

*Type genus.*—*Schistosoma* Weinland, 1858.

KEY TO THE SUBFAMILIES OF SCHISTOSOMIDAE

- Females slender, more or less cylindrical in cross section; males larger than females, flattened, and with the lateral edges infolded, forming a gynaeophoric canal; intestinal ceca usually unite caudad of the equator of the body; testes situated cephalad of the cecal union.....**Schistosominae**, p. 3.
- Females similar to males in shape; males without well-developed gynaeophoric canal; cecal branches unite cephalad of the equator of the body; testes situated caudad of the cecal union.....**Bilharziellinae**, p. 25.

Subfamily SCHISTOSOMINAE Stiles and Hassall, 1898

*Synonym.*—Schistosomatinae Stiles and Hassall, 1926, p. 96.

*Subfamily diagnosis.*—Schistosomidae: Males flattened and with the lateral edges of the body infolded ventrally to form a gynaeophoric canal. Suckers present. Intestinal ceca long, usually uniting caudad of the equator of the body; common cecum relatively short. Testes situated in the anterior or posterior half of the body, always cephalad of the cecal union. Females slender, threadlike, either longer or shorter than the males. Uterus usually contains many eggs.

*Type genus.*—*Schistosoma* Weinland, 1858.

KEY TO THE GENERA OF SCHISTOSOMINAE

1. Either male or female unknown.....2.  
Male and female both known.....3.
2. Male unknown. Female slender, flattened; ovary spiral, in posterior third of body; intestinal ceca unite near the posterior end of the body; vitellaria consist of a few scattered follicles between the cecal branches; in birds.  
**Paraschistosomatium**, p. 15.  
Female unknown. Gynaeophoric canal well developed; testes numerous, in posterior third of body and cephalad of the cecal union; in mammals.  
**Heterobilharzia**, p. 14.
3. Testes 60 or more in number; ovary spiral, in anterior third of body.  
**Ornithobilharzia**, p. 17.  
Testes 20 or less in number; ovary equatorial or post-equatorial.....4.
4. Anterior end of gynaeophoric canal near the equator of body; testes in two rows, at anterior end of gynaeophoric canal; genital pore immediately in front of the anterior testis; intestinal ceca with short lateral diverticula; common cecum in both sexes short; ovary pre-equatorial.  
**Schistosomatium**, p. 12.



- Anterior end of gynaecophoric canal near acetabulum; genital pore of male a short distance caudad of acetabulum; intestinal ceca without diverticula; common cecum usually long; ovary pre-equatorial or post-equatorial in position -----5.
5. Testes less than 10 in number; ovary oval-----*Schistosoma*, p. 4.  
Testes 18 to 20 in number; ovary spiral-----6.
6. Anterior end of gynaecophoric canal slightly caudad of the acetabulum; oral sucker lacking in female; ovary situated about one-third of the body length from the posterior extremity -----*Austroilharzia*, p. 16.  
Anterior end of gynaecophoric canal cephalad of the acetabulum; oral sucker present in female; ovary pre-equatorial -----*Microilharzia*, p. 24.

### Genus SCHISTOSOMA Weinland, 1858

*Synonyms*.—*Gynaecophorus* Diesing, 1858, pp. 356–357; *Bilharzia* Cobbold, 1859, p. 364; *Thecosoma* Moquin-Tandon, 1860, p. 342.

*Generic diagnosis*.—Schistosominae: Preacetabular portion of male short, cylindrical or nearly so; postacetabular portion widened and with the edges inrolled ventrally forming a gynaecophoric canal. Cirrus pouch absent. Seminal vesicle present, pretesticular. Testes few in number (less than 10), situated at the beginning of the gynaecophoric canal. Female filiform, longer than male. Ovary elongated, in median line, usually caudad, rarely cephalad, of equator of body. Laurer's canal absent. Eggs oval, or spindle-shaped, not operculated, with terminal or lateral spine, or with a rudimentary lateral spine, and ultimately containing a ciliated miracidium. Parasitic in the blood vessels of mammals.

Larva a furcocercous, apharyngeal, spinose cercaria without eyespots; with paired group of penetration glands around the acetabulum; penetration gland ducts opening at the anterior end of the oral sucker and capped by hollow piercing spines; excretory system consisting of four or five pairs of flame cells, one pair of which is located in the base of the tail stem. Larval stages in snails.

*Type species*.—*Schistosoma haematobium* (Bilharz, 1852) Weinland, 1858.

#### KEY TO THE SPECIES OF SCHISTOSOMA<sup>1</sup>

1. Cuticle of male smooth; testes seven in number; ovary equatorial or post-equatorial; egg  $74\mu$  to  $106\mu$  long by  $60\mu$  to  $80\mu$  wide, with rudimentary lateral spine-----*S. japonicum*, p. 7.  
Cuticle of male tuberculate and spiny; testes more or less than seven in number; ovary usually post-equatorial, sometimes equatorial; egg with well-developed terminal or lateral spine-----2.
2. Intestinal ceca of male unite near equator, or cephalad of equator of body--3.  
Intestinal ceca of male unite caudad of equator of body-----4.

<sup>1</sup> *Schistosoma incognitum* Chandler, 1926, and *S. faradjei* are not included in this key, as the adults of these species are unknown. *S. faradjei* is a name proposed by Walkiers (1928) for a schistosome whose eggs were found in the feces of man in Africa, presumably the Belgian Congo. No characters are given except that the egg is unarmed. For description of the egg of *S. incognitum* see p. 12.

3. Intestinal ceca of male unite near junction of anterior and middle thirds of body; testes eight to nine in number; ovary in anterior half of body; egg  $120\mu$  to  $160\mu$  long by  $60\mu$  to  $70\mu$  wide, with well-developed lateral spine.

*S. mansoni*, p. 6.

Intestinal ceca of male unite near equator of body; testes four to five in number; ovary near junction of posterior and middle thirds of body; egg  $120\mu$  to  $150\mu$  long by  $40\mu$  to  $60\mu$  wide, with terminal spine.

*S. haematobium*, p. 5.

4. Testes three to six in number; ovary in posterior half of body; egg spindle-shaped, symmetrical,  $160\mu$  to  $180\mu$  long by  $50\mu$  to  $80\mu$  wide, with terminal spine-----*S. bovis*, p. 8.

Testes usually more than six in number; ovary near equator of body-----5.

5. Egg oval,  $92\mu$  to  $120\mu$  long by  $42\mu$  to  $72\mu$  wide, with terminal spine.

*S. indicum*, p. 11.

Egg spindle-shaped, asymmetrical,  $248\mu$  to  $400\mu$  long by  $52\mu$  to  $72\mu$  wide, with terminal spine-----*S. spindalis*, p. 9.

#### SCHISTOSOMA HAEMATOBIIUM (Bilharz, 1852) Weinland, 1858

Figures 1—4 b

*Synonyms*.—*Distoma haematobium* Bilharz, 1852, pp. 72–76 (in *Homo*, Egypt); *Gynaecophorus haematobius* (Bilharz, 1852) Diesing, 1858, pp. 356–357; *Bilharzia haematobia* (Bilharz, 1852) Cobbold, 1859, p. 364; *Bilharzia magna* Cobbold, 1859, p. 364; *Thecosoma haematobium* (Bilharz, 1852) Moquin-Tandon, 1860, p. 342; *Bilharzia capensis* Harley, 1864, p. 63; *Gynaecophorus magnus* (Cobbold, 1859) Stossich, 1892, p. 6; *Bilharzia haematobia hominis* Kowalewski, 1895, p. 26; *Bilharzia haematobia magna* (Cobbold, 1859) Kowalewski, 1895, p. 27.

*Specific diagnosis*.—*Schistosoma*:

*Male* 4 to 15 mm. long by about 1 mm. wide. Anterior part of body short, subcylindrical; posterior part long, flattened, and with lateral edges infolded ventrally, forming the gynaecophoric canal. Cuticle tuberculate and spiny. Oral sucker subterminal, elongated anteroposteriorly, and lined with fine spines; acetabulum circular, pedunculated, spiny, and situated a short distance caudad of oral sucker. Esophagus short and surrounded by esophageal glands; immediately in front of acetabulum the esophagus bifurcates to form the paired intestinal ceca, the two branches extending caudad to about the equator of the body, where they unite to form a common cecum, which terminates near the posterior end of the body. Testes 4 to 5 in number, situated dorsally near the beginning of the gynaecophoric canal. Seminal vesicle spherical, situated in front of the anterior testis. The genital pore opens in the median line at the beginning of the gynaecophoric canal.

*Female* about 20 mm. long, filiform, and with a maximum width of  $250\mu$ . Cuticle without spines, except in suckers and at posterior end of body. Digestive tract similar to that of male. Ovary elon-

gate, in posterior half of body, and cephalad of cecal union. Uterus long, ending posteriorly in a bulblike ootype, immediately posterior of which the shell gland, oviduct, and vitelline duct unite. Vitellaria composed of transversely elongated follicles situated on each side of the common cecum, extending from the cecal union to the posterior end of the body. Egg oval,  $120\mu$  to  $160\mu$  long by  $40\mu$  to  $60\mu$  wide, provided with a terminal spine.

*Cercaria furcocercous*, apharyngeal, spinose. Body, according to Faust (1926),  $140\mu$  to  $240\mu$  long by  $57\mu$  to  $100\mu$  wide; tail stem  $175\mu$  to  $250\mu$  long by  $35\mu$  to  $50\mu$  wide; furcal rami  $60\mu$  to  $100\mu$  long. Oral sucker  $64\mu$  long by  $60\mu$  wide; acetabulum small. Penetration glands consist of two pairs of large nucleated cells with granular acidophilic cytoplasm and three pairs with basophilic cytoplasm. Penetration gland ducts moderately thick, opening at the anterior end of oral sucker and capped by five pairs of hollow piercing spines. The germ cells lie caudad of acetabulum and consist of several large cells. The excretory system pattern consists of three pairs of flame cells in the body and one pair in the tail stem.

*Hosts*.—Primary, man, monkey (*Cercocebus atys* Audebert=*Cercopithecus fuliginosus*), and, experimentally, rats and mice; secondary, snails (*Bulinus contortus*, *B. dybowskii* and *B. innesi* in Egypt; *B. brochii* in Tunis; *Physopsis africana* in Belgian Congo, Natal, and Transvaal; *P. (?) globosa* in Nyasaland and Sierra Leone; *P. nasuta* in Tanganyika Territory; *Lymnaea natalensis* in South Africa; and *Planorbis dufourii* in Portugal).

*Location*.—Portal and mesenteric veins and veins of bladder.

*Distribution*.—Africa, Australia, Asia (Arabia, Cyprus, India, Mesopotamia, Palestine, and Persia), and Europe (Greece and Portugal).

#### SCHISTOSOMA MANSONI Sambon, 1907

Figures 6-11

*Synonymy*.—*Distoma haematobium* Bilharz, 1852, in part; *Schistosomum americanum* Piraja da Silva, 1909, p. 294; *Bilharzia mansoni* (Sambon, 1907) Ascanio-Rodriguez, 1916, p. 92; *Distomum mansoni* (Sambon, 1907) Iturbe, 1917, p. 52.

*Specific diagnosis*.—*Schistosoma*:

*Male* about 10 mm. long by 1.2 mm. wide. Body form similar to that of *S. haematobium*. Cuticle tuberculate and spiny. Oral sucker subterminal; acetabulum pedunculated and situated about  $530\mu$  caudad of oral sucker. Esophagus surrounded by esophageal glands; intestinal ceca short, uniting in front of equator of body; common cecum very long, terminating near the posterior extremity of the body. Testes small, 8 to 9 in number, situated at anterior end of



gynaecophoric canal. Seminal vesicle small, in front of testes. Genital pore opens in median line about the level of the first testis.

*Female* 15 mm. long, filiform, and about  $170\mu$  wide. Suckers small; acetabulum situated about  $224\mu$  to  $252\mu$  caudad of the oral sucker. Digestive system similar to that of male. Ovary elongate, in anterior half of body and immediately in front of cecal union. Uterus short and usually containing but one egg at a time. The vitellaria occupy about two-thirds of body length, extending posteriorly from immediately caudad of cecal union. Egg oval,  $120\mu$  to  $160\mu$  long by  $60\mu$  to  $70\mu$  wide, and provided with a strong lateral spine.

*Cercaria* furcocercous, apharyngeal, spinose. Body  $140\mu$  to  $190\mu$  long by  $50\mu$  to  $75\mu$  wide; tail stem  $200\mu$  to  $260\mu$  long by  $25\mu$  to  $40\mu$  wide; furcal rami  $50\mu$  to  $75\mu$  long. Oral sucker  $30\mu$  to  $60\mu$  wide; acetabulum small. Penetration glands consist of two pairs of large nucleated acidophilic, granular cells and four pairs with small nuclei and basophilic cytoplasm; penetration gland ducts very thick, opening at the anterior end of oral sucker and capped by six pairs of hollow piercing spines. Germ cells small and situated caudad of acetabulum. Excretory system pattern consists of three pairs of flame cells in the body and one pair in the tail stem.

*Hosts*.—Primary, man, and experimentally, rats and mice; secondary, snails (*Planorbis boissyi* in Egypt; *Planorbis pfeifferi*, *Physopsis africana* and *Bulinus tropicus* in South Africa; *Planorbis guadelupensis* in Venezuela; *Planorbis centimetralis* and *P. olivaceus* in Brazil; and *P. antiguensis* in the West Indies).

*Location*.—Mesenteric veins.

*Distribution*.—Africa, South America, and West Indies.

#### SCHISTOSOMA JAPONICUM Katsurada, 1904

Figs. 12-16

*Synonyms*.—*Schistosoma cattoi* R. Blanchard in Catto, 1905, p. 70-73; *Bilharzia japonica* (Katsurada, 1904) Hutyra and Marek, 1913, p. 1128.

*Specific diagnosis*.—*Schistosoma*:

*Male* 9.5 to 17.8 mm. long by  $557\mu$  to  $967\mu$  wide. Cuticle smooth except for small spines along gynaecophoric canal and in suckers. Oral sucker subterminal,  $200\mu$  to  $350\mu$  in diameter; acetabulum pedunculated,  $156\mu$  to  $420\mu$  in diameter, situated  $550\mu$  to  $780\mu$  caudad of oral sucker. The digestive tract is similar to that of *S. haematobium*; intestinal ceca unite caudally about one-fourth of body length from posterior extremity of body. Testes 7 in number (6 to 8 according to some authors), situated near anterior end of gynaecophoric canal. Seminal vesicle spherical,  $125\mu$  in diameter, and situated immediately in front of the first testis.

*Female* 15 to 20 mm. long and  $312\mu$  to  $358\mu$  wide at the cecal union. Cuticle smooth. Oral sucker subterminal,  $60\mu$  to  $70\mu$  in diameter; acetabulum pedunculated,  $45\mu$  to  $60\mu$  in diameter, situated  $266\mu$  to  $298\mu$  caudad of oral sucker. Ovary elongate,  $580\mu$  to  $700\mu$  long by  $135\mu$  to  $185\mu$  wide, situated at equator, or caudad of equator of body. Uterus long and containing numerous eggs. Genital pore immediately caudad of acetabulum. Vitellaria occupy the space from the cecal union to the posterior end of the body, and are composed of transversely elongated follicles lying on both sides of the common cecum. Egg oval,  $74\mu$  to  $106\mu$  long by  $60\mu$  to  $80\mu$  wide, provided with a small, lateral, hooked or rudimentary spine.

*Cercaria* furcocercous, apharyngeal, spinose. Body  $100\mu$  to  $160\mu$  long by  $40\mu$  to  $66\mu$  wide; tail stem  $140\mu$  to  $160\mu$  long by  $20\mu$  to  $35\mu$  wide; furcal rami  $50\mu$  to  $75\mu$  long. Oral sucker  $54\mu$  long by  $33\mu$  wide; acetabulum small. Penetration glands consist of five pairs of large nucleated cells with granular, acidophilic cytoplasm; penetration gland ducts very thick, opening at anterior end of oral sucker and capped by five pairs of hollow piercing spines. The germ cells consist of a clustered mass immediately caudad of the acetabulum. The excretory system pattern consists of three pairs of flame cells in the body and one pair in the tail stem.

