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THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

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PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

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Acanthocephalan Nomenclature Introduced by Lauro Travassos

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The purpose of this paper is to determine, as accurately as possible, the valid dates for the various names for Acanthocephala introduced by Dr. Lauro Travassos. Since his investigations on Acanthocephala were in large measure concerned with the Archiacanthocephala, they have particular significance for students of the parasites of mammals and birds. Because of the uncertainty of many of the dates, there has arisen much confusion in the literature. The writer regrets that because of his personal limitations this study could not be extended to include all the other groups of parasitic worms treated by Travassos. The evidences regarding some of the names and concepts are so conflicting that many hundreds of hours have been spent in futile attempts at making individual decisions. After considering all of the available evidences it is entirely possible that some opinions here expressed may be in error. In part the potential error may be attributable to the fact that several of Travassos' papers have never been received by any of the research libraries of North America. In this study, the facilities of the private library of the writer have been supplemented by the very extensive collections of the University of Illinois with numerous other large libraries cooperating through inter-library loans. Although every reasonable effort has been made to secure all of the pertinent literature, there are three of Travassos' papers dealing with Acanthocephala which have never become available for examination by the present writer. European investigators and catalogers have evidently been confronted by a similar situation.

The writer has been particularly anxious to keep this analysis strictly objective. The sole intention has been to render a service to other investigators who deal with zoological nomenclature and the problems of validity, priority and synonymy, all of which depend upon accurate dating. Calling attention to an error in judgment and correcting that error carries no implication regarding the over-all soundness or scientific value of the work in which the error occurs.

In the period from 1913 to 1926, Travassos carried on the most significant program of studies on the Acanthocephala of South America that has ever been attempted. The distinctive mammals and birds of that continent had long been recognized as hosts for peculiar species of Acanthocephala which are either restricted to South and Central America or have extended their geographical distribution along with the dispersal of the vertebrate faunas. Some of the species with which Travassos was concerned have practically cosmopolitan distribution and therefore concern all workers in the field. The pioneer explorations of K. M. Diesing and of H. von Ihering in South

America and the early European investigations on widely distributed species of Acanthocephala had opened the way for the development of an intensive program of studies in which the acanthocephalan fauna was to be reevaluated at new taxonomic levels. All of the earlier studies, prior to the epoch making work of Hamann (1892), had been confined to a consideration of classification at the level of species, since it had been customary up until that time to regard practically all Acanthocephala as belonging to the single genus Echinorhynchus.

In his intensive program of studies on the Acanthocephala of Brazil, Travassos aimed particularly at the proper evaluation of the species at the level of genus and family. His studies attained much more than local significance because he was dealing with several groups which are widely distributed.

More recently the active interest in taxonomy of the Acanthocephala has proceeded to a third step in its development, namely, to the recognition of natural grouping of genera and families into consistent units, such as classes and orders, within the phylum (Meyer 1932-3, Van Cleave 1948). The soundness of the taxonomic superstructure depends upon the reliability of individual elements of its construction. Hence correction of even minor errors often becomes important.

The practice of citing authors for names of higher categories has importance primarily as a bibliographic aid, although it does tend to place too great emphasis upon the legalistic aspects of nomenclature rather than upon the underlying fundamental concepts. Thus, according to the International Rules of Zoological Nomenclature (Art. 5), "The name of a family or subfamily is to be changed when the name of its type genus is changed." By strict application, this could involve only an automatic substitution, yet frequently the author who replaces a generic homonym by a new name fails to alter the name of the family based upon that genus. The duty then falls to some subsequent worker in the field.

Priority does not apply to the higher nomenclatorial categories. Although names at this level may be accepted or rejected at will, the addition of the name and date of the authority for the name has values in rendering bibliographic researches less tedious and time consuming.

Because of the general inaccessibility of many of Travassos' publications and confusion as to date of publication, there has existed a very unusual degree of uncertainty regarding much of Travassos' nomenclature. The policy of publishing very brief preliminary notes, followed by more extensive treatments, has added to the confusion, especially when dates for either of the publications could not be established with certainty. Furthermore, for some time Travassos frequently cited the date on which a paper was read on a scientific program as the date for new names and taxonomic concepts. He apparently continued this practice for approximately ten years, but after 1923 the dates which he gave were the actual dates of publication.

In 1923, or possibly later, Travassos published a list of his contributions for the period between 1913 and 1923. For a time this list seemed to offer promise of definitive dates for his publications. However, in 1938, when his colleagues assembled a Jubilee Volume commemorating his twenty-fifth year of scientific activity, they included a complete bibliography of Travassos' scientific works arranged by years for the quarter century from 1913 to 1938. This list gives every indication of critical editing to correct erroneous dates and to place the titles in chronological sequence within each year.* Every bibliographic reference in this list is assigned a number with the numerals running in direct sequence, then beside each number there is given in parenthesis the numeral which the article bore in the earlier printed list of the works of Travassos. Since the earlier series of numbers was used by Travassos in stamping the contribution number on the cover of each reprint, cross reference between the old and new sequences is easily followed.

The revised list, from 1913 to 1932 inclusive contains a total of 90 references. A comparison of this listing with the earlier list and with the dates on reprints, shows that in the revision 29 of the 90 entries have been shifted to different years. Usually this shift involes a discrepancy of one or two years but in one instance an article originally attributed to 1919 in the earlier bibliography was stamped as 1921 on the reprint and was allocated as 1923 in the list of the Jubilee Volume. This is item 88 in the Travassos bibliography at the close of the present paper.

In taxonomic work, where zoological nomenclature is especially involved, inconsistency in dates may be highly significant in determining priority of names. Some of the worst confusion in the acanthocephalan literature concerns the three generic names which Travassos proposed in a paper given before a medical congress convened on December 6, 1916. Throughout his publications, even down to as late as 1925, Travassos continued to cite 1916 as date for Macracanthorhynchus, Empodius and Oncicola. However, in the corrected bibliographic list in the Livro Jubilar, 1938, the article in which these names first appeared was listed within the year 1917 under the following citation:

> "28 (28) Gigantorhynchidae brasileiras. Congresso Medico Paulista, 5 (2): 181-191."

There is no similar entry in the list for 1916, as there had been in the earlier bibliography of Travassos' writings. It therefore seems reasonably certain that 1917 must be accepted as the date for Empodius, Macracanthorhynchus and Oncicola. In his monograph on the Acanthocephala, Meyer (1932) attributed Oncicola to 1916, Macracanthorhynchus to 1917, and for Empodius he cited the two dates 1916 and 1917. This is a measure of the uncertainty that has surrounded the dates of many of the names proposed by Travassos and as a random sample these three names will be discussed further, considering the diverse dates proposed for them in the literature.

Because of the vastness of the world literature and unavailability of many publications to the average investigator, zoologists have been forced to rely upon reputable indices and nomenclators for citation of critical dates for those publications which are not accessible. At times these sources accept dates of presumed issue printed on periodicals or on reprints without confirmation. Or, at other times, they cite dates quoted from other writers who may or may not have verified the reference. For instances such as the latter, Zoological Record has usually inserted the letters "N. V." to indicate that the editor had not seen the original article but took the reference on the authority of some other writer. In the years following the close of the two world wars, there was a long time before the literature accumulated during hostilities became available to workers outside the country of its origin. Furthermore,

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*After copy for this paper was prepared, one error in date of publication has been discovered in the Travassos Bibliography of the Livro Jubilar. Miss Mildred Doss, through the Welch Memorial Library of Johns Hopkins University, verified that the paper listed as No. 88 in the list of Travassos' publications near the end of this paper was published in 1921, not in 1923.

loss of trained staff members and shortages of paper and of skilled printers seriously impeded progress after publications began to be distributed. Thus the Zoological Record, on which taxonomists had come to rely for foreign bibliographies, made no mention of Oncicola (Travassos, 1917) until the 1929 volume when it was cited as a new genus, dating from its subsequent appearance in the Memorias do Instituto Oswaldo Cruz for 1917 rather than from the prior appearance in the "Congresso Medico Paulista" of that same year. Macracanthorhynchus and Empodius, which appeared originally along with Oncicola, were not entered in the Zoological Record until 1930 when the three genera were all attributed to 1916 with reference to that erroneous date along with the memorandum that the publication had not been seen by the editor and citing the 1917 volume of the Memorias do Instituto Oswaldo Cruz as supporting the earlier reference.

Although the Stiles and Hassall Index Catalogue of Roundworms was published in 1920, the deadline of entries was some time during 1916, consequently none of the Travassos 1917 names are indexed.

For Empodius, Macracanthorhynchus and Oncicola, Neave in his exhaustive Nomenclator Zoologicus cited Travassos, 1916, as author and gave as source the uncorrected date for the sessions of the Congresso Medico Paulista, but for Macracanthorhynchus he followed the system adopted in the Zoological Record when he added the Memorias do Instituto Oswaldo Cruz for 1917 as a supporting reference. In his very voluminous and generally reliable Nomenclator Animalium generum et subgenerum, Schulze made no mention of any of these three generic names by Travassos. From the foregoing discussion it is clear that some of the names of Travassos for genera of Acanthocephala have been entirely overlooked by some catalogers while those who have listed them have not always been objectively critical of the dates accepted for the names.

Regarding other names for Acanthocephala proposed by Travassos, there has been frequent confusion of dates in the literature similiar to the instances already cited. Instead of discussing these individually, lists will serve to correct the date for each in so far as apparently reliable confirmation is accessible. Additional information about other dates that have appeared in the literature will be given under each name in the lists.