*Hosts*.—Primary, man, *Bos sinicus*,<sup>2</sup> cattle (*Bos taurus*), dog, cat, horse, swine, sheep, and experimentally, guinea pigs, monkeys, rabbits, rats, and mice; secondary, snails (*Katayama nosophora* and *K. n. yoshidai* in Japan; *K. formosana* in Formosa; *Oncomelania (Hemibia) hupensis*, *Katayama fausti* and *K. f. cantoni* in China).

*Location*.—Portal and mesenteric veins.

*Distribution*.—Asia (China, Japan, Formosa, and Philippine Islands) and Africa.

SCHISTOSOMA BOVIS (Sonsino, 1876) R. Blanchard, 1895

Figures 23-25

*Synonyms*.—*Bilharzia bovis* Sonsino, 1876, pp. 84-87 (in *Bos taurus*; Egypt); *Bilharzia crassa* Sonsino, 1878, p. 652; *Bilharzia ovis* Cobbold, 1885, p. 499; *Gynaecophorus crassus* (Sonsino, 1878) Stossich, 1892, p. 6; *Gynaecophorus bovis* (Sonsino, 1876) Railliet, 1893, p. 375; *Bilharzia haematobia crassa* (Sonsino, 1878) Kowalewski, 1895, pp. 18, 19, 27; *Schistosoma crassum* (Sonsino, 1876) Looss, 1899, pp. 657, 658.

*Specific diagnosis*.—*Schistosoma*:

*Male* 9 to 14 mm. long. Cuticle with tubercles and spines. Oral sucker subterminal,  $230\mu$  long and  $150\mu$  deep; acetabulum  $420\mu$  in

<sup>2</sup> Brumpt (Précis de Parasitologie, ed. 3 (1922), p. 398) gives *Bos sinicus* as a host for *Schistosoma japonicum*. This host name is not recognized by mammalogists, and since no geographical locality is given, its identity is problematical.



diameter. Esophagus  $500\mu$  long; cecal branches unite posteriorly at the beginning of the posterior fourth of the body and may show two or three anastomoses before their final union; common cecum terminates near posterior end of body. Testes 3 to 6 in number (usually 4, according to Khalil (1924)), each  $120\mu$  long by  $100\mu$  wide, in a row on dorsal aspect of body, caudad of acetabulum. Seminal vesicle pear-shaped,  $80\mu$  in diameter, and situated immediately in front of the anterior testis. Cirrus pouch and prostate absent. Genital pore slightly salient and situated immediately caudad of the acetabulum.

*Female* 12 to 17 mm. long, cylindrical, and attenuated at the extremities. Cuticle smooth and without spines. Oral sucker small,  $40\mu$  in diameter; acetabulum usually retracted,  $50\mu$  in diameter. Intestinal ceca unite caudally at the posterior fourth of body; common cecum relatively short and terminating about  $160\mu$  from posterior extremity. Ovary elongated,  $300\mu$  long and  $150\mu$  wide, and situated immediately in front of cecal union. Shell gland small and ill-defined, situated in front of anterior pole of ovary. Uterus long and containing numerous eggs. Vitellaria consist of elongate, densely packed follicles beginning about  $100\mu$  caudad of ovary and extending about  $200\mu$  from posterior extremity. Egg spindle-shaped, symmetrical,  $160\mu$  to  $180\mu$  long by  $50\mu$  to  $60\mu$  wide, and provided with a blunt spine at one pole.

*Hosts*.—Primary, mammals (*Bos taurus*, *Ovis aries* and (?) man); secondary, snails (*Physopsis africana* in South Africa, the host of *Cercaria octadena* which is regarded by Faust (1926) as the larva of *S. bovis*).

*Location*.—Portal and intestinal veins.

*Distribution*.—Europe (Italy, Sardinia, and Sicily), Asia (India, Annam, and Malay States), and Africa (Egypt and South Africa).

SCHISTOSOMA SPINDALIS Montgomery, 1906

Figures 17-22

*Synonym*.—*Bilharzia spindalis* (Montgomery, 1906) Odhner, 1912, p. 59.

*Specific diagnosis*.—*Schistosoma*:

*Male* 8.24 to 9.58 mm. long by  $527\mu$  thick (4.5 to 12.2 mm. long by  $250\mu$  to  $667\mu$  wide, according to Vryburg (1907)). Cuticle covered with tubercles and spines; spines are also present in suckers and at borders of gynaecophoric canal. Oral sucker  $306\mu$  in diameter; acetabulum pedunculated,  $357\mu$  in diameter, and situated  $900\mu$  caudad of oral sucker. (Oral sucker  $300\mu$  by  $250\mu$ ; acetabulum  $267\mu$  in diameter and  $767\mu$  caudad of oral sucker, according to Vryburg.) Testes 6 to 7 in number, each  $85\mu$  in diameter. Caudal end of body terminates in a conical projection and at the apex is located the excretory pore.

*Female* 14.1 mm. long by  $200\mu$  wide (7.17 to 7.25 mm. long by  $100\mu$  to  $175\mu$  wide, according to Vryburg). Cuticle devoid of spines except at the posterior end of body and in cavity of oral sucker. Oral sucker subterminal,  $68\mu$  in diameter; acetabulum small, retracted, and situated  $268\mu$  caudad of the oral sucker. Esophagus simple; intestinal caeca unite posteriorly 7.702 mm. caudad of esophageal bifurcation; common cecum 6 mm. long and terminating  $144\mu$  from posterior end of body. Ovary oval and situated posterior of equator of body. Vitellaria are composed of discrete follicles lying lateral to the common cecum and extending posteriorly from the cecal union to within a short distance of the posterior extremity of the body. Egg spindle-shaped, asymmetrical, with a spine  $14\mu$  to  $15\mu$  long present at one pole; uterine egg  $284\mu$  long by  $44\mu$  wide; immature egg, in which embryo is not defined,  $304\mu$  to  $316\mu$  long and  $52\mu$  to  $54\mu$  wide; mature egg, containing a miracidium,  $364\mu$  to  $400\mu$  long by  $68\mu$  to  $72\mu$  wide at the widest portion and  $12\mu$  to  $14\mu$  across the polar prolongations.

*Cercaria* furcocercous, apharyngeal, spinose. Total length  $490\mu$ ; body  $200\mu$  long by  $50\mu$  wide; tail stem  $290\mu$  long by  $30\mu$  wide; furcal rami  $100\mu$  long. Oral sucker  $60\mu$  long by  $40\mu$  wide; acetabulum  $20\mu$  in diameter. Penetration glands consist of five pairs of pyriform cells, the two anterior pairs being acidophilic, coarsely granular, and with large nuclei and the posterior three pairs being finely granular, basophilic, and with somewhat larger nuclei. Penetration gland ducts thick, opening at anterior end of oral sucker, and capped by five pairs of hollow piercing spines. The germ cells, 24 in number, lie caudad of acetabulum. The excretory system pattern consists of four pairs of flame cells in the body and one pair in the tail stem.

*Hosts*.—Primary, mammals (*Bos (Bubalus) bubalis* Linnaeus, 1766 (synonym, *Buffelus indicus* Rutimeyer, 1865=*Bos indicus*)) and man, and, experimentally, goat, water buffalo, monkey (*Macaca sinica*), guinea pig, and rats; secondary, snails (*Planorbis exustus* and, rarely, *Lymnaea acuminata* in India; *Planorbis pfeifferi* and *Bulinus tropicus* in Africa).

*Location*.—Mesenteric and portal veins.

*Distribution*.—Asia (India and Sumatra) and Africa (South Africa).

Recently Porter (1926) described a new variety of *Schistosoma spindalis* from South Africa for which she proposed the name *S. spindalis* variety *africana*. The characters upon which the new variety is based are the egg size, smaller than that described by Montgomery for the Indian species, and also a cercaria smaller than that described by Soparkar (1921). The eggs of the new variety were obtained from the urine of man and measured  $163\mu$  to  $258\mu$

long by  $46.4\mu$  to  $70\mu$  wide. The cercaria, obtained by infecting *Planorbis pfeifferi* and *Bulinus tropicus*, measured as follows: Body  $153.3\mu$  to  $183\mu$  long by  $50.8\mu$  to  $86.6\mu$  wide; tail stem  $173.3\mu$  to  $200\mu$  long by  $50.8\mu$  to  $86.6\mu$  wide; furcal rami  $66.6\mu$  to  $83.3\mu$  long by  $21\mu$  to  $26.6\mu$  wide; oral sucker  $40\mu$  to  $53.3\mu$  long by  $30\mu$  to  $33\mu$  wide; acetabulum  $18.5\mu$  by  $26.6\mu$ .

The reported occurrence of *S. spindalis* in man includes at least three apparently authentic cases, one reported by Cawston (1925) and two by Porter, and there are one or two doubtful cases. Daubney (1923) considers the egg reported from the urine of a Madras native by Christophers and Stephens (1905) as probably belonging to this species. It is possible that the eggs described from human urine by Chesterman (1923) may also be those of *S. spindalis*.

SCHISTOSOMA INDICUM Montgomery, 1906

Figures 26-29

*Synonymy*.—*Bilharzia indica* (Montgomery, 1906) Hutyra and Marek, 1910, p. 902.

*Specific diagnosis*.—*Schistosoma*:

*Male* 8.35 to 17 mm. long; anterior part of body straight, 1 to 1.5 mm. long and  $400\mu$  wide; posterior part of body cylindrical due to inrolling of the edges to form the gynaecophoric canal; maximum dorsal width  $350\mu$  and greatest dorsoventral width  $400\mu$  to  $500\mu$ . Cuticle tuberculate and spiny. Oral sucker subterminal, infundibuliform,  $270\mu$  to  $320\mu$  in diameter; acetabulum pedunculated,  $350\mu$  to  $425\mu$  in diameter, and situated 0.9 to 1.5 mm. caudad of oral sucker. Esophagus  $425\mu$  long; cecal branches unite caudally about 0.85 to 1.5 mm. from posterior end of body, forming a common cecum which terminates about  $100\mu$  from the posterior extremity. Testes 5 to 9 in number, situated about  $400\mu$  caudad of acetabulum; seminal vesicle small,  $85\mu$  in diameter and lying in front of the first testis; the genital pore opens in the median line at the anterior end of the gynaecophoric canal. The excretory bladder is  $80\mu$  long; excretory pore terminal.

*Female* 9 to 22 mm. long and  $190\mu$  wide. Cuticle smooth except for a few spines on the posterior end of body and on the inside of suckers. Oral sucker small, subterminal; acetabulum  $50\mu$  to  $60\mu$  in diameter, usually retracted. Esophagus  $230\mu$  long; cecal branches unite caudad of ovary, forming a slender common cecum which terminates about  $200\mu$  from the posterior extremity. Ovary situated at equator of body, oval in shape,  $500\mu$  to  $750\mu$  long by  $100\mu$  wide; uterus 5 to 7 mm. long; genital pore immediately caudad of acetabulum. Vitellaria lie on each side of the common cecum and extend from the cecal union to  $200\mu$  to  $300\mu$  from the posterior end of body. Egg oval and provided with a spine at one pole; uterine egg from  $92\mu$



to  $100\mu$  long by  $42\mu$  to  $44\mu$  wide, spine  $14\mu$  long; mature egg in tissue from  $120\mu$  to  $140\mu$  long by  $68\mu$  to  $72\mu$  wide.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, mammals (*Equus caballus*, *E. asinus*, *Camelus dromedarius*, and *Ovis aries*); secondary, unknown.

*Location*.—Mesenteric, pancreatic, pelvic, portal, and hepatic veins.

*Distribution*.—India.

Specimens of schistosomes from sheep (United States National Museum Helminthological Collections No. 14828), from Lahore, India, donated by Capt. S. H. Gaiger, have been studied and identified as *Schistosoma indicum*. The males measure 5.9 to 7.6 mm. long by  $484\mu$  to  $718\mu$  wide. The anterior part of the body is subcylindrical,  $546\mu$  to  $692\mu$  long and  $235\mu$  wide. Oral sucker subterminal,  $172\mu$  to  $187\mu$  in diameter; acetabulum pedunculated,  $187\mu$  to  $203\mu$  in diameter, and situated  $156\mu$  to  $312\mu$  caudad of oral sucker. Testes nine in number, each elongated dorsoventrally and with their edges in apposition, and situated dorsally at the anterior end of the gynaecophoric canal; an oval seminal vesicle  $109\mu$  long by  $62\mu$  to  $78\mu$  wide is situated in front of the anterior testis.

The females measure 7.3 to 14.5 mm. long by  $172\mu$  wide. Oral sucker and acetabulum equal in size,  $30\mu$  in diameter; the acetabulum is situated about  $170\mu$  caudad of oral sucker. Ovary elongated,  $525\mu$  to  $572\mu$  long by  $95\mu$  to  $125\mu$  wide, and situated caudad of equator of body. The uterus is long and filled with eggs. Vitellaria occupy the entire space from the cecal union to the posterior end of the body. Uterine egg oval,  $86\mu$  to  $91\mu$  long by  $43\mu$  to  $47\mu$  wide, and provided with a terminal spine  $12\mu$  long.

#### SCHISTOSOMA INCOGNITUM Chandler, 1926

Figure 5

*Specific diagnosis*.—*Schistosoma*:

*Male* unknown.

*Female* unknown. Egg  $95\mu$  to  $100\mu$  long by  $41.5\mu$  to  $50\mu$  wide, with a subterminal spine  $7.3\mu$  long.

*Cercaria* unknown or unrecognized.

*Host*.—Primary, mammals (man); secondary, unknown.

*Location*.—Feces (for eggs).

*Distribution*.—Asia (India).

#### Genus SCHISTOSOMATIUM Tanabe, 1923

*Generic diagnosis*.—Schistosominae: Male larger and longer than female. Suckers present, well developed. Anterior two-fifths of body flattened; posterior three-fifths infolded to form the gynae-

cophoric canal. Intestinal ceca provided with lateral diverticula and united near posterior end of body. Testes 14 to 18 in number, arranged in two rows at anterior end of gynaecophoric canal. Genital pore median, in front of the anterior testis. Female flattened. Ovary in anterior half of body. Uterus containing numerous oval, spineless eggs. Genital pore caudad of acetabulum. Vitellaria composed of lobulated, densely packed follicles extending from the distal pole of ovary to posterior end of body.

Larva a furcocercous, apharyngeal cercaria, with eye spots, and with an excretory system consisting of six pairs of flame cells, one pair of which is located in the base of the tail stem.

*Type species.*—*Schistosomatium pathlopticum* Tanabe, 1923.

SCHISTOSOMATIUM PATHLOPTICUM Tanabe, 1923

Figures 30-32

*Synonym.*—*Schistosoma pathlopticum* Tanabe in Strong, 1923, p. 516.

*Specific diagnosis.*—*Schistosomatium*:

*Male* 5.6 to 11.8 mm. long by  $400\mu$  to  $900\mu$  wide. Anterior portion of body flattened, 2.4 to 4.7 mm. long by  $260\mu$  to  $580\mu$  wide; posterior portion, 3.2 to 7.1 mm. long by 1.04 mm. wide when flattened, with edges infolded forming a gynaecophoric canal; between the anterior and posterior portions the body is narrowed and is  $240\mu$  to  $410\mu$  wide. Cuticle spiny but without tubercles. Oral sucker subterminal,  $130\mu$  to  $160\mu$  in diameter; acetabulum pedunculated,  $250\mu$  to  $260\mu$  in diameter. Esophagus simple, about  $520\mu$  long; intestinal ceca provided with short lateral diverticula and united posteriorly about  $600\mu$  from the caudal extremity; common cecum short and terminating about  $140\mu$  from posterior end of body. Testes 14 to 18 in number, spherical,  $100\mu$  to  $180\mu$  in diameter, in two parallel rows in the median line and slightly pre-equatorial. Seminal vesicle large, semi-lunar in outline, and situated to the left of the median line. Genital pore situated at anterior end of gynaecophoric canal, slightly to left of median line. Excretory system consists of two slender, lateral tubes which unite to form a common tube opening slightly dorsad at the extreme posterior end of body.