Using the information made available in the biblography of the Travassos Jubilee Volume (1938) for correcting the dates of reprints and periodicals, the following annotated lists of taxonomic names have been prepared. In this listing it has been necessary to accept citations of three papers which have not been available to the present writer. In the appended bibliography these are entries 1917a, 1918b, and 1920a. Although several clear instances of synonymy and homonymy have been indicated by enclosing a name in parentheses, the inclusion of a name in this list does not necessarily imply validity. This is particularly true for the names of families and subfamilies where groupings of genera have undergone radical shifts in the various systems that have been advocated. The corrected bibliography of all Travassos papers dealing with acanthocephalan nomenclature appears at the end of this paper.

In many of the reprints distributed by Dr. Travassos, the pagination is changed from that of the original periodical, although in some the original and the new pagination both occur. When available, the original pagination is cited. To avoid confusion, the letter (R) is inserted after page references taken from reprints.

ANNOTATED LIST OF ACANTHOCEPHALAN FAMILY AND SUB-FAMILY NAMES PROPOSED BY TRAVASSOS

CENTRORHYNCHINAE Travassos 1920c p7 (not indicated as new).
  Family CENTRORHYNCHIDAE Van Cleave 1916 p227 reduced to sub-family status.
  Travassos 1920c p7 cited as Travassos 1919 on basis of presentation on a scientific program 8 Dec. 1919.
  Meyer 1931 p51 and 1932 p100 erroneously claimed Meyer 1931 as author.
ECHINORHYNCHINAE Travassos 1920c p6 (not indicated as new).
  Travassos 1920c p6 cited as Travassos 1919 on basis of presentation on a scientific program 8 Dec. 1919.
  Meyer 1931 p58 claimed this as a new sub-family.
GIGANTORHYNCHINAE n. sub-fam. Travassos 1915b p137.
(NEOECHINORHYNCHIDAE Travassos 1917d p10) (not indicated as new).
  Van Cleave 1916 p228 was the first to use this name.
  Travassos 1926b p34 cited as Travassos 1917.
  Travassos 1917b p9 and 1920 p6 attributed to Hamann 1905.
  Meyer 1931 p58 attributed to Van Cleave 1919.
  Meyer 1932 p168 attributed to Hamann, no date.
NEOECHINORHYNCHINAE n. sub-fam. Travassos 1926b p34.
PROSTHENORCHINAE n. sub-fam. Travassos 1915b p137.
RHADINORHYNCHIDAE Travassos 1923b p2(R) (not indicated as new).
  Travassos 1926b p35 attributed to Travassos 1923 p12.

ANNOTATED LIST OF ACANTHOCEPHALAN GENERIC NAMES PROPOSED BY TRAVASSOS

Echinopardalis Travassos 1918b (paper not seen by Van Cleave).
  Travassos 1920c p10 cites as Travassos 1918.
(*Empodius* Travassos 1917a) (paper not seen by Van Cleave).
  Synonym of *Mediorhynchus* Van Cleave 1916.
  Usually cited as 1916 or 1917.
  Meyer 1932 erroneously regarded *Empodius* as a valid genus.
(*Hamania* Travassos 1915a p89) preoccupied.
  Error in spelling for "*Hamannia.*"
  Synonym of *Hamanniella* Travassos 1915b p137.
  Travassos 1915b p137 corrected spelling to "*Hamannia.*"
(*Hamaniella* Travassos 1915b p137).
  Error in spelling for "*Hamanniella*" Travassos 1915.
  Travassos 1917c p121 attempted to correct spelling but misspelled as "*Mamanniella.*"
  Travassos 1917d p18 corrected spelling to "*Hamanniella.*"
(*Hamannia* Travassos 1915b p137).
  Corrected spelling of "*Hamania*" Travassos 1915a.
  Synonym of *Hamanniella* Travassos 1915b p137.
Hamanniella Travassos 1915b p137 (intention as patronym clear though as of this date the name was misspelled "*Hamaniella*").
  Travassos 1917b p18 spelling finally corrected to "*Hamanniella.*"
Lueheia Travassos 1920c p8 (cited as of 1919, date when given on scientific program.)
  Meyer 1932 p135 cited as Travassos 1919.
  Zoological Record cited as Travassos 1921.

Macracanthorhynchus Travassos 1917a (paper not seen by Van Cleave).
Travassos 1917d p20 cited as Travassos 1916, the date on which the name was given in paper on program.
(*Mamanniella* Travassos 1917c p121 misspelling for "*Hamanniella*").
(*Micracanthorhynchus* Travassos 1917d :60)
Synonym for *Mediorhynchus* Van Cleave 1916.
Moniliformis Travassos 1915b p137.
Oligacanthorhynchus Travassos 1915b :137.
Oncicola Travassos 1917a (paper not seen by Van Cleave).
Travassos 1917d p18 cited as Travassos 1916, the date on which the name was given in paper on a scientific program.
(*Pardalis* Travassos 1917c p21) preoccupied.
Synonym of *Echinopardalis* Travassos 1918b.
Polyacanthorhynchus Travassos 1920a (paper not seen by Van Cleave).
Quoted from Neave's Nomenclator.
Meyer 1932 p59 cited as 1926.
(*Prostenorchis* Travassos 1915a p4(R)) error in spelling of "*Prosthenorchis.*"
Travassos 1915b p137 corrected to "*Prosthenorchis.*"
(*Prosthenorchis* Neiva 1915) error in authorship of publication.
Prosthenorchis Travassos 1915a (article by Neiva republished in same volume, same year with authorship corrected to Travassos.)

ANNOTATED LIST OF SPECIES OF ACANTHOCEPHALA DESCRIBED BY TRAVASSOS

Centrorhynchus giganteus n. sp. Travassos 1921 p6 (R), 42 of journal.
Travassos 1921 p6 (R) misspelled as "*gicanteus.*"
Travassos 1923b p12 and 1926b p38 corected to "*giganteus*" (cited 1919, the date of its presentation on a program).
Travassos 1921 p42 claimed 1919 for this paper which was read 8 Dec. 1919, changed to 1923 in Livro Jubilar).
Meyer 1932 p113 cited as 1919.
Zoological Record cited as 1921.
Centrorhynchus opimus n. sp. Travassos 1921 p7 (R).
Travassos reprint carries 1921 as date, changed in error to 1923 in Livro Jubilar.
Meyer 1932 p114 cited as 1919.
Centrorhynchus polymorphus n. sp. Travassos 1926a p935.
Travassos 1926b p45 claimed 1925 as date but corrected to 1926 in Livro Jubilar.
Echinorhynchus jucundus n. sp. Travassos 1923b p12.
(*Gigantorhynchus aurae* n. sp.) Travassos 1913 p252.
Meyer 1932 p195 cited as 1912 and included as synonym of *Oligacanthorhynchus spira* (Diesing 1851).
Hamanniella carinii Travassos 1917a (not seen by Van Cleave).
Travassos 1917d p19 cited as 1916, date of delivery of paper before Congr. Med. Paulista. Corrected to 1917 in Livro Jubilar.
Meyer 1931e p58 questioned Travassosia as a tentative n.g. but gave no diagnosis and cited no species, therefore a *nomen nudum.*
Meyer 1932 p203 diagnosed Travassosia as a new genus, mistakenly attributing it to Meyer 1931 and calling it "nom. nov." with *H. carinii* Travassos 1916 (error for 1917) as genotype.

Lüheia lühei Travassos 1920c p8 diagnosis validates both genus and species.
Travassos 1920c p8 cited 1919 as date but that was date for reading of paper on program.
Travassos 1921 p7 (R) cited as n. sp.
Meyer 1932:135 cited as 1919.
Mediorhynchus oswaldocruzi n. sp. Travassos 1923a p12.
Meyer 1932 p189 cited as Travassos 1923, 1924.
Mediorhynchus pintoi n. sp. Travassos 1923a p12.
Meyer 1932 p189 cited as Travassos 1923, 1924.
Oligacanthorhynchus iheringi Travassos 1917a (not seen by Van Cleave).
Travassos 1917d p36 cited as 1916, the date of delivery of paper.
Meyer 1932 p197 cited as Travassos 1916.
Polymorphus caryosoma n. sp. Travassos 1915c p4 (R).
Travassos 1923c p5 (R) corrected to *"corynosoma."*
Polymorphus inerme n. sp. Travassos 1923b p3 (R).
Meyer 1932 p70 changed spelling to *"inermis."*
Prosthenorchis avicola Travassos 1917a (not seen by Van Cleave).
Travassos 1917d p46 cited as 1916, the date of delivery of paper.
Meyer 1932 p211 cited as Travassos 1916; misspelled *"avicula."*
Prosthenorchis luehei Travassos 1917a (not seen by Van Cleave).
Travasso 1917d p45 cited as 1916, date of delivery of paper.
Meyer 1932 p210 cited as Travasso 1916.
Prosthorhynchus angrense n. sp. Travassos 1926a p937.
Prosthorhynchus longirostris n. sp. Travassos 1926a p936.

PUBLICATIONS OF LAURO TRAVASSOS ON ACANTHOCEPHALA

Numerals to left are to chronological sequence in the bibliography of Travassos published in the Livro Jubilar, 1938.

References not seen by the present writer indicated with asterisk.

4 1913 Contribuiçoes para o conhecimento da fauna helmintolojica brazileira. I. Gigantorhynchus aurae n. sp. Mem. Inst. Oswaldo Cruz 5(3):252-254.

17 1915a Revisao dos Acantocephalos brasileiros. I. Fam. Gigantorhynchidae Hamann, 1892. (Nota prévia). Brazil Medico 29 (12): 89.
Authorship credited to Arthur Neiva.
Same article republished with authorship attribtued to Lauro Travassos in same volume, same year no. 14:105.

18 1915b Revisao dos Acantocephalos brazileiros. I. Fam. Gigantorhynchidae Hamann, 1892. (2a. Nota prévia). Brazil Medico 29 (18):137.

20 1915c Revisao dos Acantocephalos brazileiros. II. Familia Echinorhynchidae Hamann, 1892. (Nota prévia). Brazil Medico 29 (48):377.

28 1917a *Gigantorhynchidae brasilerias. Congresso Medico Paulista 5 (2): 181-191.

33 1917b Alguns helminthos da colleçao do Instituto Bacteriologico de S. Paulo. Brazil Medico 31(12):99-100.

34 1917c Helminthos da colleçao do Museu Paulista. Brazil Medico 31 (15):121-122.

36 1917d Contribuiçoes para o conhecimento da fauna helmintolojica brazileiros. VI. Revisao dos acantocefalos brazileiros.

Parte I. Fam. Gigantorhynchidae Hamann, 1892. Mem. Inst. Oswaldo Cruz 9(1):5-62.

39 1918a Pesquizas sobre as Gigantorhynchidae. Rev. Soc. Brasil. Sci. 2:79-81.

43 1918b *Helminthes parasitos de animaes domesticos. I. Rev. Vet. e Zootech. 8(1):3-15.

47 1919 Informaçoes sobre o material helminthologico colleccionado na Ilha da Trinidade em 1916. Arch. Mus. Nac. Rio de Janeiro 22: 161-167.

54 1920a *Um novo typo de Acantocefalo. Rev. Soc. Brasil. Sci. 3:209-215.

55 1920b (Nota sobre Gigantorhynchidae). Rev. Soc. Brasil. Sci. 3:235.

57 1920c Acanthocephalos dos animaes domesticos. Rev. Vet. e Zootech. 10(1):3-23.

84 1923a Gigantorhinchidios novos. Folha Medica 4(2):12.

85 1923b Informaçoes sobre a fauna helminthologica de Matto Grosso (II Nota). Folha Medica 4(2):12.

88 1921 Contribuiçao para o conhecimento dos Acanthocefalos da subfamilia Centrorhynchidae. Folha Medica 4(6):42-43.

98 1924 Contribuiçoes para o conhecimento da fauna helminthologica brasileira. XVII. Revisao dos Acanthocephalos brazileiros. I. Famil. Gigantorhynchidae Hamann, 1892. Suplemento. Mem. Inst. Oswaldo Cruz 17(2):365-375. (In French 377-387).

101 1925 Quelques notes sur les Acanthocéphales. Comptes Rendus Soc. Biol. 93:142-143.

111 1926a Ocanthocéphales nouveaux. Comptes Rendus. Soc. Biol. 93:935-937.

113 1926b Contribuiçoes para o conhecimento da fauna helminthologica brasileira. XX. Revisao dos Acanthocephalos brasileiros.
Parte II. Familia Echinorhynchidae Hamann, 1892, sub-fam. Centrorhynchinae Travassos, 1919. Mem. Inst. Oswaldo Cruz 19 (1):31-125.

118 1926c Notas helminthologicas. Bol. Biol. 4:85-86.

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——— 1932-3 Acanthocephala. Bronn's Klassen und Ordnungen des Tierreichs, 4Bd., 2 Abt., 2 Buch. Leipzig.

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———. 1948 Expanding horizons in the recognition of a phylum. Jour. Parasitol. 34:1-20.

Exposure of Planorbid Snails from the Western Hemisphere to Miracidia of the Egyptian Strain of *Schistosoma mansoni*

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During and soon after World War II schistosomiasis became of concern to investigators in helminth diseases, as well as to military personnel. It was believed by some that military personnel returning from endemic areas might possibly introduce schistosomiasis into the United States should the proper conditions and circumstances prevail. Consequently studies were initiated to determine whether snails native to North America were capable of serving as intermediate hosts for propagation of the schistosomiases of man.

Stunkard (1946) attempted, unsuccessfully, to infect snails from different localities in the United States with miracidia of the schistosomes of man. Miracidia of *Schistosoma japonicum, S. haematobium* and *S. mansoni* were exposed to 22, 25 and 24 species of molluscs, respectively. Similar studies (Cram, Jones and Wright, 1944, 1945; Cram and Files, 1946) undertaken by investigators at the National Institutes of Health, U. S. Public Health Service, revealed that *Tropicorbis havanensis* from Louisiana was an inefficient, though a potential, vector for the Puerto Rican strain of *S. mansoni.* There was a diversion in interest and approach to this problem as Files and Cram (1949) continued these studies emphasizing the relative susceptibilities of known planorbid vectors to infection with geographic strains of *S. mansoni.* Their results indicated that *Australorbis glabratus* from Puerto Rico was rather highly susceptible to infection by the Puerto Rican (human and animal source), Venezuelan (animal source) and Brazilian-Puerto Rican (animal source) cross strains of *S. mansoni* but only a few snails could be infected with the Egyptian strain of the parasite originating from laboratory animals. Similarly, *A. glabratus* from Venezuela showed a higher rate of infection with miracidia from the Venezuelan and with the Brazilian-Puerto Rican cross strains (animal source) than with the Egyptian schistosome (animal source). *A. glabratus* from Brazil demonstrated a low rate of infection to miracidia from the Puerto Rican (human source) strain of *S. mansoni* and was refractory to those from experimental animals infected with the Puerto Rican, Venezuelan and the Egyptian strain. *Biomphalaria boissyi* were refractory to the Puerto Rican, Venezuelan and Brazilian-Puerto Rican cross strains but 30 per cent were infected with the Egyptian strain. Abdel-Malek (1950) pursuing similar interests also exposed *B. boissyi* from Egypt to the Puerto Rican (animal source) strain of *S. mansoni.* He showed that these snails were refractory to the Puerto Rican strain of the parasite but that a rather high percentage of infection resulted if the same snails were re-exposed to miracidia of the Egyptian strain (animal source) of *S. mansoni.*

The present study has been undertaken to augment the studies mentioned above and to: (a) learn whether known vectors of *S. mansoni* (*Australorbis glabratus* from Venezuela and Puerto Rico) from the western hemisphere and the vector in Egypt, *Biomphalaria boissyi,* are equally susceptible to infec-

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[1] Lieutenant, MSC, U. S. Navy. The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

The author is indebted to George Malakatis, HM2, U. S. Navy, for technical assistance.

tion by the Egyptian strain of *S. mansoni;* (b) learn whether *Tropicorbis havanensis,* a proven potential carrier for the Puerto Rican strain of schistosome in United States, can be infected with the Egyptian strain of parasite; and (c) determine whether several non-vector planorbids from western hemisphere are capable of being infected with the Egyptian strain of *S. mansoni.*

MATERIALS AND METHODS

A small breeding stock of several species of *Tropicorbis* (*T. havanensis* (Pfeiffer) from Baton Rouge, Louisiana; *T. havanensis* from El Pompon, Cuba; *T. albicans* (Pfeiffer) from Puerto Rico; *T. pallidus* (C. B. Adams) from Venezuela and *T. obstructus* (Morelet) from Guatemala; and *Australorbis glabratus* (Say) from Venezuela were obtained from the Division of Tropical Diseases, National Institutes of Health, Bethesda, Maryland, through the courtesy of Dr. Elmer G. Berry and Dr. Eloise B. Cram. The *A. glabratus* from Puerto Rico were of a stock reared for over three years in the laboratory of the Naval Medical Research Institute of Bethesda, Maryland. The snails were transported to Cairo, Egypt, in 1948 in one-pint fruit jars. While en route the snails were fed fresh lettuce and dried corn leaves, and a part of the water was siphoned off and replaced with fresh water at two- or three-day intervals. *Biomphalaria boissyi* were raised in aquaria in the parasitology laboratory of Naval Medical Research Unit No. 3, Cairo, Egypt.

The majority of snails were exposed individually to 5 to 7 miracidia. Snails were placed in small shell vials containing 2 to 4 cc. of pond or aquarium water and miracidia pipetted from the washed fecal specimens of infected school children. A small series of each species of snails was exposed under similar conditions to 15 to 20 miricidia each. When feasible, for the sake of comparison and as a control, 25-50 *B. boissyi,* the local vector for *S. mansoni,* were exposed to the same numbers of miricidia and under the same conditions as the planorbids from the western hemisphere. The latter seemed very desirable in view of the fact that records of snail infectivity have shown considerable variation in relation to conditions associated with exposures, as well as with the date on which exposures are made. An attempt was made to include different size or age groups of snails in each series.

Snails were observed through part of the exposure period and individual snails were resubmerged at intervals in event of attempted escape. After exposure of snails to miracidia for 18 to 24 hours they were transferred to aquaria with lettuce, corn leaves and aerated water. The first examination was made at the end of 30 to 35 days when snails were placed in gum dishes in the warmth of sunlight to encourage emergence of cercariae. Infected snails were separated from the non-infected snails and observations were repeated at 3- to 5-day intervals until 40 to 50 days after the date of exposure. Snails dying after the 25th day or those negative after several examinations were crushed and examined under dissecting or compound microscope.

The rate of infection is expressed as the percentage of living or recently dead snails passing cercariae or possessing sporocysts with developing embryos.