*Female* 4.5 to 10.2 mm. long by  $180\mu$  to  $380\mu$  wide. Suckers weak and rudimentary. Cuticle spiny in anterior part of body, especially around suckers and genital pore. Ovary oval in shape and situated in front of equator of body. Shell gland poorly defined, in front of ovary, and at the junction of the oviduct, vitelline duct, and uterus. Uterus about  $500\mu$  long and filled with eggs. Vitellaria composed of densely packed lobulated follicles, and occupying almost the entire

space from the ovary to the posterior end of the body. Egg oval,  $59\mu$  long by  $40\mu$  wide, without spine.

*Cercaria furcocercous*, apharyngeal, spinose. Total length  $410\mu$ ; body  $180\mu$  long by  $80\mu$  wide; tail stem  $230\mu$  long by  $45\mu$  wide; furcal rami  $100\mu$  long. Eyespots present, pigmented,  $8\mu$  in diameter, lying near equator of body. Oral sucker  $50\mu$  long by  $47\mu$  wide; acetabulum  $24\mu$  in diameter. Penetration glands consist of three pairs of acidophilic cells which nearly fill the postacetabular region of body; penetration gland ducts open at anterior end of acetabulum and are capped by an equal number of hollow piercing spines. The germ cells lie in the median line caudad of the acetabulum. Excretory system pattern consists of five pairs of flame cells in the body and one pair in the tail stem.

*Hosts*.—Primary, mammals (white rats and mice, experimentally); secondary, snail (*Lymnaea palustris*).

*Location*.—Intestinal veins, portal vein, and liver.

*Distribution*.—North America (United States (Boston, Massachusetts)).

#### HETEROBILHARZIA, new genus

*Generic diagnosis*.—Schistosominae: Preacetabular portion of male short, subcylindrical; posterior portion with edges inrolled, forming a deep gynaecophoric canal. Suckers present. Cuticle covered with small tubercles. Intestinal ceca unite caudally near posterior end of body. Testes numerous, 70 to 83 in number, arranged in two irregular rows in posterior third of body anterior to cecal union. Cirrus pouch present and containing the seminal vesicle. Genital pore situated at the beginning of the gynaecophoric canal and to the left of the median line. Female unknown.

*Type species*.—*Heterobilharzia americana*, new species.

#### HETEROBILHARZIA AMERICANA, new species

Figures 33-34

*Specific diagnosis*.—*Heterobilharzia*:

*Male* 10 to 14 mm. long by 3 mm. wide. Cuticle covered with small tubercles. Oral sucker subterminal,  $350\mu$  to  $355\mu$  in diameter; acetabulum pedunculated,  $426\mu$  to  $453\mu$  in diameter, situated about  $568\mu$  caudad of oral sucker. Esophagus long and surrounded by the esophageal glands; intestinal ceca sinuous and uniting about  $500\mu$  to  $750\mu$  from posterior end of body; common cecum short and terminating  $140\mu$  to  $150\mu$  from posterior end of body. Testes 70 to 83 in number, arranged in two irregular rows between the intestinal ceca in posterior third of body. Cirrus pouch elongated transversely,  $210\mu$  to  $315\mu$  long by  $70\mu$  wide, and situated about  $568\mu$  caudad of



acetabulum; seminal vesicle oval and lying entirely within the cirrus pouch. Genital pore  $570\mu$  caudad of acetabulum and to the left of median line. Excretory system consists of a short bladder which opens at excretory pore at the tip of the body, and of two slender branches extending cephalad on each side of body.

*Female* unknown.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, mammals (*Lynx* species, probably *L. vinta*); secondary, unknown.

*Location*.—Mesenteric veins.

*Distribution*.—North America (United States (Washington, D. C., National Zoological Park)).

*Type specimens*.—United States National Museum Helminthological Collections No. 14532, collected August 27, 1907, by Dr. M. C. Hall and Dr. A. Hassall.

#### PARASCHISTOSOMATIUM, new genus

*Generic diagnosis*.—Schistosominae: Male unknown. Female slender, flattened, and tapering toward the extremities. Cuticle smooth. Oral sucker subterminal, well developed; acetabulum pedunculated. Esophagus simple; intestinal ceca without lateral diverticula and united caudally near posterior end of body; common cecum very short. Ovary spirally curved, in posterior third of body; uterus long and filled with eggs. Vitelline follicles few in number, situated posterior to ovary and between the cecal branches.

*Type species*.—*Paraschistosomatium anhingae*, new species.

#### PARASCHISTOSOMATIUM ANHINGAE, new species

Figure 35

*Specific diagnosis*.—*Paraschistosomatium*:

*Male* unknown.

*Female* 6.9 mm. long by  $325\mu$  wide. Body flattened and tapering gradually toward the extremities. Cuticle smooth and without spines except in suckers. Suckers equal in size,  $143\mu$  in diameter; oral sucker subterminal; acetabulum pedunculated and situated  $480\mu$  caudad of oral sucker. Esophagus simple, bifurcating in front of acetabulum; intestinal ceca unite caudally about  $460\mu$  from posterior end of body; common cecum  $200\mu$  long. Ovary spiral,  $585\mu$  long as measured in a straight line and exclusive of length of spiral, and situated in the anterior part of the posterior third of body. Vitellaria consist of a few scattered follicles lying posterior to the ovary and between the cecal branches. Genital pore is situated immediately caudad of the acetabulum. Uterus long and filled with thin-shelled eggs which measure about  $70\mu$  long by  $43\mu$  wide.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Anhinga anhinga*); secondary, unknown.

*Location*.—Portal vein.

*Distribution*.—North America (United States (Texas)).

*Type specimen*.—United States National Museum Helminthological Collections No. 27887, collected by the writer, April 8, 1922, at Bryan, Tex.

This trematode is probably more closely related to species of the genus *Schistosomatium* than those of any of the other genera. The union of the intestinal ceca near the posterior end of the body is similar to that in *S. pathlopticum*; in *P. anhingae*, however, the ceca do not have lateral diverticula, the ovary is more posterior, and the distribution of the vitelline follicles is very different from that in *S. pathlopticum*. In view of these differences the writer has tentatively proposed the new genus *Paraschistosomatium* to include this species.

#### Genus AUSTROBILHARZIA Johnston, 1917

*Generic diagnosis*.—Schistosominae: Male shorter than female. Gynaecophoric canal extends from posterior edge of acetabulum to posterior end of body. Suckers well developed and prominent. Esophagus bifurcates in front of acetabulum; intestinal ceca unite caudally in the posterior fourth of body and may show several anastomoses before the final union; common cecum short. Testes 18 to 20 in number, situated between the ceca, originating anteriorly a short distance caudad of acetabulum and extending to equator of body. Genital pore situated caudad of acetabulum, a little to the left of median line. Cirrus pouch present, enclosing the seminal vesicle and prostate. Female slender, the anterior portion thread-like and the posterior portion flattened. Oral sucker not developed, acetabulum present. Ovary long and loosely spiral. Vitellaria well developed and occupying the region behind the ovary.

*Type species*.—*Austrobilharzia terrigalensis* Johnston, 1917.

#### AUSTROBILHARZIA TERRIGALENSIS Johnston, 1917

##### Figure 36

*Specific diagnosis*.—*Austrobilharzia*:

*Male* 3.5 to 4 mm. long by 400 $\mu$  wide dorsoventrally. Cuticle smooth. Suckers about equal in size, 175 $\mu$  in diameter; acetabulum pedunculated and lined with fine spines. Intestinal ceca provided with small diverticula; in the posterior third of the body the ceca are united by commissures, forming two loops which are separated by a short stem; common cecum short and terminating near posterior end of body. Testes 18 to 20 in number, symmetrically placed between the intestinal ceca, originating about 200 $\mu$  caudad of genital pore and extending

to equator of body. Cirrus pouch moderately developed and enclosing the seminal vesicle and prostate. Genital pore situated about  $125\mu$  caudad of the acetabulum and to the left of the median line. The excretory system consists of a Y-shaped vesicle opening at the extreme posterior end of the body, with two fine ciliated tubes given off from the anterior limbs of the Y.

*Female* 4.5 to 5 mm. long; anterior part of body slender, 2.65 mm. long by  $58\mu$  in diameter; posterior portion flattened, 1.85 mm. long by  $136\mu$  wide. Oral sucker absent; acetabulum pedunculated,  $35\mu$  in diameter. Oral opening ventral,  $30\mu$  from the anterior end of body; esophagus  $200\mu$  long; intestinal ceca unite caudally at the union of anterior and posterior parts of body; common cecum slender and terminating near posterior end of body. Ovary spirally curved,  $388\mu$  long when measured in a straight line, disregarding spiral length, and situated at the union of anterior and posterior parts of body. The oviduct extends forward and widens near its anterior end to form the uterus which contains a single egg. The genital pore is situated immediately behind and to one side of the acetabulum. The vitellaria occupy the space from the distal pole of the ovary to the posterior end of the body. Egg  $32\mu$  long by  $26\mu$  wide.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Hydrocoloeus novae-hollandiae*=*Larus novae-hollandiae*); secondary, unknown.

*Location*.—Intestinal blood vessels.

*Distribution*.—Australia (New South Wales).

#### Genus ORNITHOBILHARZIA Odhner, 1912

*Synonym*.—*Macrobilharzia* Travassos, 1923, p. 18.

*Generic diagnosis*.—Schistosominae: Female shorter than male. Male with well developed gynaecophoric canal, formed by an infolding of the lateral edges of the body. Suckers present. Cuticle covered with spines. Digestive tract similar to that of *Schistosoma*; intestinal ceca long and showing a tendency to form several anastomoses before finally uniting to form the common cecum. Testes numerous (60 or more), commencing a short distance caudad of acetabulum, and extending into posterior half of body. Cirrus pouch rudimentary or absent. Seminal vesicle free in the parenchyma; prostate absent. Genital pore small and situated immediately caudad of acetabulum. Female elongate, slender, and flattened. Ovary elongated, loosely or tightly coiled, and situated in anterior third of body. Vitellaria extensive, occupying about two-thirds of body length. Laurer's canal present (at least in some species). Uterus short and containing but one egg at a time.

*Type species*.—*Ornithobilharzia intermedia* Odhner, 1912.



KEY TO SPECIES OF ORNITHOBILHARZIA <sup>3</sup>

1. Parasitic in mammals-----2.  
 Parasitic in birds-----3.  
 2. Cuticle of male smooth; testes 70 to 80 in number; egg  $72\mu$  to  $74\mu$  by  $22\mu$  to  $26\mu$ , with a spinous process at each pole-----*O. turkestanicum*, p. 21.  
 Cuticle of male tuberculate; testes 61 in number; egg  $100\mu$  to  $136\mu$  by  $44\mu$  to  $60\mu$ , with a spine at one pole-----*O. bomfordi*, p. 22.  
 3. Species inadequately described-----4.  
 Species adequately described-----5.  
 4. Male 14 mm. long; oral sucker  $364\mu$  in diameter; acetabulum  $560\mu$  in diameter; female unknown; in *Hydrocoloeus melanocephalus*.  
*O. kowalewskii*, p. 19.  
 Male 16 mm. long; oral sucker  $312\mu$  by  $104\mu$  to  $160\mu$ ; acetabulum  $450\mu$  in diameter; female shorter than male; in *Thalassus maximus* (= *Sterna galericulata*)-----*O. canaliculata*, p. 19.  
 5. Male 40 to 57 mm. long; testes 230 to 250 in number; female unknown.  
*O. macrobilharzia*, p. 21.  
 Male 11 mm. or less in length; female known-----6.  
 6. Male 8 to 10.6 mm. long; testes 90 to 110 in number; intestinal ceca in female unite posteriorly immediately caudad of ovary-----*O. intermedia*, p. 18.  
 Male 6 to 7 m. long; testes 65 in number; intestinal ceca unite posteriorly a considerable distance caudad of ovary-----*O. odhneri*, p. 20.

## ORNITHOBILHARZIA INTERMEDIA Odhner, 1912

## Figure 39

*Specific diagnosis.*—*Ornithobilharzia*:

*Male* 8 to 10.6 mm. long and  $420\mu$  wide. Cuticle provided with thick blunt spines. Oral sucker  $200\mu$  to  $250\mu$  in diameter; acetabulum  $300\mu$  to  $350\mu$  in diameter. Testes 90 to 110 in number, commencing a short distance caudad of acetabulum and extending almost to posterior fourth of body; terminal portion of genital system (Endapparat) small and situated at posterior edge of acetabulum; seminal vesicle entirely outside of a rudimentary cirrus pouch; prostate absent. The genital pore is situated immediately caudad of the acetabulum and to the left of the median line.

*Female* 4.5 to 5.75 mm. long and  $170\mu$  to  $220\mu$  wide in region of ovary. Cuticle spiny. Oral sucker  $40\mu$  to  $50\mu$  in diameter; acetabulum  $25\mu$  to  $35\mu$  in diameter. Ovary long, spirally twisted, and situ-

<sup>3</sup> While this paper was in preparation, Linton (1928) described an *Ornithobilharzia* species from several water birds at Woods Hole, Mass. The writer has recently examined specimens of this species which were deposited in the U. S. National Museum, and also several additional specimens which Professor Linton kindly loaned for study. In this material there appear to be two species represented. The specimen (Cat. No. 7946, U. S. N. M.) from *Larus argentatus* is a species of *Ornithobilharzia*, but owing to the fact that the female is inclosed in the gynaecophoric canal of the male, it is impossible to make out the necessary specific characters. The remaining specimens, with the possible exception of the one from *Nycticorax nycticorax naevius* (which is in such a poor state of preservation that none of the structures can be made out) appear to be closely related to, if not identical with, *Microbilharzia chapini*. The males of these specimens are somewhat more robust than *M. chapini* from *Marila affinis*, but are otherwise very similar.

ated in the anterior fourth of body. Vitellaria extend from a short distance caudad of ovary to posterior end of body. Egg  $70\mu$  long by  $50\mu$  wide.

*Cercaria* unknown or unrecognized.

*Hosts.*—Primary, birds (*Larus fuscus* and *Hydrocoloeus melanocephalus*); secondary, unknown.

*Location.*—Intestinal veins.

*Distribution.*—Europe (Sweden).

**ORNITHOBILHARZIA CANALICULATA (Rudolphi, 1819) Odhner, 1912**

Figure 40

*Synonyms.*—*Distoma canaliculatum* Rudolphi, 1819, p. 676 (in *Sterna* species; Brazil); *Bilharziella canaliculata* (Rudolphi, 1819) Braun, 1902, p. 142.

*Specific diagnosis.*—*Ornithobilharzia*:

*Male* 16 mm. long and from 1 to 1.4 mm. wide. Oral sucker subterminal,  $312\mu$  long by  $104\mu$  to  $106\mu$  wide; acetabulum pedunculated,  $450\mu$  in diameter and  $100\mu$  to  $150\mu$  in height, and situated about 1 mm. caudad of oral sucker. Testes numerous, originating caudad of copulatory apparatus and extending posteriorly to equator of body. The genital pore is situated in anterior part of gynaeophoric canal. The cirrus pouch (?) lies at a right angle to the long axis of the body.

*Female* shorter than male, cylindrical, and thinner anteriorly than posteriorly, the anterior part of body being about  $60\mu$  wide and the posterior part about  $145\mu$  wide.

*Cercaria* unknown or unrecognized.

*Hosts.*—Primary, birds (*Thalasseus maximus*=*Sterna galericulata*); secondary, unknown.

*Location.*—Intestine (probably from intestinal veins).

*Distribution.*—South America (Brazil).