RESULTS

During the period from fall of 1948 to the spring of 1951, 1730 *Tropicorbis havanensis* were exposed to miracidia (Table 1). Of this total 586

TABLE 1.—*Infections Resulting from Exposure of Planorbid Snails from Western Hemisphere, and* Biomphalaria boissyi, *to Miracidia of Egyptian Strain of* Schistosoma mansoni

	Lots of snails exposed	Number of snails exposed	Number of snails examined for evidence of infection	Percentage infection in surviving snails examined	
				Range	Mean
Tropicorbis havanensis Louisiana, USA	14	586	254	0.0 5.25	1.57
Tropicorbis havanensis El Pompon, Cuba	20	1,114	612	0.0 0.0	0.0
Tropicorbis albicans Puerto Rico	12	853	342	0.0 0.0	0.0
Tropicorbis pallidus Venezuela	7	307	192	0.0 0.0	0.0
Tropicorbis obstructus Guatemala	13	412	296	One poorly developed sporocyst in each of two snails.	
Australorbis glabratus Venezuela	19	1,811	1,246	4.9 83.4	31.7
Australorbis glabratus Puerto Rico	15	1,018	727	0.0 72.1	33.4
Biomphalaria boissyi Cairo, Egypt	21	874	608	0.0 90.5	43.6

were of the strain of *T. havanensis* descended from specimens collected near Baton Rouge, Louisiana. Two hundred and fifty-four of the 586 snails exposed lived until the end of the expected incubation period. The snails in the first nine lots were declared negative after isolation and examination for cercariae. No developmental stages of sporocysts or cercariae were found when snails were crushed 35 to 50 days after the date of exposure. However, in lot number 10 (Oct. 1950) two of 39 *T. havanensis* crushed for examination 41 days after exposure to miracidia possessed sporocysts and numerous developing cercarial embryos. It seems likely that the cercariae would have emerged from the snail had the infection been allowed to progress for another week. A second lot (No. 13) of 54 snails isolated in vials in May 1951 yielded two snails passing schistosome cercariae. Cercariae emerged from the snails in considerable numbers (50-250) for several days. Mice, each exposed to 100 to 150 of these cercariae, when autopsied after six weeks, possessed 17 to 24 worms. Well developed sporocysts and numerous developing cercariae were present in the tissues of the snails.

Although a much larger number of *T. havanensis* originating from Cuba were exposed to miracidia under identical conditions and often at the same time, no infections were recognized in living or crushed molluscs. Even those snails exposed to 15 to 20 miracidia each showed no evidence of miracidia having established themselves in the snails' tissues. *T. albicans* from Puerto Rico and *T. pallidus* from Venezuela were likewise refractory to infection even though 15 to 20 miracidia were employed on several occasions.

A rather interesting find was that one snail in each of two different lots of *T. obstructus* from Guatemala possessed poorly developed sporocysts in their bodies. Although the tissues of crushed molluscs were examined carefully under the higher magnification lens of a dissecting microscope it was only by accident that these very small and retarded sporocysts were detected. Further examination under greater magnification revealed that the sporocysts were definitely viable but in a stage of development corresponding to that expected 8 to 10 days after entry of a miracidium into a favorable snail host. Control *B. boissyi* exposed to miracidia at the same time, i.e. 46 days earlier, had been passing cercariae for 8 to 12 days.

Australorbis glabratus originating from Venezuela and Puerto Rico after exposure to 5 to 7 miracidia of *S. mansoni* produced a mean infection rate of 31.7 per cent and 33.4 per cent, respectively. Laboratory raised *B. boissyi* exposed to miracidia from the same fecal specimens gave a range of infections from 0.0 to 90.5 per cent, with a mean of 43.6 per cent. Mice exposed to 200 cercariae from either strain of *A. glabratus* produced 30 to 50 adult schistosomes.

No infections were noted in small numbers of each species of planorbid snails exposed to miracidia of *S. haematobium.*

DISCUSSION

The present investigation adds information to the accumulated knowledge on the biology of the schistosomes and particularly to the relative susceptibility of known, suspected and possible snail vectors to infection by *S. mansoni.* The results obtained demonstrate that at least one species of snail in the southern United States may be a potential host for the Egyptian strain of *S. mansoni.* A small species of planorbid snail from Central America may also be added to the list of possible potential intermediate hosts. The results derived from this study do not support entirely, some of the earlier discussions employing susceptibility patterns as an indication of the probable relationships of schistosomes and their vectors in different geographical regions.

Files and Cram (1949) infecting different snail hosts with various geographical strains of *S. mansoni* were able to infect only 7 per cent and 9 per cent, respectively, of *A. glabratus* from Venezuela and Puerto Rico when exposed to the miracidia from animals infected with the Egyptian strain of *S. mansoni.* In the Cairo laboratory *A. glabratus* from Venezuela and Puerto Rico, respectively, showed 31.7 per cent and 33.4 per cent infection. These results indicate that these two strains of *A. glabratus* are equally susceptible to infection by the Egyptian strain of *S. mansoni,* and the infection rates even compare favorably with those for the native *B. boissyi.* Of 608 snails of the latter species 43.6 per cent became infected.

Although *A. glabratus* from Puerto Rico, Venezuela and Brazil are morphologically indistinguishable, the snails from Brazil have been considered physiologically different from the hosts of Puerto Rico and Venezuela on the basis of differences in their susceptibility pattern after exposure to miracidia from different strains of *S. mansoni.* It must be borne in mind, that it is very difficult to compare data on this type of investigation and that the findings often disagree as a result of the work having been done under different laboratory or environmental conditions, and in this case, with materials originating from different, if not from unnatural sources. For instance, the fact that all exposures in our laboratory were made with schistosome miracidia derived from human infections may well account for discrepancies when comparing the present data with the percentages of infection in snails exposed to miracidia from experimental hosts. Add to these the fact that the planorbids from the western hemisphere transported to Cairo, are molluscs which had been maintained in the laboratory for a number of generations. Although the *B. boissyi* controls used in this study were laboratory-reared they were only one generation removed from their natural habitat.

Although the phase of work relating to snail infection by the West Indian strain of *S. mansoni* was not considered in this study it is interesting to note that previous investigators (Stunkard, 1946; Cram, Files and Jones, 1947) found *B. boissyi* refractory to the schistosome native to Puerto Rico. Abdel-Malek (1950), likewise, found *B. boissyi* refractory to the Puerto Rican *S. mansoni* (animal source) but successfully infected (32.9 per cent) the same snails when re-exposed to the Egyptian strain of *S. mansoni.* Files and Cram also found *B. boissyi* refractory to the Venezuelan strain of *S. mansoni* but *Biomphalaria pfeifferi* from Liberia was readily infected with the Puerto Rican and Venezuelan, as well as with the Egyptian strain of the parasite.

Data from these studies present a rather peculiar picture portraying relationships between parasites and their vectors in the eastern and western hemispheres. Obviously much more investigation on a larger scale must be completed before we can state with finality that certain vectors and schistosome parasites show evolutionary affinities or geographical relationships.

Perhaps the most interesting information derived from this study is that *Tropicorbis havanensis* from Louisiana can, on occasion, be infected by the Egyptian strain of *S. mansoni.* A number of *T. havanensis,* (612) from Cuba, on the other hand, showed no evidence of infection. Although only four of 254 specimens of *T. havanensis* from Louisiana became infected after exposure to miracidia from school children the results are interesting parasitologically. The same may be said of the fact that miracidia from the same source invaded the tissues and temporarily infected specimens of *T. obstructus* descended from snails collected in Guatemala.

The finding of poorly developed sporocysts in the tissues of *T. obstructus,* an unproven and perhaps unnatural host for schistosomes, is not too surprising in view of Stunkard's (1946) experience while working with a similar problem in schistosome biology. He found poorly developed sporocysts but no cercarial development in *T. havanensis* and *B. boissyi* exposed to the West Indian strain of *S. mansoni.* Since many of these intermediate hosts are related, the presence of sporocysts in *T. obstructus* is not at all alarming, if one only considers that cogeneric species could possibly, if not probably, share varying degrees of susceptibility, as well as certain similar morphological characteristics. In view of the fact that the schistosomes demonstrate considerable plasticity in their ability to infect distantly related mammalian hosts, why is it not reasonable to assume that the larval stages of the parasite may also demonstrate a comparable degree of non-specificity for their intermediate hosts?

Many investigators have assumed that the capability of a miracidium to enter, or even be attracted by a snail is an indication that a mollusc is the proper host for the trematode in concern. As a matter of fact it was on the basis of such an observation that Cram, Jones and Wright (1945) and Cram and Files (1946) attempted infection of members of the genus *Tropicorbis.* It had been noted in earlier investigations (Cram, Jones and Wright, 1944) that *T. donbilli* from Texas among a list of eleven species of planorbids "exhibited the greatest attraction for miracidia." General observations during the present study, as well as in other problems of trematode biology has led the author to believe that certain numbers of the miricidia attack and penetrate all planorbid snails, and possibly other species of snails. These observations suggest that infection may well be a chance phenomenon in which there is no precise selectivity of hosts by the miracidium. The observations of Abdel-Malek (1950) lend additional weight to this contention and point out, furthermore, that the miracidia of *S. mansoni* will attack a grain of gravel or an empty snail shell as readily as a living snail.

It seems that the survival or destruction of the miracidium after entry into a snail may depend upon the harmonious or the incompatible relationships of parasite and host. Successful development of larval stages of the parasite is likely a positive expression of the physiological capability of the sporocyst to nourish itself in a snail's tissues and the physiological tolerance of the molluscan host for the parasite. Since individuals exhibit different physiological features and varying degrees of susceptibility, it is not at all unusual to expect to find a wide range of infectivity in groups of individuals of a known vector, or possilbly a transient or a nonproductive infection in the species of a genus closely related to an acceptable vector. This hypothesis is supported by the results obtained in experimental infection of schistosome and other trematode parasites in which one seldom, if ever, finds 100 per cent infection in a group of molluscs exposed to miracidia under seemingly ideal conditions, and by the infections of *S. mansoni* in *T. havenensis* and *T. obstructus.* As Stunkard (1946) has stated, and it seems quite logical, "the failure to infect a sample of any species (snail) does not thereby demonstrate that the species is incapable of transmitting the parasites." To this, it seems, a corollary may be added. The fact that a few specimens out of many snails exposed to miracidia give rise to poorly developed sporocysts or rediae, or even limited numbers of cercariae does not necessarily imply that a parasite is likely to establish itself permanently in a new host species. As further suggested by Stunkard, it may be said, that actually very little is known concerning the factors which control or effect susceptibility and resistance, and many more studies are required before we can expect to have a satisfactory clarification or explanation regarding host-parasite relationships.

SUMMARY

The exposure of several species of planorbid snails from the western hemisphere to the miracidia (from infected school children) of the Egyptian strain of *Schistosoma mansoni* indicates:

1. That *Australorbis glabratus* from Venezuela and Puerto Rico are equally susceptible to infection and the rates of infection fall within the range recorded for *Biomphalaria boissyi,* the natural vector of *S. mansoni* in Egypt.
2. *Tropicorbis havanensis* from Louisiana can be infected under favorable circumstances.
3. *T. havanensis* from Cuba, exposed under identical conditions with *T. havanensis* from Louisiana, was refractory, as were *T. pallidus* from Venezuela and *T. albicans* from Puerto Rico.
4. *Tropicorbis obstructus* from Guatemala can be infected, if one considers the presence of poorly developed sporocysts, a satisfactory criterion of infection.
5. Much more investigation of this type is necessary to explain geographic relationships of hosts and parasites. A brief discussion is given concerning host-parasite relationships.

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Notes on Some Trematodes Parasitic in Alaskan Canidae

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Except for the report of Hadwen (1922) and a few miscellaneous records, little information is available relative to the helminth parasites infecting canine animals in Alaska. During the past two years, 520 autopsies on canids have been performed in connection with the investigation of animal-borne diseases. The purpose of this note is to record the occurrence of four species of trematodes observed in Alaskan canids during the course of these studies; one species is apparently reported for the first time from North America. These four parasites are mentioned separately below:

Metorchis albidus (Braun, 1833)

Ackert (1937) recorded this trematode from an Eskimo dog which had been imported into the United States from Alaska. The present report is the second record of the species from North America.

One of 18 Eskimo dogs, autopsied at Kotzebue in the fall of 1950, was infected with this parasite. Most of the several hundred specimens obtained were found in the bile ducts, but a few apparently had entered the intestine after the death of the host. Ackert (1937) has pointed out certain differences between his specimens and the typical European form; our material agrees very closely with Acketr's description. Dollfus and Callot (1945) have demonstrated some of the variation observed in *M. albidus,* and we consequently concur with Ackert that there is little justification to consider the North American material specifically distinct. Baer (1943) has also recorded observations on variation in *M. revilliodi* Baer, 1931.

The animal from which these parasites were taken was obtained in the course of routine parasitological investigation and showed no obvious pathological condition.

Cryptocotyle lingua (Creplin, 1825)

Although previously recorded from the United States and Canada, *C. lingua* has never been observed in Alaskan canids. Moderate infections with this trematode were observed in the small intestine of six of 18 dogs autopsied at Kotzebue during November, 1950. A maximum number of about 200 worms was obtained from a single animal. The specimens studied were typical in morphological detail.

Alaria canis LaRue and Fallis, 1936

We have obtained this trematode from eight red foxes (*Vulpes fulva alascensis,* Merriam), all but one of which were collected about 200 miles northeast of Anchorage. The other animal was collected along the Alaska Highway about 50 miles west of the Canadian border. The infections were light to moderate, with as many as 200 trematodes in one animal. Although we have examined a large number of red foxes from Northern Alaska, we have not yet recorded *A. canis* from that region.[1] We have obtained this parasite once from a wolf, *Canis lupus* ssp., collected in the same region where the infected foxes were taken. This trematode was first described from a dog imported to the United States from Northern Canada, and Erickson (1944) has reported it from red and grey foxes in Minnesota. Some observations on the morphology of the Alaskan specimens have been given by Dubois and Rausch (1950).

Plagiorchis ?massino Petrov and Tikhonov, 1927

(Fig. 1)

Trematodes belonging to the genus *Plagiorchis* were taken from the small intestine of an Alaskan red fox, collected approximately 200 miles northeast of Anchorage. There does not appear to be any record of trematodes of this genus from North American canids, although two species, *P. massino* Petrov and Tikhonov, 1927, and *P. popowi* Palimpsestow, 1929, have been recorded from dogs in Russia.

The status of many species of the genus *Plagiorchis* is uncertain. Schul'ts (1933), as quoted in Africa and Garcia (1937), stated that the large number of species in the genus (more than 50) probably could be reduced to 15 or 20. While our specimens do not agree entirely with any of the previously-described species, it seems advisable to assign them tentatively to the species *P. massino,* from which they differ only in minor detail. The primary difference lies in the degree to which the vitellaria extend anteriorly. Our specimens are also smaller than those previously reported.

In view of the uncertain basis for assigning this form to any known species, we are including herewith a brief description:

DIAGNOSIS: Plagiorchiidae. Small trematode with bluntly rounded extremities. Body from 800 μ to 1.2 mm. long by 200 to 270 μ wide. Oral sucker subterminal, 144 to 166 by 120 to 134 μ. Prepharynx apparently absent. Pharynx 61 to 80 by 69 to 96 μ. Esophagus short or absent. Intestinal ceca extend to near posterior end of body. Oval acetabulum situated at posterior edge of anterior body-third, 102 to 120 by 96 to 108 μ. Ovary ovoid with smooth edges, 61 to 86 by 48 to 67 μ, located posterior and slightly dextral to acetabulum; spherical to ellipsoidal testes smooth, obliquely placed in second

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[1] Since this paper was submitted, two dogs from Fort Yukon, Alaska, eight miles north of the Arctic Circle, were found infected with this species.

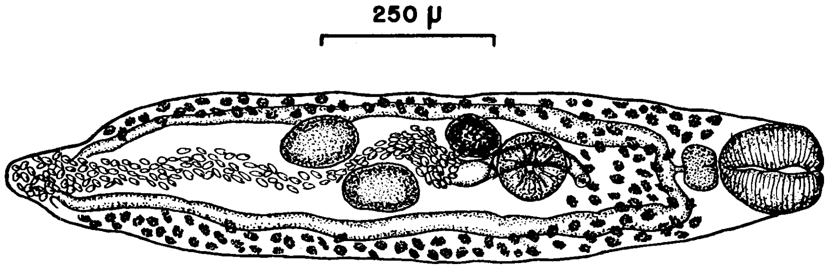

Fig. 1. *Plagiorchis ?massino* Petrov and Tikhonov, 1927.

body-third. Anterior testis 74 to 102 µ long. Posterior testis 67 to 124 by 45 to 108 µ. Relatively long cirrus sac overlaps acetabulum; posterior swelling slight; seminal vesicle present. Uterus without transverse loops; average egg-size 33 by 22 µ. Descending ramus of uterus passes between testes and widens near posterior end of body; ascending ramus, nearly devoid of eggs, narrows into long metraterm. Genital pore anterior to acetabulum. Vitellaria composed of large follicles which extend from level of posterior margin of pharynx to near posterior end of body; vitellaria confluent anterior to acetabulum.

HOST: *Vulpes fulva alascensis* Merriam.

A slide containing whole mounts of this trematode has been deposited in the Helminthological Collection of the United States National Museum, slide No. 47091.

Continued parasitological investigation of this host-group may reveal additional species of trematodes. A compilation of parasites of the Canidae obtained to date is presently being made, and it is expected that a record of these findings may be reported in a later publication.

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Three New Dilepidid Cestodes, *Dictymetra numenii* n. gen. n. sp.; *Dictymetra paranumenii* n. sp. and *Anomotaenia filovata* n. sp.

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Between October 1949 and October 1950, 148 birds from Nebraska were examined for helminth parasites. Most of the birds were collected from the vicinity of Lincoln; a few were from the vicinity of Fort Robinson. The birds collected comprise 9 orders, 43 genera and 55 species. Of the 148 birds examined 62 (41.8%) were found infected with helminths, 43 (29.0%) with cestodes, 8 (5.4%) with acanthocephala, 6 (4.0%) with trematodes and 5 (3.3%) with nematodes. In only 8 of the birds were two groups of helminths represented.

The intestines and gizzards of the birds were usually the only organs examined since these organs could be removed without damage to the remainder of the birds which were given to the University of Nebraska Museum for the preparation of study skins. In most cases the birds were identified by Mr. Thomas B. Thorson whose help is greatly appreciated.

This paper deals with only a portion of the cestodes collected. They are three new species of which two are assigned to a new genus.

METHODS

All of the cestodes were killed by swirling them in alcohol-formol-acetic solution for a few minutes and then left for about 30 minutes before removing them to 70% alcohol for storage. Delafield's hematoxylin was used for staining all toto-mounts, and all specimens were cleared in xylol and mounted in permount. When necessary serial sections were made and stained with Delafield's hematoxylin and eosine.

In order to observe the structure of the eggs, a modification of the method suggested by Hanson (1950) was used. Instead of teasing apart a gravid proglottid from a living specimen in saline, fixed specimens were teased apart in permount on a slide. The eggs were then covered with a coverglass. This method was also used to isolate rostellar hooks. The portion of the rostellum bearing the hooks can be mounted *en face* by this method.

All measurements were made from specimens mounted in permount.

Anomotaenia filovata n. sp.

(Figures 1-4)

From the intestine of one killdeer (*Charadrius vociferus vociferus*) 13 cestodes were obtained of which 7 retained their scolices. All of the specimens were in excellent condition.

Description: Scolex 0.198 to 0.264 mm. long and 0.214 to 0.300 mm. wide at the level of the suckers. Suckers 0.132 to 0.175 mm. long and 0.112 to 0.124 mm. wide. Retractile rosetellum 0.231 to 0.280 mm. long and 0.033 to 0.066 mm. wide. Long rostellar pouch extends a short distance posterior to the scolex into the short neck. There are 18 to 20 rostellar hooks arranged in a double row. Hooks (Fig. 3) of both rows are 0.024 mm. long.