**ORNITHOBILHARZIA KOWALEWSKII (Parona and Ariola, 1896), Odhner, 1912**

Figures 41–42

*Synonyms.*—*Bilharzia kowalewskii* Parona and Ariola, 1896, pp. 114–116 (in *Larus melanocephalus*; Italy); *Schistosoma kowalewskii* (Parona and Ariola, 1896) Railliet, 1899, p. 788; *Bilharziella kowalewskii* (Parona and Ariola, 1896) Looss, 1899, p. 658.

*Specific diagnosis.*—*Ornithobilharzia*:

*Male* 14 mm. long by 1 mm. wide. Oral sucker cuplike, subterminal, smaller than acetabulum, and measuring  $364\mu$  in diameter; acetabulum pedunculated, circular,  $560\mu$  in diameter. Cuticle without tubercles or spines. Esophagus bifurcates about  $750\mu$  caudad of oral sucker, common cecum short. The gynaeophoric canal origi-

nates abruptly just posterior to acetabulum and extends to posterior tip of body. Testes numerous, disposed in two rows commencing about  $490\mu$  caudad of acetabulum and terminating about one-fourth of body length from posterior end.

*Female* unknown.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Hydrocoloeus melanocephalus*); secondary, unknown.

*Location*.—Heart.

*Distribution*.—Europe (Italy).

So far as may be determined from Parona and Ariola's (1896) description, there appears to be no essential difference, as Odhner (1912) points out, between *Ornithobilharzia kowalewskii* and *O. cancellulata*. The available descriptions are, however, so incomplete that a study of specimens of these species is necessary before final decision should be made.

#### ORNITHOBILHARZIA ODHNERI Faust, 1924

Figures 43-45

*Specific diagnosis*.—*Ornithobilharzia*:

*Male* 6 to 7 mm. long by  $220\mu$  to  $260\mu$  in cross section. Cuticle covered with spines. Oral sucker  $120\mu$  to  $155\mu$  in diameter; acetabulum  $160\mu$  to  $165\mu$  in diameter. The gynaecophoric canal is deep and broad. The esophagus branches immediately cephalad of the acetabulum; intestinal ceca sinuous, uniting caudally six-sevenths of body length from anterior end; common cecum short. Testes oval, about 65 in number, and lying in median line in equatorial three-sevenths of body. Seminal vesicle situated midway between anterior testis and acetabulum, and communicating directly with a rudimentary cirrus pouch which lies dorsad of the genital pore; ejaculatory duct rudimentary; prostate absent.

*Female* 3 mm. long by  $100\mu$  to  $120\mu$  in diameter in cross section. Cuticle covered with fine spines. Oral sucker and acetabulum equal in size and measuring  $70\mu$  in diameter. The esophagus bifurcates cephalad of acetabulum, and the intestinal ceca unite about four-fifths of body length from anterior end; common cecum short. Ovary elongate, loosely coiled, and situated in anterior third of body. The oviduct arises from the posterior pole of ovary, bending laterad and continuing anteriorly to the ootype; seminal receptacle well developed, situated behind the ovary, and connected with oviduct by a short duct. Laurer's canal arises from dorsal aspect of seminal receptacle and opens through a minute pore on dorsal side of body. The vitellaria consist of paired follicles extending from a short distance caudad of seminal receptacle to near posterior end of body. The vitelline duct



extends forward parallel with the oviduct and joins it at the ootype. Uterus short and containing a single egg. The genital pore occupies a median position immediately caudad of acetabulum.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (Asiatic curlew (*Numenius arquatus*)); secondary, unknown.

*Location*.—Portal vein.

*Distribution*.—Asia (China).

**ORNITHOBILHARZIA MACROBILHARZIA (Travassos, 1923), new combination**

*Synonym*.—*Macrobilharzia macrobilharzia* Travassos, 1923, pp. 18–19 (in *Plotus anhinga*; Brazil).

*Specific diagnosis*.—*Ornithobilharzia*:

*Male* 40 to 57 mm. long and 3.5 mm. wide when folded. Post-acetabular portion of body folded longitudinally but not permanently; preacetabular portion 4 mm. long and separated from posterior portion by a constriction. Oral sucker terminal, 740 $\mu$  in diameter; acetabulum salient, 1.3 mm. in diameter. Esophagus 1 mm. long; pharynx absent; intestinal ceca sinuous and uniting caudally near posterior end of body. Testes 230 to 250 in number, disposed in two rows in anterior half of body, and having an average diameter of 170 $\mu$  to 200 $\mu$ . Seminal vesicle present, pretesticular.

*Female* unknown.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Anhinga anhinga*=*Plotus anhinga*); secondary, unknown.

*Location*.—Portal vein.

*Distribution*.—South America (Brazil).

This species was described by Travassos (1923) as the type of a new genus, *Macrobilharzia*. On analysis, the characters given by Travassos do not appear to differ sufficiently from those of the genus *Ornithobilharzia* Odhner to justify the recognition of *Macrobilharzia* as a distinct genus. The body form, the disposition of the large number of small testes, and the position of the seminal vesicle are the same as for species of *Ornithobilharzia*. Its size, admittedly, is unusual for this genus, but size alone can not be regarded as a character of generic value.

**ORNITHOBILHARZIA TURKESTANICUM (Skrjabin, 1913), new combination**

Figures 46–50

*Synonyms*.—*Schistosoma turkestanicum* Skrjabin, 1913, pp. 458–468 (in *Bos taurus*; Russian Turkestan); *Schistosoma bomfordi* Montgomery of Marotel, 1908.

*Specific diagnosis*.—*Ornithobilharzia*:

*Male* 4.2 to 8 mm. long by  $340\mu$  to  $476\mu$  wide. Cuticle without tubercles. Oral sucker subterminal,  $255\mu$  long by  $154\mu$  wide; acetabulum  $289\mu$  by  $278\mu$ , and situated about  $425\mu$  caudad of the oral sucker. The esophagus shows two dilations and is surrounded by the esophageal glands; intestinal ceca unite caudally about 1.2 mm. from posterior end of body; in some specimens transverse commissures are present in posterior half of body which connect the two ceca. The testes, 70 to 80 in number, occupy a space about 3 mm. long in the median line. The genital pore lies immediately caudad of the acetabulum.

*Female* 3.4 to 5.5 mm. long by  $102\mu$  wide in region of ovary; body slender and almost circular in cross section. The suckers measure  $72\mu$  in diameter, and the acetabulum is situated about  $170\mu$  caudad of the oral sucker. Esophagus simple; intestinal ceca unite 1.632 mm. from posterior end of body. Ovary spiral,  $255\mu$  long, and situated anterior to cecal union. The vitellaria are composed of elongate follicles which occupy the space from the cecal union to the posterior end of body. Egg oval,  $72\mu$  to  $74\mu$  long by  $22\mu$  to  $26\mu$  wide, and provided with a spinelike prolongation at each pole.

*Cercariae* unknown or unrecognized.

*Hosts*.—Primary, mammals (*Bos taurus* and *Felis domestica*); secondary, unknown.

*Location*.—Branches of the portal vein.

*Distribution*.—Asia (Russian Turkestan) and Europe (France).

**ORNITHOBILHARZIA BOMFORDI** (Montgomery, 1906), new combination

Figures 51-52

*Synonyms*.—*Schistosoma bomfordi* Montgomery, 1906, pp. 143-147 (in *Bos indicus*; India).

*Specific diagnosis*.—*Ornithobilharzia*:

Male 7.089 mm. long; anterior portion of body  $357\mu$  wide; posterior portion  $408\mu$  wide in region of testes and  $170\mu$  in diameter at caudal extremity. The anterior portion of the body is flattened and the posterior portion inrolled, forming the gynaeophoric canal. Cuticle tuberculate and spiny; spines also present in suckers and in gynaeophoric canal. Oral sucker cup-shaped,  $306\mu$  in diameter; acetabulum pedunculated,  $340\mu$  in diameter, and situated  $850\mu$  caudad of oral sucker. Testes 61 in number, oval in shape, and measuring  $100\mu$  by  $90\mu$ , the total length of the chain of testes being 3.06 mm., or about three-sevenths of total body length. The seminal vesicle is situated in front of the testes, about  $200\mu$  caudad of the union of the anterior and posterior portions of the body.

*Female* 7.31 mm. long by  $172\mu$  wide at the ovary. Cuticle devoid of spines, except in suckers and at posterior end of body. Oral

sucker subterminal,  $46\mu$  in diameter; acetabulum slightly salient,  $42\mu$  in diameter. Esophagus simple,  $204\mu$  long; intestinal ceca unite posteriorly 1.819 mm. from the esophageal bifurcation; common cecum 5.109 mm. long and terminating  $178\mu$  from posterior extremity. Ovary oval in outline,  $300\mu$  long, and situated in front of cecal union. Uterus 1.4 mm. long; genital pore slightly salient and situated immediately caudad of acetabulum. The vitellaria lie on each side of the common cecum and extend from the cecal union to the posterior end of body. Egg oval and provided with a terminal spine; immature egg  $100\mu$  to  $115\mu$  long by  $44\mu$  to  $48\mu$  wide, spine  $8\mu$  to  $10\mu$  long; mature egg, containing a miracidium,  $125\mu$  to  $136\mu$  long by  $53\mu$  to  $60\mu$  wide, spine  $6\mu$  to  $8\mu$  long.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, mammal (*Bos (Bubalus) bubalis*=*Bos indicus*); secondary, unknown.

*Location*.—Mesenteric veins.

*Distribution*.—Asia (India).

*Schistosoma bomfordi* Montgomery and *S. turkestanicum* Skrjabin are transferred to the genus *Ornithobilharzia* on the basis of morphological similarity to other species of the genus. The number and position of the testes in the male, and the shape and position of the ovary in the female are so similar to those in *Ornithobilharzia intermedia* Odhner, type of *Ornithobilharzia*, that they are obviously congeneric. The fact that both *O. bomfordi* and *O. turkestanicum* are at present known only from mammalian hosts does not appeal to the writer as being a matter of sufficient importance to justify their retention in the genus *Schistosoma*. In view of the morphological relationship of *O. bomfordi* and *O. turkestanicum* to species occurring in birds, it may be assumed that these parasites, which are of rare occurrence in their mammalian hosts, may be only accidental and facultative parasites of these hosts, and it may be surmised that they are normal parasites in birds of some sort.

The report of the occurrence of *O. bomfordi* as a parasite of cattle in France, by Marotel (1908), is apparently erroneous, as the species which he described has an egg with two spines, one at each end, which measures  $80\mu$  to  $100\mu$  long by  $30\mu$  to  $35\mu$  wide. Since *O. turkestanicum* is the only schistosome reported from cattle as having a large number of testes, and an egg of the type described, it appears that this was the species found by Marotel. Velu and Barotte (1924; p. 328) are apparently of this opinion as they give France as a locality for *O. turkestanicum* and their description of the egg of this species is essentially the same as that given by Marotel for *O. bomfordi*.



## MICROBILHARZIA, new genus

*Generic diagnosis.*—Schistosominae: Male longer than female. Gynaecophoric canal well developed, commencing in front of the acetabulum. Suckers present in both sexes. Digestive tract similar to that of *Schistosoma*. Testes 18 to 20 in number, arranged in two irregular rows in anterior half of body. Genital pore situated about midway between acetabulum and the anterior testis. Female slender, almost cylindrical anteriorly, flattened posteriorly. Ovary loosely spiral, slightly pre-equatorial in position. Uterus long and containing a single egg. Vitellaria occupy about one-half of body length. Larva unknown or unrecognized.

*Type species.*—*Microbilharzia chapini*, new species.

## MICROBILHARZIA CHAPINI, new species

Figures 37-38

*Synonym.*—*Ornithobilharzia* species Chapin, 1924, p. 208.

*Specific diagnosis.*—*Microbilharzia*:

*Male* 3.27 to 4.25 mm. long by 626 $\mu$  wide. Anterior part of body short, subcylindrical; posterior part long and with the lateral edges infolded, forming a deep gynaecophoric canal which originates anteriorly a short distance in front of acetabulum and extends to posterior end of body. Cuticle lacking (apparently due to maceration) in all specimens available for study. Oral sucker subterminal, 152 $\mu$  in diameter; acetabulum pedunculated, 175 $\mu$  in diameter, situated 437 $\mu$  caudad of oral sucker. Esophagus simple, bifurcating in front of the acetabulum as in other schistosomes; intestinal ceca sinuous and uniting posteriorly about 390 $\mu$  from posterior end of body. Testes 18 to 20 in number, arranged in two irregular rows originating anteriorly about 540 $\mu$  to 550 $\mu$  caudad of acetabulum and extending slightly posterior to equator of body. Seminal vesicle small and situated about midway between acetabulum and anterior testis.

*Female* 3.7 mm. long by 100 $\mu$  wide. Cuticle smooth. Oral sucker poorly developed, 30 $\mu$  in diameter. Ovary slender, loosely spiral, 390 $\mu$  long when measured in a straight line and disregarding total length of spiral, and slightly pre-equatorial in position. The vitellaria consist of transversely elongated follicles, and extend from the distal pole of the ovary to the posterior end of body. Uterus long and apparently containing but one egg.

*Cercaria* unknown or unrecognized.

*Hosts.*—Primary, birds (*Marila affinis*); secondary, unknown.

*Location.*—Mesenteric veins.

*Distribution.*—North America (United States; Shadyside, Md.).

*Type specimens.*—United States National Museum Helminthological Collections No. 25169; paratype No. 27888; collected by Dr. E. A. Chapin, January 20, 1923.

This trematode appears to have closer affinities with species of *Austrobilharzia* than with those of any other genus. There are some characters in this species which differ from *A. terrigalensis*, type of *Austrobilharzia*, to such an extent that the writer hesitates to place his species in this genus; a new genus, *Microbilharzia*, is therefore proposed for it. In proposing this genus the writer realizes that the characters given in the diagnosis may be of specific rather than of generic value, but in order to include this species in *Austrobilharzia*, or in any of the other genera, it would be necessary to emend the generic diagnosis more or less extensively; this is regarded as inadvisable until more material is available for study.

### BILHARZIELLINAE, new subfamily

*Subfamily diagnosis.*—Schistosomidae: Male and female similar in form, either flattened or threadlike. Suckers present or absent. Gynaecophoric canal absent or imperfectly formed. Paired intestinal ceca short; common cecum long, with or without lateral dendritic branches. Testes numerous and situated along the course of the common cecum. Uterus short and containing a single egg.

*Type genus.*—*Bilharziella* Looss, 1899.

#### KEY TO THE GENERA OF BILHARZIELLINAE

1. Body cylindrical or nearly so..... 2.  
Body flattened..... 3.
2. Female unknown; posterior end of body threadlike, middle portion wider than either the anterior or posterior portions; no gynaecophoric canal; suckers present..... *Trichobilharzia*, p. 29.  
Male and female very long and slender; gynaecophoric canal reduced to a short groove in the anterior part of the body; suckers absent.  
*Gigantobilharzia*, p. 30.
3. Suckers present; common cecum without lateral dendritic branches.  
*Bilharziella*, p. 25.  
Suckers absent; common cecum with short, lateral dendritic branches.  
*Dendritobilharzia*, p. 28.

#### Genus BILHARZIELLA Looss, 1899

*Generic diagnosis.*—Bilharziellinae: Both sexes with the posterior part of the body distinctly flattened. Female shorter than male. Intestinal ceca united posteriorly at or near equator of body; common cecum long, without lateral branches, and extending in a zigzag manner to posterior end of body. Male genital opening situated on left side of body a considerable distance caudad of acetabulum. Cirrus pouch present, containing the prostate and the ejaculatory duct.

Seminal vesicle long and free in the parenchyma. Testes, about 110 in number, in posterior part of body on each side of the common cecum. Female genital opening immediately posterior to acetabulum. Uterus short and containing a single egg. Vitellaria situated on each side of the common cecum. Egg elongated anteriorly, enlarged and provided with a small spine posteriorly.

*Type species.*—*Bilharziella polonica* (Kowalewski, 1895) Looss, 1899.