Strobilae measure from 20 to 40 mm. in length and approximately 1.5 mm. in width. All proglottids are broader than long. Genital pores are irregularly

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*Studies from the Department of Zoology, University of Nebraska. No. 254. This work was done under the direction of Dr. Harold W. Manter.

alternate in the anterior one-sixth of the lateral margin of the proglottid. Genital ducts pass between the dorsal and ventral excretory vessels which are 0.007 to 0.011 mm. and 0.018 to 0.040 mm. in diameter respectively.

There are 55 to 65 testes located in the posterior half of the proglottid. Testes are spherical to subspherical and measure 0.050 to 0.070 mm. in diameter. Vas deferens is highly coiled near the anterior margin of the proglottid and on the poral side of the ovary. Vas deferens serves as a seminal vesicle which is absent. It loops a few times within the cirrus sac before it joins the straight unarmed cirrus. Cirrus sac is small and slender, 0.165 to 0.214 mm. long by 0.039 to 0.040 mm. wide. Cirrus opens anterior to the vagina into a short tubular genital atrium.

The very large ovary fills a large part of the anterior half of the proglottid. The young ovary consists of branches radiating anteriorly and laterally. Vagina extends inward from the genital atrium following the posterior curvature of the cirrus sac. It connects with a conspicuous ovoid seminal receptacle located at the poral side of Mehlis' gland. Mehlis' gland is immediately posterior to the ovary and immediately anterior to the irregularly lobed vitellarium. The latter measures 0.100 to 0.115 mm. in length and 0.200 to 0.300 mm. in width. Seminal receptacle is 0.231 to 0.313 mm. by 0.050 to 0.100 mm., and lies dorsal to the ovary. The sac-like uterus extends to the anterior and posterior borders of the proglottid and slightly lateral to the excretory vessels. Eggs (Fig. 4) have a very characteristic appearance. Embryophore is oval and distinct, surrounded by an outer shell which is drawn out into a long tubular thread at each pole. Immature eggs in which the embryophore and oncosphere have not differentiated are spindle shaped; the polar threads are not as long as in mature eggs. Typical measurements for the egg excluding the polar thread are 0.024 by 0.017 mm. for the embryophore, 0.018 by 0.015 mm. for the oncosphere, and 0.07 mm. long for the oncosphere hooklets. Except at the poles, the outer shell closely surrounds the embryophore.

Host: *Charadrius vociferus vociferus* Linnaeus, killdeer.

Locality: Whitney Lake, Whitney, Nebraska.

Habitat: Small Intestine.

Type: U. S. Nat. Mus. Helm. Coll. No. 37305.

Discussion: The genus *Anomotaenia* Cohn, 1900 is large, containing more than 60 species all of which are parasites in birds. The species are based chiefly on size, shape and number of rostellar hooks, and number of testes.

Only four species of *Anomotaenia* possess hooks comparable in size to those of *A. filovata.* These are: *A. aegyptica* (Krabbe, 1869) Joyeux and Baer, 1936; *A. bacilligera* (Krabbe, 1869) Joyeux and Baer, 1936; *A. borealis* (Krabbe, 1869) Fuhrmann, 1908; and *A. brevis* (Clerc, 1902) Fuhrmann, 1908. These four species all possess less than 20 testes as compared with 55 to 65 in *A. filovata.* The filamentous extensions of the outer shell occur in many species of *Anomotaenia,* but they usually are not as long and slender as in *A. filovata.* The trivial name is in reference to these long slender threads.

From the intestine of two long-billed curlews (*Numenius americanus americanus*) approximately 50 cestodes were collected constituting two distinct new species. Both species are Dilepididae, subfamily Dilepidinae, and related to the genus *Choanotaenia.* They are placed in a new genus because of the uterus which is entirely different from the uterus of *Choanotaenia* and other Dilepididae.

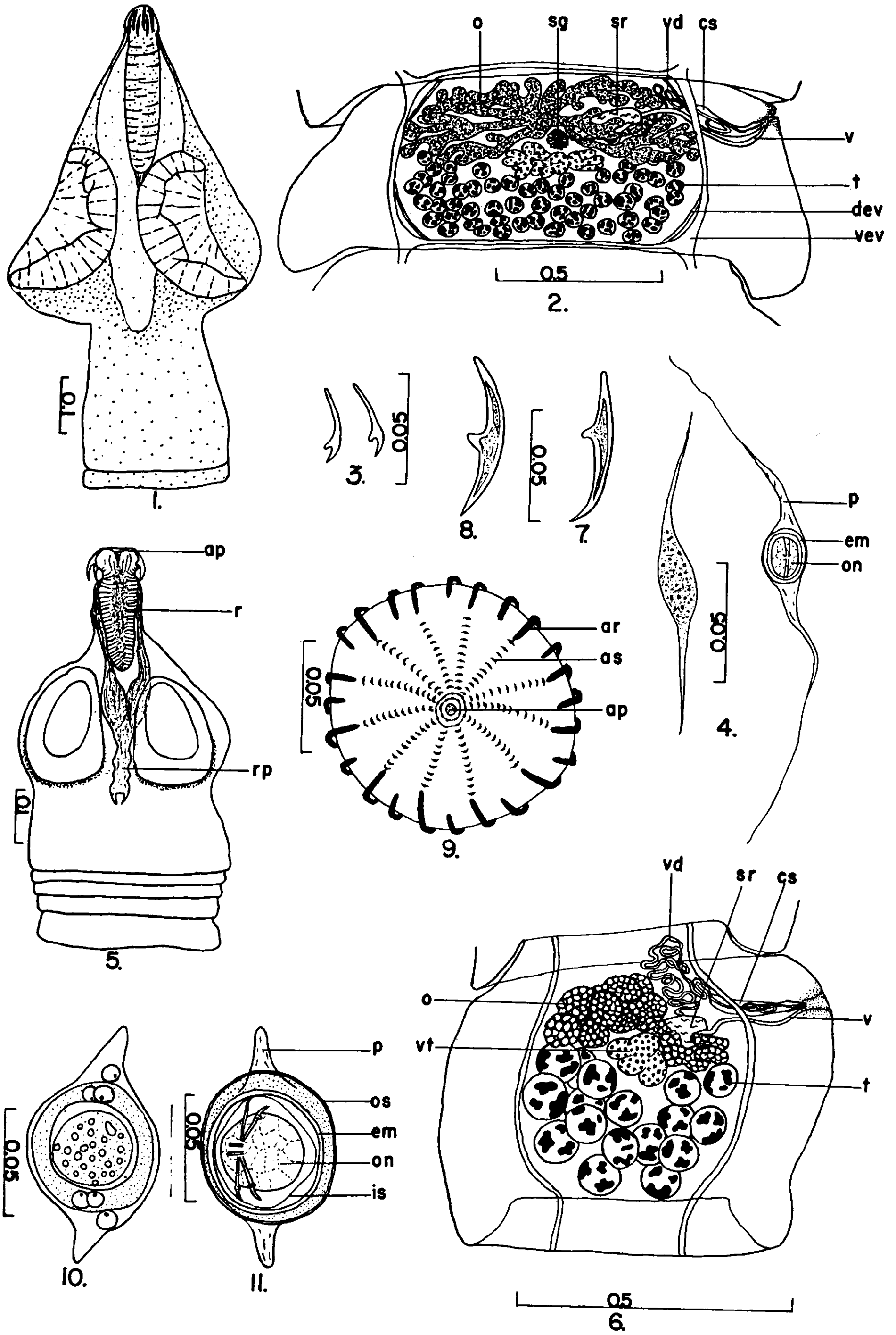
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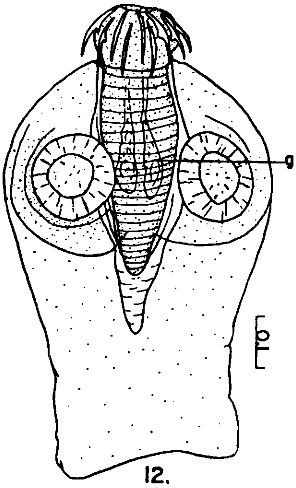
PLATE I



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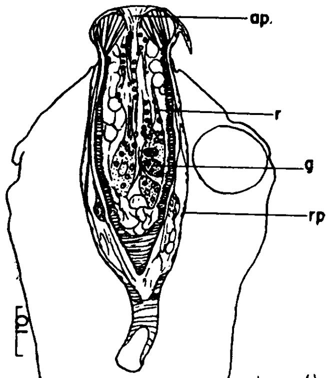

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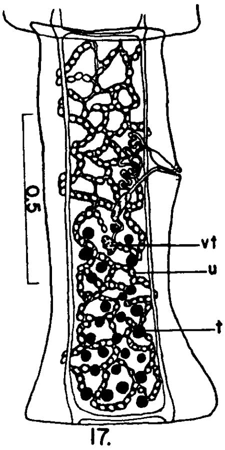

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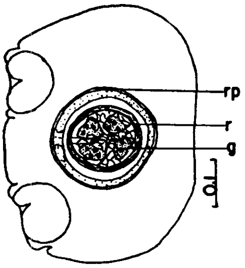

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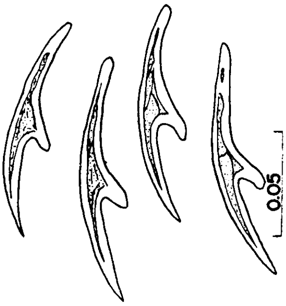

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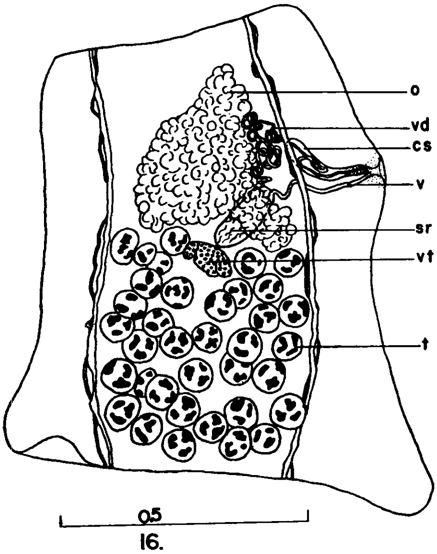

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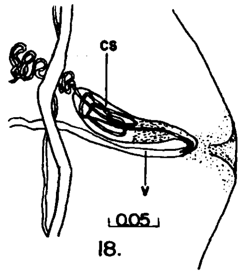

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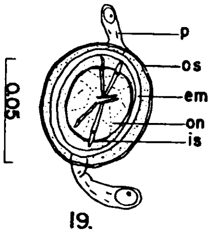

19.

PLATE II

Dictymetra numenii n. gen., n. sp.

(Figures 5-11)

Description: Scolex is 0.247 to 0.330 mm. long and 0.280 to 0.413 mm. in width. The broadest point is at the level of the suckers which are large, poorly developed structures measuring 0.204 to 0.231 mm. in length and 0.130 to 0.135 mm. in width. Retractile rostellum is mushroom-shaped and measures 0.280 to 0.333 mm. in length and is 0.083 to 0.115 mm. in greatest width. The long rostellar pouch extends a short distance posterior to the suckers into the short neck. There is a minute pore at the apex of the rostellum (Fig. 9). From this apical pore are twelve rows of minute spines or scales radiating to the anterior root of each hook in the anterior row of rostellar hooks. The 24 rostellar hooks are arranged in two rows. All of the hooks are 0.065 to 0.068 mm. long, but are of two different shapes. Hooks of the anterior row have a blade about 0.041 mm. long, anterior root 0.026 mm. long and a width including the posterior root, of 0.014 mm. Hooks of the posterior row have a blade 0.034 mm. long, anterior root 0.033 mm. long, and a width, including the posterior root, of 0.017 mm. Hooks of the anterior row are almost straight except for a rather sudden curve near the tip. Hooks of the posterior row show a more uniform curvature throughout their length (Figs. 7 and 8).

The length of the strobila is from 15.0 to 25.0 mm. consisting of a maximum of approximately 75 proglottids. Mature proglottids are wider than long measuring from 0.6 to 1.0 mm. in width, and the gravid proglottids are approximately twice as long as wide, sometimes reaching a length of 1.5 mm. Mature proglottids appear about 20 to 40 segments posterior to the scolex,

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EXPLANATION OF PLATES

Figs. 1-4. *Anomotaenia filovata* n. sp. 1—Scolex. 2—Mature proglottid, ventral view. 3—Two rostellar hooks. 4—Immature and mature eggs.

Figs. 5-11. *Dictymetra numenii* n. gen. n. sp. 5—Scolex. 6—Mature proglottid, ventral view. 7—Rostellar hook from anterior row. 8—Rostellar hook from posterior row. 9—Apical (*en face*) view of rostellum, showing apical pore and radiating rows of scales. 10—Immature egg. 11—Mature egg.

Figs. 12-19. *Dictymetra paranumenii* n. sp. 12—Scolex. 13—Median longitudinal section through scolex, showing apical pore and glandular regions. 14—Transverse section through the scolex, showing the arrangement of the four glandular regions. 15—Series of four rostellar hooks. 16—Mature proglottid, ventral view. 17—Gravid proglottid, dorsal view. 18—Lateral portion of poral side of a mature proglottid, ventral view, showing terminal genital organs. The terminal portion of the cirrus sac and cirrus are inserted into the vagina. 19—Mature egg.

LEGEND

All figures (1-19) were drawn with the aid of a camera lucida. The projected scale has a value in millimeters indicated on each figure. Abbreviations are as follows: *ap*, apical pore; *ar*, anterior root; *as*, apical scales; *cs*, cirrus sac; *dev* dorsal excretory vessel; *em*, embryophore; *g*, glandular region of rostellum; *is*, inner shell; *o*, ovary; *on*, onchosphere; *os*, outer shell; *p*, polar prolongation; *r*, rostellum; *rp*, rostellar pouch; *sg*, Mehlis' gland; *sr*, seminal receptacle; *t*, testes; *u*, uterus; *v*, vagina; *vd*, vas deferens; *vev*, ventral excretory vessel; *vt*, vitellarium.

and organs of both sexes develop at the same time. Genital pores are irregularly alternate and are located in the anterior one fourth of the lateral margin of the proglottid. Genital atrium is well developed and rather deep. Ventral excretory vessel is 0.016 to 0.023 mm. in diameter, and the dorsal excretory vessel is 0.003 to 0.005 mm. in diameter. Genital ducts pass between the dorsal and ventral excretory vessels.

There are 15 to 17 spherical testes located posterior to the female genital organs. They measure 0.075 to 0.095 mm. in diameter. Cirrus sac is 0.146 to to 0.198 mm. by 0.023 to 0.035 mm. and extends from the genital pore diagonally inward and anteriorly to a point almost one half its length past the ventral excretory vessel. Terminal portion of the cirrus sac is chitinized somewhat as reported in *Choanotaenia* species by Hansen (1950) and Fuhrmann and Baer (1944). Vas deferens passes directly anteriorly and dorsal to the vitellarium where it curves porally and becomes highly coiled anterior and poral to the ovary before entering the cirrus sac. After entering the cirrus sac the vas deferens continues to be somewhat coiled, then straightens and becomes surrounded by the chitinous portion of the cirrus sac (Fig. 6). A true cirrus seems to be lacking or is poorly developed.

Mature ovary appears as a single, more or less crescent-shaped mass, composed of clusters of eggs cells. Each cluster contains approximately 20 egg cells. Ovary extends laterally to the excretory vessels and anteriorly to the anterior border of the proglottid. Vitellarium is multi-lobed, posterior to the ovary, and measures 0.043 to 0.066 mm. in length and 0.090 to 0.110 mm. in width. Between and dorsal to the ovary and vitellarium is a well-defined spherical shell gland. From the genital pore the vagina passes medianly in a slightly curved course a short distance past the ventral excretory vessel where it joins the seminal receptacle which is 0.080 to 0.100 mm. by 0.030 to 0.050 mm. Seminal receptacle lies dorsal to the poral portion of the ovary. Uterus is an anastomosing tube forming a complex network throughout the entire proglottid and extending laterally to the excretory vessels. The uterine wall is persistent even in the most gravid proglottids. By the time the uterus is filled with developing eggs, the ovary is almost entirely gone. In completely gravid proglottids the cirrus sac, vas deferens, testes, and seminal receptacle are still present, and portions of the vitellarium and shell gland can be seen. Eggs consist of an oncosphere surrounded by three shells or envelopes. Outer shell bears two polar, somewhat pointed prolongations. Embryophore is relatively thick. Inner shell is very thin and closely surrounds the oncosphere. Space between the embryophore and the outer shell is filled with an evenly distributed granular material, and usually two large spherical cells at each pole. There is usually another large spherical cell in each polar prolongation. Egg is slightly ovoid. Typical measurements for the egg are 0.066 by 0.060 mm. for the outer shell excluding the polar prolongations of the outer shell, 0.045 to 0.050 mm. for the oncosphere which varies in shape from oval to spherical, and 0.017 mm. for the oncosphere hooklets.

Host: Numenius americanus americanus Bechstein, long-billed curlew.
Locality: Whitney lake, Whitney, Nebraska.
Habitat: Small Intestine.
Type: U. S. Nat. Mus. Helm. Coll. No. 37303.

Discussion: Dictymetra numenii is similar to *Choanotaenia upupae* Fuhrmann, 1943, and *C. riccii* Fuhrmann and Baer, 1944 in possessing a tubular, anastomosing uterus. *D. numenii,* however, can be distinguished from *C.*

upupae by the number of testes which is 15 to 17 in *D. numenii* and more than 30 in *C. upupae. D. numenii* can best be distinguished from *C. riccii* by the size of hooks which is 0.065 to 0.068 mm. in *D. numenii* and 0.090 to 0.105 mm. in *C. riccii.*

The apical pore and scales were also found on the rostellum of the species described below, and a discussion of these structures will be given later.

All three shells of the eggs of *Dictymetra numenii* are completely formed within a well defined uterine wall which indicates that the outer shell is not formed from parenchyma cells or from the remains of a degenerating uterus. The development of these eggs is apparently the same as described by Fuhrmann and Baer (1944) for *Choanotaenia riccii.*

The trivial name *numenii* refers to the host from which this species was collected.

Dictymetra paranumenii n. sp.

(Figures 12-19)

Description: Scolex is 0.408 to 0.620 mm. long and 0.476 to 0.523 mm. wide. The four suckers are circular and rather muscular measuring from 0.143 to 0.165 mm. in diameter. Retractile rostellum is 0.442 to 0.516 mm. long and 0.136 to 0.176 mm. in diameter. It is contained in a rostellar pouch which is 0.408 to 0.620 mm. long and 0.176 to 0.204 mm. in diameter. Rostellum and pouch may extend a short distance posterior to the suckers. Rostellum bears a crown of 20 hooks arranged in a double row. Hooks of the anterior row are 0.100 to 0.105 mm. long; with blades approximately 0.046 mm., anterior roots approximately 0.056 mm. and a width including the posterior roots of approximately 0.023 mm. Hooks of the posterior row are longer, being 0.110 to 0.115 mm. long; the blades are approximately 0.065 mm., the anterior roots approximately 0.044 mm. There is a minute apical pore at the apex of the rostellum and ten rows of minute scales radiating to the anterior roots of the ten anterior rostellar hooks.