KEY TO SPECIES OF BILHARZIELLA

Male 4 mm. long by  $530\mu$  wide; testes 110 in number; female 2 mm. long; egg  $385\mu$  to  $400\mu$  long by  $100\mu$  wide, elongated anteriorly and widened posteriorly.

**B. polonica**, p. 26.

Male 2.3 mm. long by  $96\mu$  wide; testes 50 to 70 in number; female 3.4 to 4 mm. long by  $65\mu$  wide; egg spindle-shaped,  $226\mu$  long by  $62\mu$  wide.

**B. yokogawai**, p. 27.

BILHARZIELLA POLONICA (Kowalewski, 1895) Looss, 1899

Figures 56-58

*Synonyms.*—*Bilharzia polonica* Kowalewski, 1895, pp. (1-27) 41-70 (in *Anas boschas fera* and *A. crecca*; Poland); *Schistosomum polonicum* (Kowalewski, 1895) Railliet, 1898, p. 412; *Ornithobilharzia polonica* (Kowalewski, 1895) Tanabe, 1925, p. 258.

*Specific diagnosis.*—*Bilharziella*:

*Male* 4 mm. long by  $530\mu$  wide. Body flattened, lanceolate. Oral sucker  $102\mu$  in diameter; acetabulum  $136\mu$  in diameter and situated about  $760\mu$  caudad of oral sucker. Esophagus simple, bifurcating in front of acetabulum; intestinal ceca unite posteriorly a short distance anterior to equator of body; common cecum long, extending caudally in a zigzag manner and terminating near posterior end of body. Testes numerous, about 110 in number, situated on both sides of the common cecum. Cirrus pouch present, containing the ejaculatory duct and a well-developed prostate. Seminal vesicle long and only partially enclosed by the cirrus pouch. Genital pore on left side of body,  $800\mu$  caudad of acetabulum.

*Female* about 2 mm. long and  $250\mu$  wide. Body form similar to that of male. Oral sucker  $51\mu$  in diameter; acetabulum  $68\mu$  in diameter and situated  $370\mu$  caudad of oral sucker. Digestive tract similar to that of male. Ovary weakly spiral and situated in front of cecal union. Uterus short and containing a single egg. Genital pore situated immediately caudad of acetabulum. Vitellaria composed of numerous follicles lying on each side of the common cecum. Egg  $385\mu$  to  $400\mu$  long by  $100\mu$  wide, elongated anteriorly and widened posteriorly, and provided with a small hooklike spine.

*Cercaria* unknown or unrecognized.



*Hosts*.—Primary, birds (*Anas platyrhynchos* (= *A. boschas fera*), *A. platyrhynchos domestica*, *Querquedula querquedula* (= *Anas querquedula*), *Nettion crecca* (= *Anas crecca*) *Dafila acuta* (= *Anas acuta*), *Fuligula fuligula* (= *Nyroca fuligula*, = *Fuligula cristata*), *Ardea cinerea*, *Nyroca leucophthalma* (= *Fuligula leucophthalma*) and *Cygnus olor*); secondary, unknown.

*Location*.—Abdominal blood vessels.

*Distribution*.—Europe (Poland and Russia) and North America (United States National Zoological Park, Washington, D. C.).

This species is represented in the Helminthological Collection of the United States National Museum by a single male specimen, No. 17432, collected October 8, 1907, by Dr. M. C. Hall, from a swan, *Cygnus olor*, which died in the National Zoological Park. This specimen is 3.4 mm. long by 300 $\mu$  wide. The oral sucker is 130 $\mu$  in diameter; the acetabulum is pedunculated, 182 $\mu$  in diameter, and situated 600 $\mu$  caudad of oral sucker. Such other characters as can be ascertained correspond so closely to those of *B. polonica* that there appears to be no doubt as to its specific identity.

BILHARZIELLA YOKOGAWAI Oiso, 1927

Figures 61-64

*Specific diagnosis*.—*Bilharziella*:

*Male* flat, 2.3 mm. long by 96 $\mu$  wide; sides of body parallel, posterior extremity truncate. Gynaecophoric canal short, extending from immediately caudad of acetabulum to level of cecal union (according to Oiso's figure). Oral sucker subterminal; acetabulum situated about 300 $\mu$  caudad of oral sucker. Esophagus about 250 $\mu$  long; intestinal caeca unite about 500 $\mu$  from anterior end of body; common cecum sinuous and terminating about 75 $\mu$  from posterior extremity of body. Testes oval, 50 to 70 in number, situated on each side of the common cecum; seminal vesicle large and irregular in outline, and situated between the cecal branches.

*Female* very slender, 3.4 to 4 mm. long by 65 $\mu$  wide. Egg spindle-shaped, 226 $\mu$  long by 62 $\mu$  wide, and containing a well-developed miracidium.

*Cerceria* furcocercous, pharyngeal (?), spinose. Body cylindrical in shape, 262 $\mu$  long by 64 $\mu$  wide; tail stem 363 $\mu$  long by 39 $\mu$  wide; furcal rami 258 $\mu$  long by 19 $\mu$  wide. Eyespots present, situated about 100 $\mu$  from anterior end of body. Acetabulum comparatively large and well developed, and situated 235 $\mu$  from anterior end of body. Pharynx present (?). Penetration glands consist of three pairs of large cells, the ducts of which open at anterior edge of oral sucker and are capped by an equal number of piercing spines. Germ cells lie in median line caudad of acetabulum. Excretory system pattern consists of seven pairs of flame cells in body and one pair in tail stem.

*Hosts*.—Primary, birds (duck, presumably *Anas platyrhynchos domestica*) secondary, snail (*Lymnaea radiæ*).

*Location*.—Portal and intestinal veins.

*Distribution*.—Formosa.

Genus DENDRITOBILHARZIA Skrjabin and Zakharow, 1920

*Generic diagnosis*.—Bilharziellinae: Body of both sexes elongated. Cuticle without spines or tubercles. Suckers absent. Digestive system similar to that in *Bilharziella*; common cecum long, zigzag, and provided with short, club-shaped or branched, lateral ceca. Genital pore of male in anterior part of body and to the left of median line. Testes numerous, situated on each side of the common cecum and extending from the cecal union to the posterior end of body. Ovary spiral and situated between the cecal branches. Vitelline follicles numerous, situated along the course of the common cecum.

*Type species*.—*Dendritobilharzia pulverulenta* (Braun, 1901) Skrjabin, 1924.

This genus has many characters in common with *Bilharziella*, but the writer regards the absence of suckers and the branched condition of the common cecum as characters warranting the recognition of *Dendritobilharzia* as a valid genus. Since *Dendritobilharzia odhneri* Skrjabin and Zakharow, 1920, was later recognized by Skrjabin (1924) as identical with *Bilharziella pulverulenta* Braun, the name of the type species becomes *D. pulverulenta* (Braun, 1901) Skrjabin, 1924.

KEY TO THE SPECIES OF DENDRITOBILHARZIA

Male 8 to 8.3 mm. long by 1 to 1.5 mm. wide; female 1.57 mm. long by 0.29 mm. wide; in *Querquedula querquedula* and *Anas platyrhynchos*.

*D. pulverulenta*, p. 28.

Male unknown. Female 14.2 mm. long by 1.41 mm. wide; in *Pelecanus onocrotalus*.

*D. loossi*, p. 29.

DENDRITOBILHARZIA PULVBRULENTA (Braun, 1901) Skrjabin, 1924

Figures 53-54

*Synonyms*.—*Bilharziella pulverulenta* Braun, 1901, pp. 946-947 (in *Anas querquedula*; Africa); *Dendritobilharzia odhneri* Skrjabin and Zakharow, 1920, pp. 2-4, 6.

*Specific diagnosis*.—*Dendritobilharzia*.

*Male* 8 to 8.3 mm. long by 1 to 1.5 mm. wide. Cuticle without spines or tubercles. Suckers absent. Esophagus 690 $\mu$  long; intestinal ceca united posteriorly about 920 $\mu$  from the esophageal bifurcation; common cecum long and zigzag, and provided with short

club-shaped, sometimes branched, lateral ceca. Testes about 110 in number, situated along the common cecum for its entire length. Seminal vesicle long, spiral, and situated in the anterior sixth of body. The genital pore is located on the left side about 1.35 mm. from anterior end of body.

*Female* (according to Semenov (1927) 1.5657 mm. long by 0.2875 mm. wide. Body divided into two parts by an irregular transverse groove, the anterior portion being 0.4228 mm. long and the posterior portion 1.1427 mm. long. Suckers absent. Oral aperture terminal. Esophagus slightly wavy; common cecum zigzag and extending to posterior end of body. Ovary 0.1028 mm. long by 0.0914 mm. wide, situated immediately caudad of the transverse groove and to one side of median line. Vitelline follicles numerous and distributed throughout posterior part of body.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Querquedula querquedula* (= *Anas querquedula*) and *Anas platyrhynchos* (= *A. boschas*)); secondary, unknown.

*Location*.—Blood vessels.

*Distribution*.—Africa (Dongola, Sudan), and Europe (Russia).

#### DENDRITOBILHARZIA LOOSI Skrjabin, 1924

*Specific diagnosis*.—*Dendritobilharzia*.

*Male* unknown.

*Female* 14.2 mm. long by 1.41 mm. wide. Oral sucker and acetabulum absent. Esophagus 450 $\mu$  long; intestinal ceca united posteriorly about 3.47 mm. from the esophageal bifurcation; common cecum as in *D. pulverulenta*. Genital organs, consisting of a spiral, tubular ovary, and an unpaired vitelline duct, lie in the space between the intestinal ceca. The vitellaria consist of follicles situated along the course of the common cecum.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Pelecanus onocrotalus*); secondary, unknown.

*Location*.—Blood vessels.

*Distribution*.—Europe (Russia).

This description is taken from that of Skrjabin (1924). Unfortunately very little detail is given as the description was based upon a single female specimen. In discussing this species, Skrjabin regards it as unlikely that this form could be identical with *D. pulverulenta* because of the great difference in size.

#### Genus TRICHOBILHARIA Skrjabin and Zakharow, 1920

*Generic diagnosis*.—Bilharziellinae; body slender and divided into two portions; the anterior wider portion separated from the posterior



threadlike portion by a slight dilation. Oral sucker smaller than acetabulum. Gynaecophoric canal absent. Cirrus pouch and seminal vesicle present. Testes numerous and situated in posterior portion of body. Female unknown.

*Type species.*—*Trichobilharzia kossarewi* Skrjabin and Zakharow, 1920.

TRICHOBILHARZIA KOSSAREWI Skrjabin and Zakharow, 1920

Figure 55

*Specific diagnosis.*—*Trichobilharzia*.

*Male* 4 mm. long; anterior portion of body  $60\mu$  wide, posterior portion  $20\mu$  wide; between the anterior and posterior portions the body is dilated to  $150\mu$  in width and this part is covered with fine spines. Oral sucker  $30\mu$  in diameter; acetabulum  $50\mu$  in diameter, spiny, and situated  $690\mu$  caudad of oral sucker. Testes numerous,  $50\mu$  long by  $18\mu$  wide, and situated in the posterior, threadlike portion of body. Cirrus pouch  $200\mu$  long. Seminal vesicle  $220\mu$  long. Genital pore 1.26 mm. from anterior end of body.

*Female* unknown.

*Cercaria* unknown or unrecognized.

*Hosts.*—Primary, birds (*Querquedula querquedula* (= *Anas circiacia*)); secondary, unknown.

*Location.*—Blood vessels.

*Distribution.*—Europe (Russia).

Genus GIGANTOBILHARZIA Odhner, 1910

*Generic diagnosis.*—Bilharziellinae: Female cylindrical and shorter than the somewhat flattened male. Posterior extremity of both sexes provided with lateral lobelike projections. Cuticle without spines or tubercles. Suckers absent. Gynaecophoric canal reduced to a short groove, situated in anterior part of body. Digestive system similar to that of *Bilharziella*. Testes originate caudad of gynaecophoric canal and extend to posterior end of body. Cirrus pouch absent. Genital pore situated at anterior end of gynaecophoric canal and slightly to the left of the median line. Ovary moderately long and spiral. Vitelline follicles occupy about nine-tenths of body length. Uterus short and containing a single egg.

*Type species.*—*Gigantobilharzia acotylea* Odhner, 1910.

GIGANTOBILHARZIA ACOTYLEA Odhner, 1910

Figures 59–60

*Specific diagnosis.*—*Gigantobilharzia*.

*Male* 140 to 165 mm. long by  $250\mu$  to  $350\mu$  wide in expanded specimens; when preserved, the length is about one-half that of expanded

specimens, the width being  $450\mu$  to  $650\mu$  and the thickness about three-fourths of the width. Anterior end of body either pointed or blunt, depending upon the amount of contraction during fixation; posterior end provided with peculiar lobelike projections which give it the appearance of being obliquely truncate. Suckers absent. The gynae-cophoric canal is reduced to a groove-like depression,  $550\mu$  to  $750\mu$  long by  $100\mu$  wide in flattened specimens, and situated  $500\mu$  from anterior end of body. Oral opening terminal; esophagus  $180\mu$  long; intestinal ceca short and united posteriorly at anterior end of gynae-cophoric canal; common cecum long and terminating near posterior end of body. Testes consist of numerous follicles situated along the course of the common cecum. Terminal portion of genital system (Endapparat) consists of a cirrus pouch containing the ejaculatory duct, prostate, and a portion of the seminal vesicle, and is situated between the branches of the intestinal ceca. The genital pore is situated on a small papilla at the anterior end of the gynae-cophoric canal and slightly to the left of the median line.

*Female* 30 to 35 mm. long, slender, circular on cross section, and  $100\mu$  to  $120\mu$  in diameter. Anterior end of body attenuated; the posterior end is similar to that of the male. Esophagus  $700\mu$  to  $900\mu$  long; intestinal ceca unite posteriorly about 2 to 3 mm. from anterior end of body; common cecum slender and extending to posterior extremity of body. Ovary tubelike and spiral, situated anterior to the cecal union. The oviduct arises from the posterior pole of the ovary and passes to a large seminal receptacle, and then extends forward ventrally to the ovary and unites with the vitelline duct a short distance in front of the ovary. Vitellaria unpaired, composed of rounded follicles extending from the cecal union to the posterior end of body. Uterus short and containing but one egg. Genital pore median, about  $60\mu$  from the anterior extremity. Egg oval, about  $100\mu$  long.

*Cercaria* unknown or unrecognized.

*Hosts*.—Primary, birds (*Larus fuscus*, *Hydrocoloeus melanocephalus* and *H. ridibundus*); secondary, unknown.

*Location*.—Intestinal veins.

*Distribution*.—Europe (Sweden and England).

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## EXPLANATION OF PLATES

## ABBREVIATIONS

<i>ac.</i> Acetabulum.	<i>os.</i> Oral sucker.
<i>c.</i> Common cecum.	<i>ov.</i> Ovary.
<i>cb.</i> Cecal branches.	<i>ovd.</i> Oviduct.
<i>cp.</i> Cirrus pouch.	<i>pg.</i> Penetration glands.
<i>e.</i> Egg.	<i>pgd.</i> Penetration gland ducts.
<i>es.</i> Eye spot.	<i>ph.</i> Pharynx.
<i>exb.</i> Excretory bladder.	<i>ps.</i> Penetration spines.
<i>exp.</i> Excretory pore.	<i>shg.</i> Shell gland.
<i>fc.</i> Flame cell.	<i>sr.</i> Seminal receptacle.
<i>gc.</i> Gynaecophoric canal.	<i>sv.</i> Seminal vesicle.
<i>gp.</i> Genital pore.	<i>t.</i> Testes.
<i>grmc.</i> Germ cells.	<i>ut.</i> Uterus.
<i>hg.</i> Head gland.	<i>vas.</i> Vas deferens.
<i>lc.</i> Laurer's canal.	<i>vd.</i> Vitelline duct.
<i>n.</i> Nervous system.	<i>vit.</i> Vitellaria.
<i>oes.</i> Esophagus.	<i>vr.</i> Vitelline reservoir.
<i>oesg.</i> Esophageal glands.	

## PLATE 1

*Schistosoma haematobium*

- FIGURE 1. Anterior end of male. Original.  
 2. Male and female. After Manson-Bahr and Fairley, 1920.  
 3. Egg; greatly enlarged. After Looss, 1896.  
 4a. Cercaria. After Bettencourt and Borges, 1922.  
 4b. Cercaria showing excretory system. After Bettencourt and Borges, 1922.

*Schistosoma incognitum*

5. Egg. After Chandler, 1926.

## PLATE 2

*Schistosoma mansoni*

- FIGURE 6. Anterior end of male; lateral view. Original.  
 7. Anterior end of male; ventral view. Original.  
 8. Male. After Manson-Bahr and Fairley, 1920.  
 9. Female. After Manson-Bahr and Fairley, 1920.  
 10. Cercaria. After Faust, 1920.  
 11. Egg. After Cort, 1919.

## PLATE 3

*Schistosoma japonicum*

- FIGURE 12. Male. Original.  
 13. Female. Original.  
 14. Cercaria. After Cort, 1919.  
 15. Cercaria showing excretory system. After Cort, 1919.  
 16. Egg. After Cort, 1919.

## PLATE 4

*Schistosoma spindalis*

- FIGURE 17. Male with female in the gynaecophoric canal. After Vryburg, 1907.  
 18. Anterior end of male. After Vryburg, 1907.  
 19. Female. After Vryburg, 1907.  
 20. Cercaria. After Soparkar, 1921.  
 21. Cercaria showing excretory system. After Soparkar, 1921.  
 22. Egg. After Montgomery, 1906.

## PLATE 5

*Schistosoma bovis*

- FIGURE 23. (a) Male, (b) female, (c) egg. After Khalil, 1924.  
 24. Male and female. After Leuckart, 1894.  
 25. Eggs. After Sonsino, 1876.



## PLATE 6

*Schistosoma indicum*

- FIGURE 26. Male; from sheep. Original.  
 27. Female; from sheep. Original.  
 28. Female genital system. Original.  
 29. Egg. After Montgomery, 1906.

## PLATE 7

*Schistosomatium pathlocopicum*

- FIGURE 30. Male and female. After Tanabe, 1923.  
 31. Cercaria. After Tanabe, 1923.  
 32. Egg. After Tanabe, 1923.

## PLATE 8

*Heterobilharzia americana*

- FIGURE 33. Male. Original.  
 34. Male; somewhat flattened. Original.

*Paraschistosomatium anhingae*

35. Female. Original.

## PLATE 9

*Austrobilharzia terrigalensis*

36. Male and female. After Johnston, 1917.

*Microbilharzia chapini*

37. Male and female. Original.  
 38. Male; ventral view. Original.

## PLATE 10

*Ornithobilharzia intermedia*

39. Male and female. After Odhner.

*Ornithobilharzia canaliculata*

40. Male and female. After Braun, 1902.

*Ornithobilharzia kowalcwskii*

41. Male. After Parona and Ariola, 1896.  
 42. Posterior end of male. After Parona, 1899.

## PLATE 11

*Ornithobilharzia odhneri*

- FIGURE 43. Male. After Faust, 1924.  
 44. Female. After Faust, 1924.  
 45. Female genital system. After Faust, 1924.

## PLATE 12

*Ornithobilharzia turkestanicum*

- FIGURE 46. Male and female. After Skrjabin, 1913.  
 47. Female; showing digestive system. After Skrjabin, 1913.  
 48. Posterior end of male. After Skrjabin, 1913.  
 49. Female genital system. After Skrjabin, 1913.  
 50. Eggs. After Skrjabin, 1913.

## PLATE 13

*Ornithobilharzia bomfordi*

- FIGURE 51. Male and female. After Montgomery, 1906.  
 52. Egg. After Montgomery, 1906.

*Dendritobilharzia pulverulenta*

53. Male. After Braun, 1902.  
 54. Male. After Skrjabin and Zakharow, 1920.

*Trichobilharzia kossarewi*

55. Male. After Skrjabin and Zakharow, 1920.

## PLATE 14

*Bilharziella polonica*

- FIGURE 56. Male. After Kowalewski, 1895.  
 57. Female. After Kowalewski, 1895.  
 58. Egg. After Kowalewski, 1895.

*Gigantobilharzia acotylca*

59. Male; (a) anterior end showing gynaecophoric canal, (b) posterior end, (c) anterior end showing digestive and reproductive systems. After Odhner, 1910.  
 60. Female; (a) anterior end, (b) female reproductive organs. After Odhner, 1910.

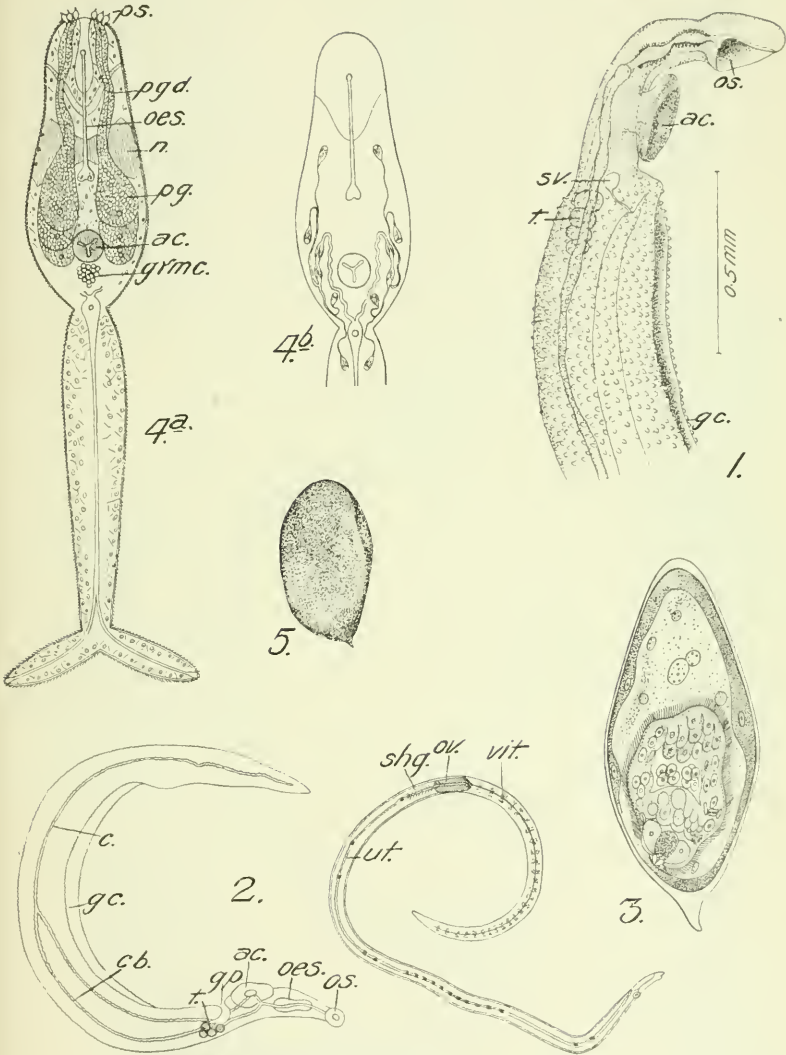
## PLATE 15

*Bilharziella yokogawai*

- FIGURE 61. Male; ventral view. After Oiso, 1927.  
 62. Male; anterior end showing gynaecophoric canal. After Oiso, 1927.  
 63. Egg. After Oiso, 1927.  
 64. Cercaria. After Oiso, 1927.



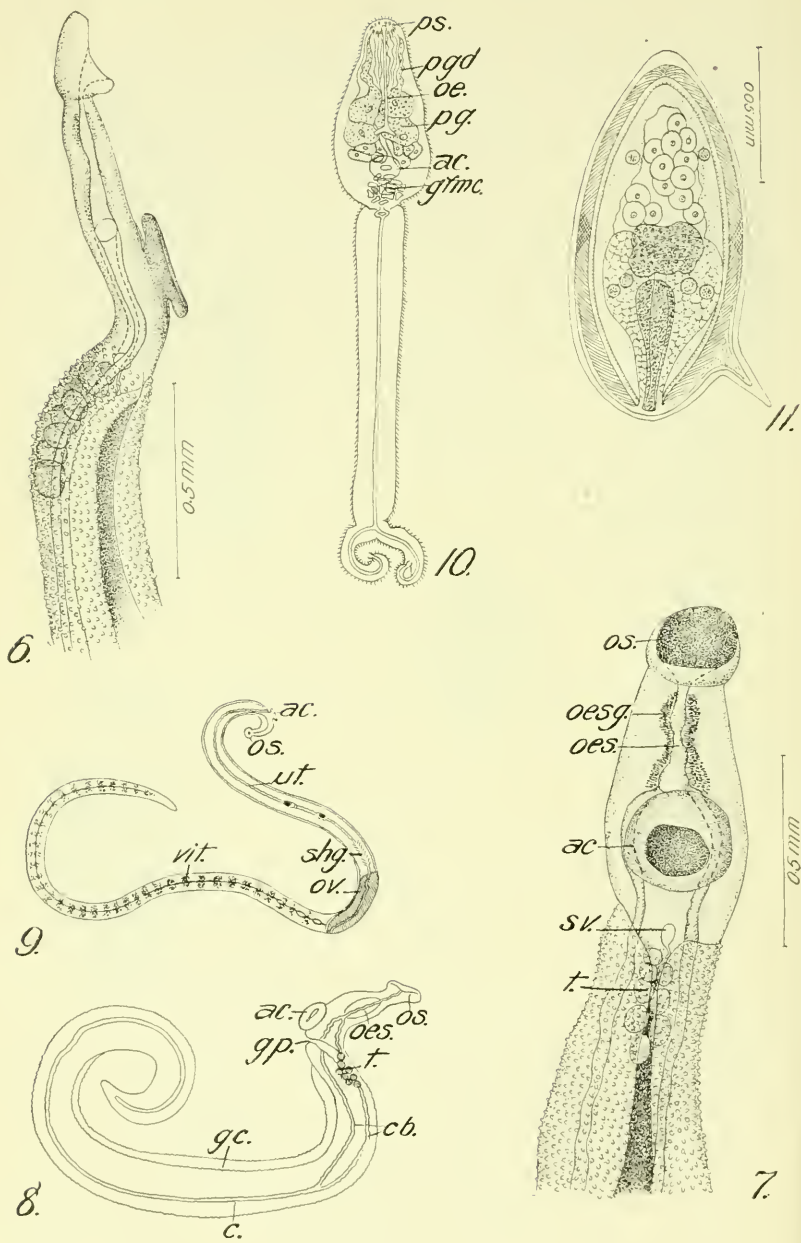




SCHISTOSOMA HAEMATOBIMUM AND S. INCOGNITUM

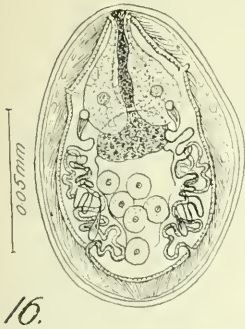
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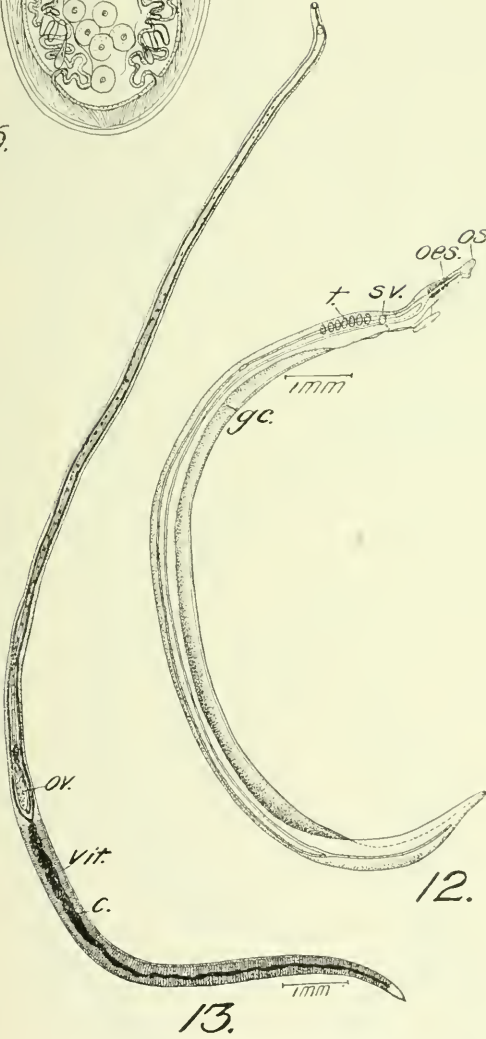


SCHISTOSOMA MANSONI

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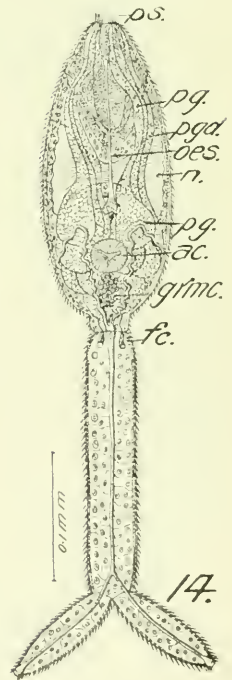


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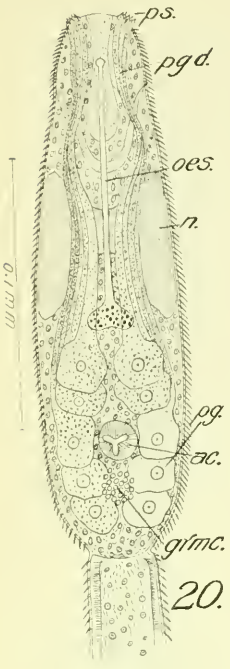
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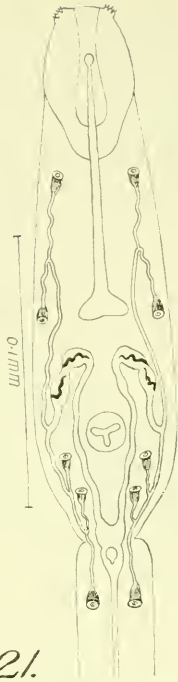
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SCHISTOSOMA JAPONICUM

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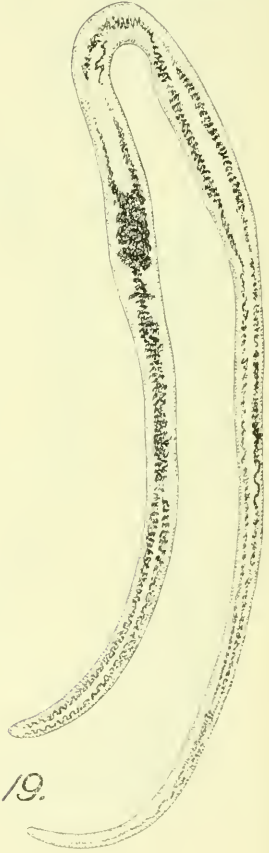
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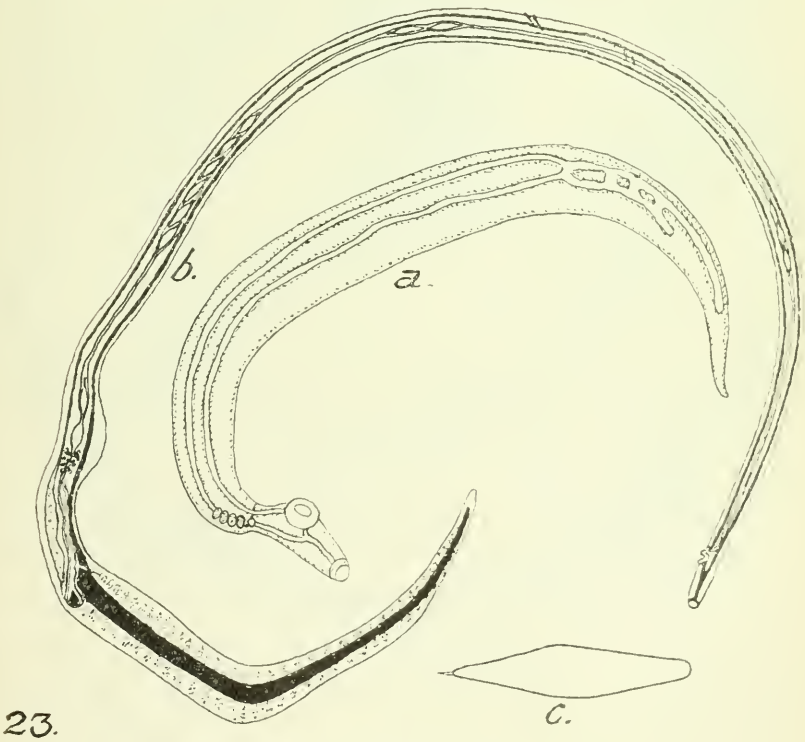
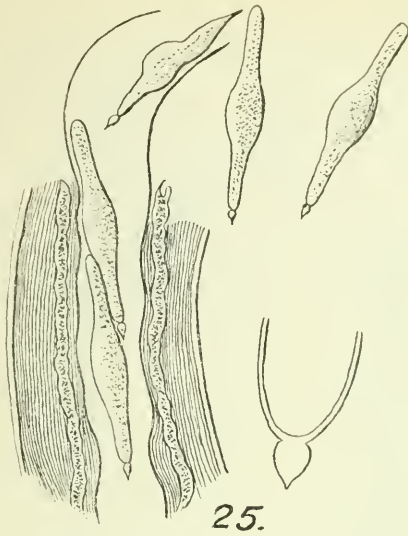
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19.

SCHISTOSOMA SPINDALIS

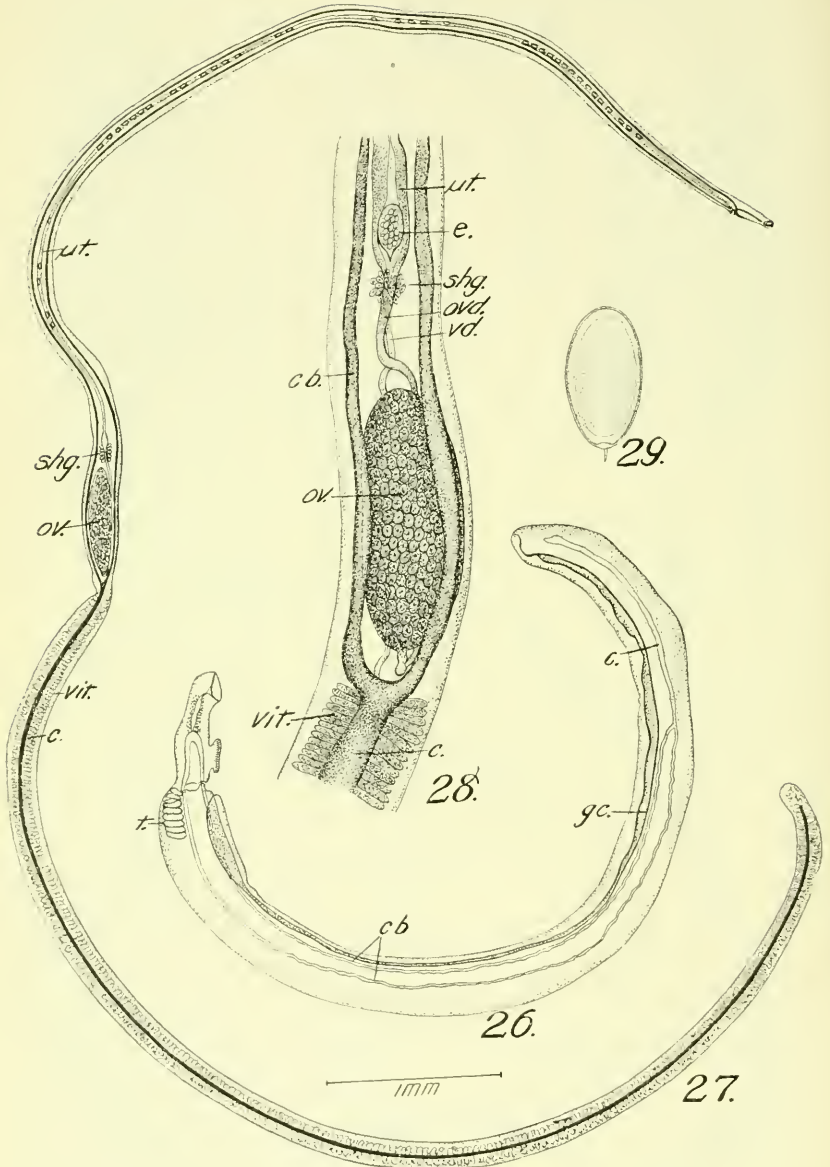
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SCHISTOSOMA BOVIS

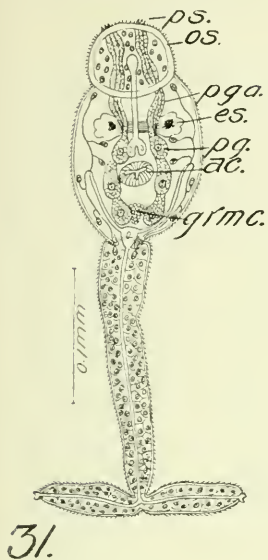
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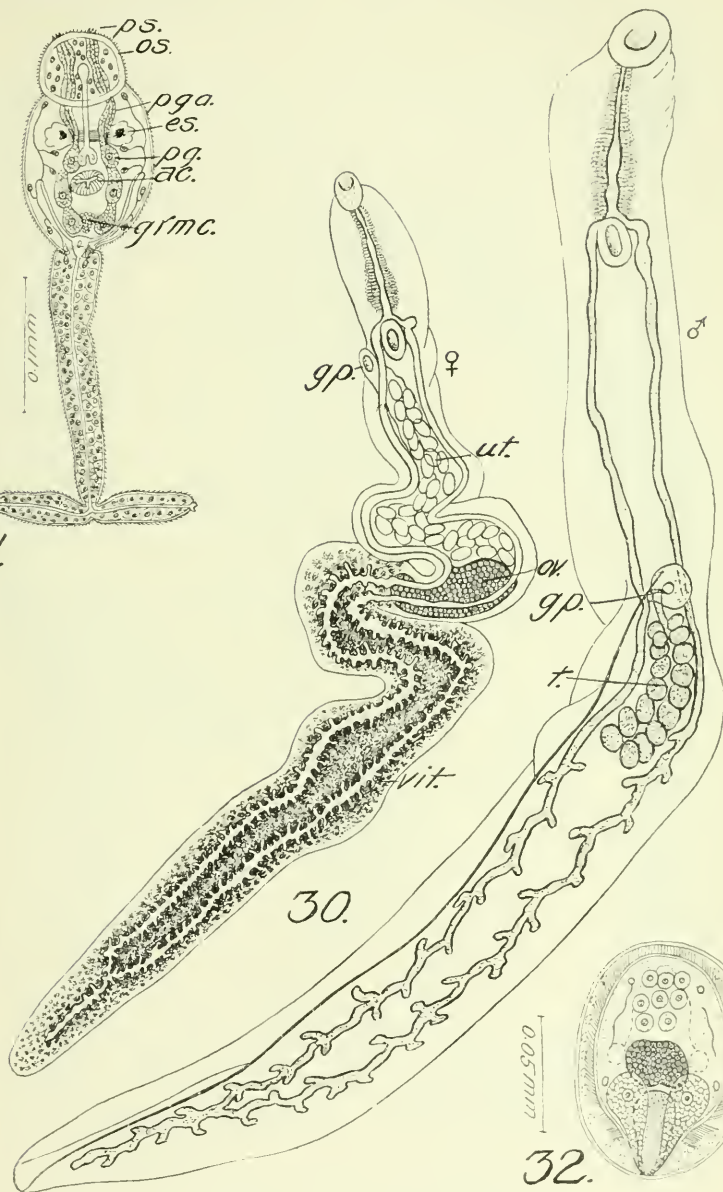


SCHISTOSOMA INDICUM

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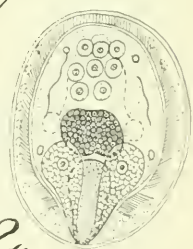


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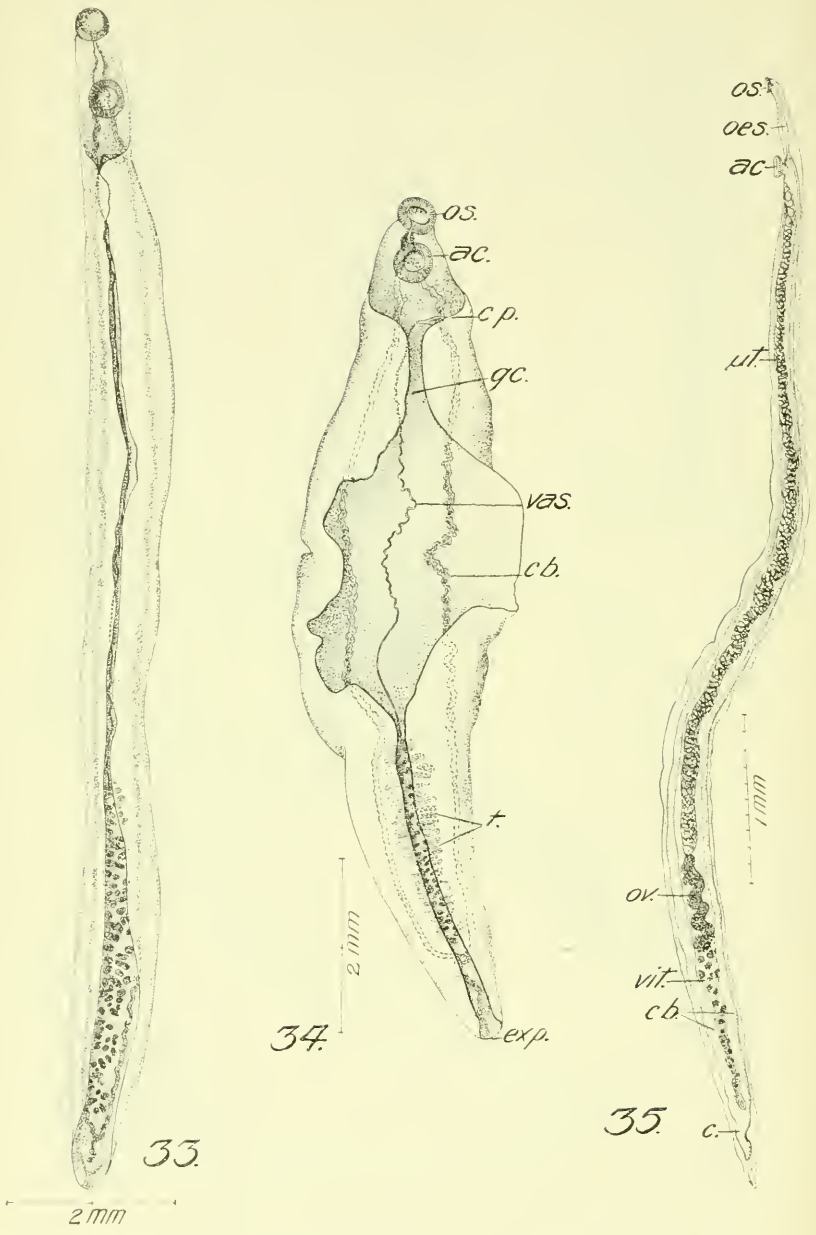
30.

32.



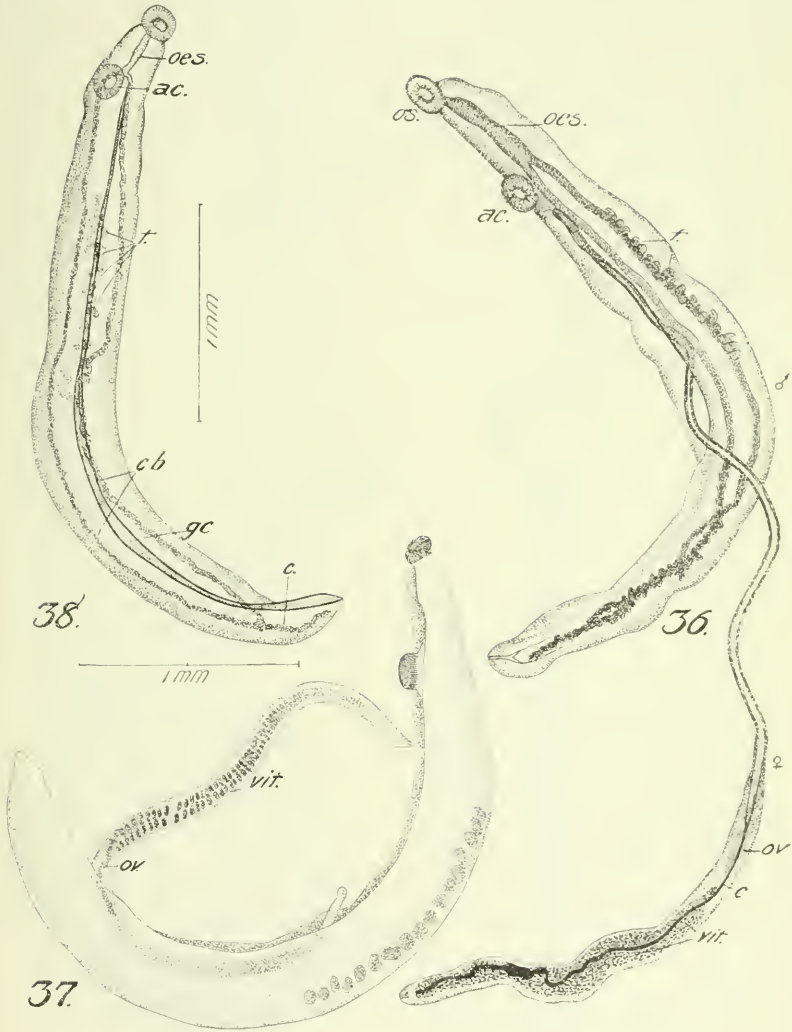
SCHISTOSOMATIUM PATHLOOPTICUM

FOR EXPLANATION OF PLATE SEE PAGE 38



HETEROBILHARZIA AMERICANA AND PARASCHISTOSOMATIUM ANHINGAE

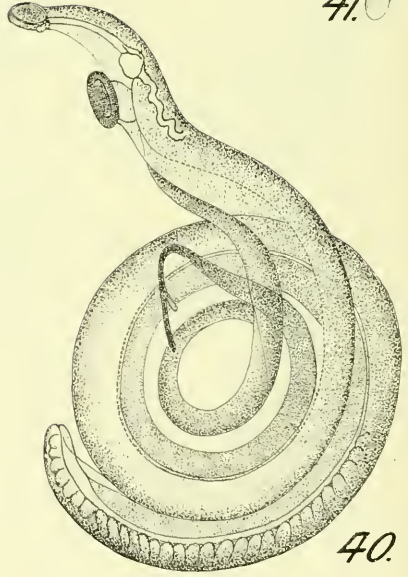
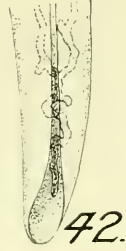
FOR EXPLANATION OF PLATE SEE PAGE 38



AUSTROILHARZIA TERRIGALENSIS AND MICROILHARZIA CHAPINI

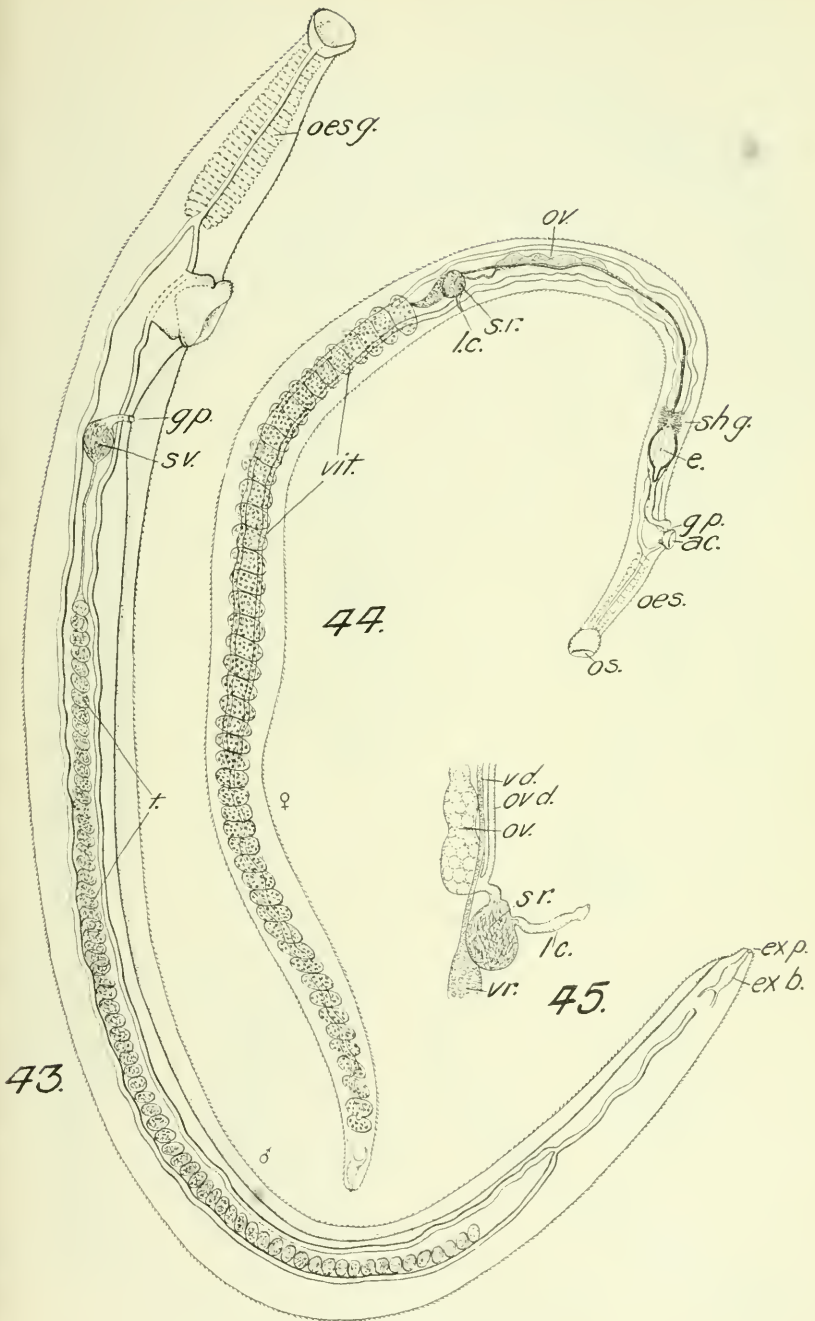
FOR EXPLANATION OF PLATE SEE PAGE 38





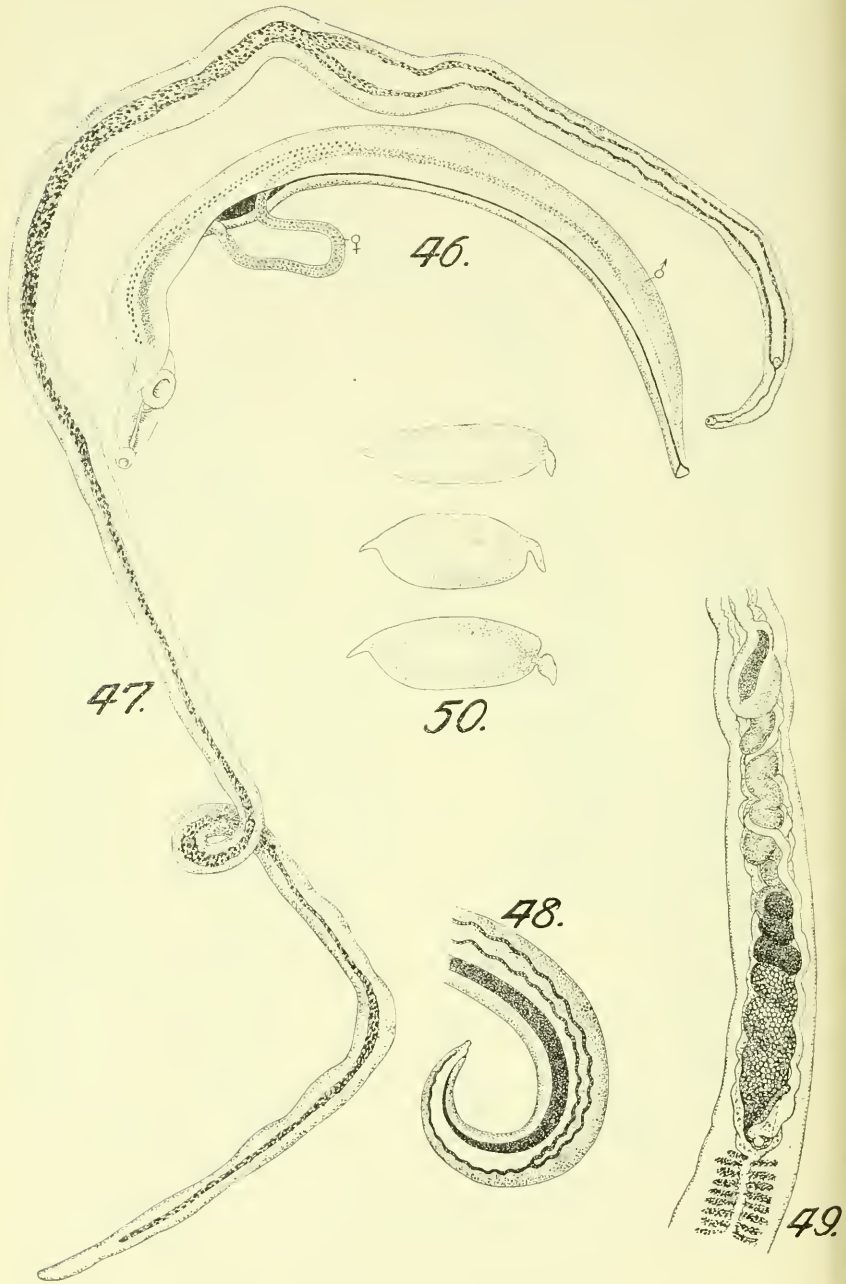
ORNITHOBILHARZIA INTERMEDIA, ORNITHOBILHARZIA CANALICULATA, AND ORNITHOBILHARZIA KOWALEWSKII

FOR EXPLANATION OF PLATE SEE PAGE 38



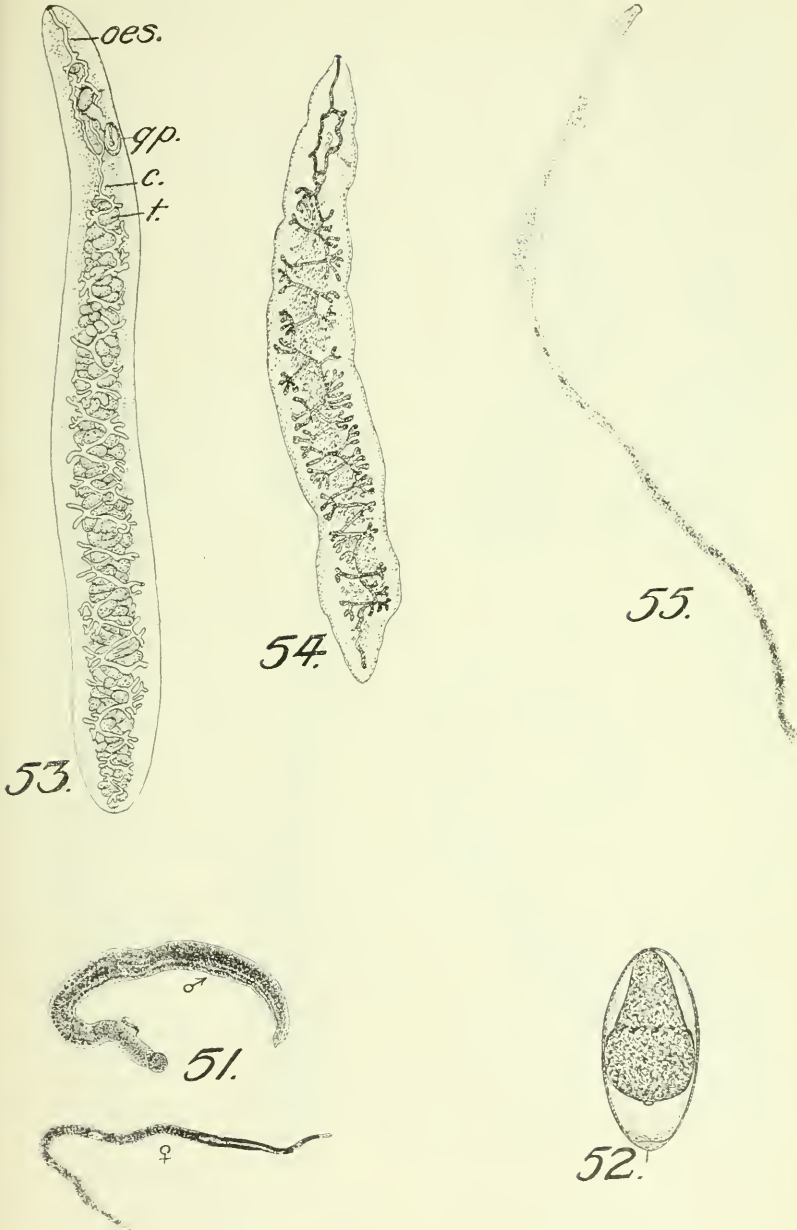
ORNITHOBILHARZIA ODHNERI

FOR EXPLANATION OF PLATE SEE PAGE 38



ORNITHOBILHARZIA TURKESTANICUM

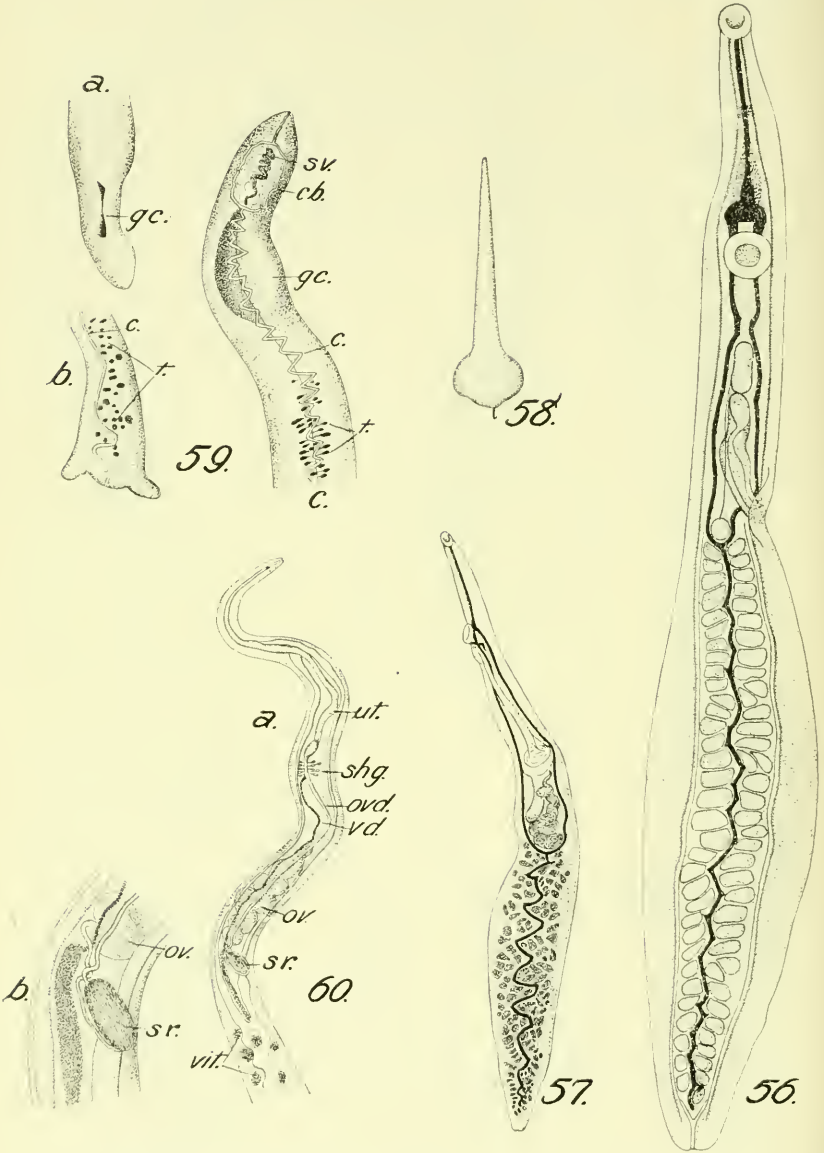
FOR EXPLANATION OF PLATE SEE PAGE 39



ORNITHOBILHARZIA BOMFORDI, DENDRITOBILHARZIA PULVERULENTA, AND TRICHOBILHARZIA KOSSAREWI

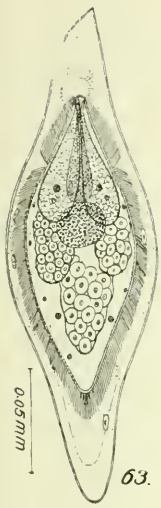
FOR EXPLANATION OF PLATE SEE PAGE 39



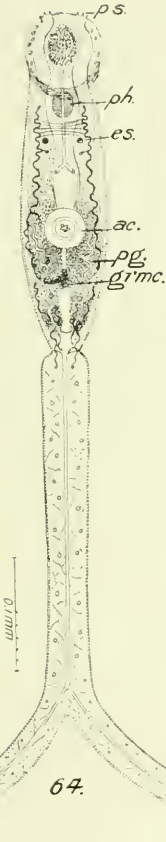


BILHARZIELLA POLONICA AND GIGANTOBILHARZIA ACOTYLEA

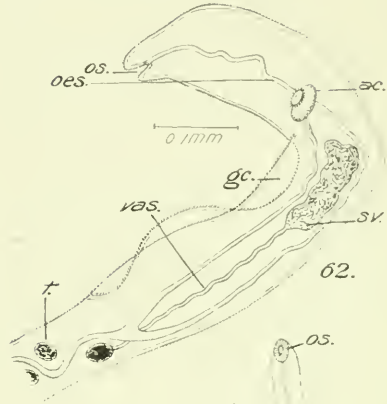
FOR EXPLANATION OF PLATE SEE PAGE 39



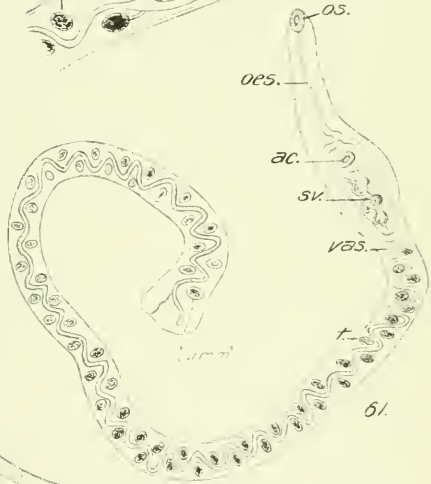
63.



64.



62.



61.

BILHARZIELLA YOKOGAWAI

FOR EXPLANATION OF PLATE SEE PAGE 39