Strobila varies from 150 mm. to 300 mm. in length with a maximum width of 2.5 mm. Proglottids are usually longer than wide. There is a short neck about 0.480 mm. long and 0.400 mm. wide. Genital organs do not appear for a distance of approximately 10.0 to 20.0 mm. posterior to the neck. Both sets of sex organs develop at the same time. Genital pores are irregularly alternate and are located approximately one third of the length of the lateral margin from the anterior end of the proglottid. Genital atrium is rather deep. Ventral excretory vessel is 0.020 to 0.035 mm. wide, and varies in width at various points. The smaller dorsal excretory vessel is of a constant width.

The 35 to 40 spherical testes are located in the posterior half of the proglottid and measure 0.060 to 0.080 mm. in diameter depending upon the age of the proglottid. Cirrus sac is 0.132 to 0.165 mm. long and 0.033 to 0.060 mm. wide. Terminal portion of the cirrus sac is only slightly chitinized. (Figs. 16 and 18.) Cirrus sac may pass a short distance median to the ventral excretory vessel in very mature proglottids, but usually it just reaches the vessel. Vas deferens passes directly anteriorly. Dorsal to the vitellarium it curves porally and becomes slightly coiled, then becomes highly coiled anterior and lateral to the poral side of the ovary. Vas deferens then passes between the excretory vessels and enters the cirrus sac where it loops a few times before forming the unarmed cirrus.

The young ovary is deeply branched and follicular, but as it matures it becomes a single follicular, semicircular structure in the anterior half of the proglottid extending nearly to the anterior edge of the proglottid and excretory vessels. Posterior to the ovary is the slightly lobed subovoid vitellarium which is 0.080 to 0.100 mm. long and 0.150 to 0.230 mm. wide. Between the ovary and the vitellarium is a poorly defined Mehlis' gland. Vaginal pore opens into the genital atrium posterior to the cirrus. Vagina passes posterior to the cirrus sac between the excretory vessels and enters the seminal receptacle a short distance median to the excretory vessels. Seminal receptacle lies dorsal to a portion of the ovary and is 0.132 to 0.200 mm. by 0.050 to 0.075 mm. Uterus forms a complex network throughout the entire proglottid. It may extend lateral to the excretory vessels. In fully gravid proglottids the eggs within the uterus are so large and numerous that the meshes become more or less confluent so that the walls of the uterus become difficult to observe. Maturing eggs within the uterus are arranged one behind the other, overlapping slightly in some regions. Ovary disappears very early. Testes slowly atrophy as the eggs develop, but the vagina, seminal receptacle, vas deferens, and cirrus sac are present in completely gravid proglottids. Eggs are slightly ovoid, and consist of an oncosphere surrounded by three shells or envelopes. Outer shell of the eggs of this species has two polar prolongations. In each of these prolongations there is usually one or two spherical cells. Eggs vary considerably in size according to the stage of development; however, an average size can be given as typical. Oncosphere is 0.034 by 0.300 mm. and the hooklets are 0.023 mm. long. Inner shell is immediately around the oncosphere. Embryophore is 0.040 by 0.035 mm., and the outer shell excluding the polar prolongations of the outer shell is 0.060 by 0.055.

Host: Numenius americanus americanus Bechstein, long-billed curlew.

Locality: Whitney Lake, Whitney, Nebraska.

Habitat: Small Intestine.

Type: U. S. Mus. Helm. Coll. No. 37304.

Discussion: Dictymetra paranumenii is most closely related to *D. numenii;* and is also similar to *Choanotaenia upupae* Fuhrmann, 1943 and *C. riccii* Fuhrmann and Baer, 1944, the only species of *Choanotaenia* described as possessing a tubular anastomosing uterus appearing as a complex network throughout the proglottid. The rostellar hooks of *C. upupae* were not described by Fuhrmann, but this species can be distinguished from *D. paranumenii* on the basis that its scolex is considerably smaller, it has more testes, and the terminal portion of the cirrus sac is not chitinized. *D. paranumenii* is very similar to *C. riccii* in that the scolex, rostellum, rostellar hooks, cirrus sac, and eggs are approximately the same size; and a chitinized terminal tube occurs at the end of the cirrus sac. *D. paranumenii,* however, differs in possessing a double crown of 20 rostellar hooks rather than a single crown of 24 hooks, and has 35 to 40 testes rather than 20 to 22.

Dictymetra paranumenii can easily be distinguished from *D. numenii* by the length of the strobila which is much greater in *D. paranumenii;* by the scolex, rostellum and rostellar hooks, all of which are much larger in *D. paranumenii;* by the number of testes which is 35 to 40 in *D. paranumenii* and only 15 to 17 in *D. numenii;* and by the 20 rostellar hooks in *D. paranumenii* rather than 24 as in *D. numenii.*

The function of the apical pore and scales found to be present in both *Dictymetra numenii* and *D. paranumenii* is not known. The pore probably serves as an opening for secretions from gland cells present in the rostellum. Transverse and longitudinal serial sections of the rostellum of *D. paranumenii* show four structural regions which appear to be glandular (Figs. 13 and 14). Actual ducts from these glandular regions were not seen. The apical scales which are present in both of the above species of *Dictymetra* may be sensory or serve to irritate the epithelium of the host. The fact that the spines are in rows radiating from the apical pore to the anterior row of rostellar hooks suggests a relationship with the hooks. In longitudinal serial sections the apical scales appear as points of attachment for the well defined muscles in the mushroomed portion of the rostellum (Fig. 13). These muscles probably control the rostellar hooks. Although an apical pore and apical spines have not been previously reported from cestodes, they may be present in other Dilepididae, being overlooked because of their small size and because they are evident only in *en face* view of the rostellum.

The trivial name *paranumenii* refers to the occurrence of *Dictymetra paranumenii* and *D. numenii* in the same two individual hosts.

DIAGNOSIS OF THE GENUS *Dictymetra*

Delipididae, Dilepidinae. Scolex armed with a single or double row of hooks. Hooks with long anterior roots. Testes in posterior half of proglottid; vas deferens coiled near poral side of ovary, passing between excretory vessels; cirrus sac reaching only to or slightly beyond excretory vessels, its terminal portion often chitinized; cirrus unarmed and weakly developed. Genital pores irregularly alternating, lateral, in anterior half of proglottid. Mehlis' gland and vitellarium posterior to ovary; seminal receptacle present; vagina extending along posterior edge of cirrus sac. Uterus persistent, tubular, anastomosing, forming a loose, complex network. Eggs relatively few with polar elongations of the outer shell often present. Type species: *Dictymetra numenii.*

Discussion: This genus is most like *Choanotaenia* which it resembles except in the form of the uterus. In *Choanotaenia* the uterus becomes transformed into numerous uterine capsules, one around each egg.

Of the numerous species of *Choanotaenia,* only two have been described as possessing a net-like uterus. These are *C. upupae* Fuhrmann, 1943 and *C. riccii* Fuhrmann and Baer, 1944. Both of these species were placed doubtfully in the genus *Choanotaenia* because of the character of the uterus.

These species should be assigned to the genus *Dictymetra,* becoming:

Dictymetra upupae (Fuhrmann, 1943) n. comb.
Syn. *Choanotaenia upupae* Fuhrmann, 1943
Dictymetra riccii (Fuhrmann and Baer, 1944) n. comb.
Syn. *Choanotaenia riccii* Fuhrmann and Baer, 1944

The genera *Anomotaenia* Cohn, 1900 and *Paricterotaenia* Fuhrmann, 1932 are both similar to the genus *Dictymetra;* but both have sacciform uterus, and *Paricterotaenia* has a single row of rostellar hooks.

There is often confusion concerning the genera *Choanotaenia, Anomotaenia* and *Paricterotaenia* due to the fact that they are differentiated only on the basis of whether the uterus is persistent or breaks down into capsules, or whether there is one or two crows of rostellar hooks. Both of these characters are often difficult, if not impossible to determine. On the other hand, the characteristic uterus of the genus *Dictymetra* is not difficult to observe.

The generic name is from *dicty,* a net; and *metra,* uterus. Hence *Dictymetra* denotes the net-like uterus.

SUMMARY

1. Three new species of cestodes (family Dilepididae, subfamily Dilepidinae) are described. A new genus is named for two of the new species. The three new species are *Anomotaenia filovata* n. sp., from the killdeer (*Charadrius vociferus vociferus*); *Dictymetra numenii* n. gen., n. sp. and *Dictymetra paranumenii* n. sp., both from the long-billed curlew (*Numenius americanus americanus*).

2. Two new combinations are proposed as follows: *Dictymetra upupae* (Synonym: *Choanotaenia upupae*); *Dictymetra riccii* (Synonym: *Choanotaenia riccii*).

3. Two new structures of the rostellum of cestodes are described. These are an apical pore and apical, radiating rows of very fine scales.

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On an Ascaris Parasite of the Fisher and Marten, *Ascaris devosi* sp. nov.

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Three ascaris parasites were mentioned in the early literature as being parasites of members of the family Mustelidae. These were (1) *Ascaris mustelarum* (2) *Ascaris gulonis* and (3) *Ascaris columnaris.*

(1) *A. mustelarum* was named by Rudolphi (1819) as a doubtful species, its previous name being *A. martis* Gmelin 1790, not *A. martis* Schrank 1788 (a synonym of *Dioctophyme renale*); *A.. martis* Rudolphi 1819, according to Dujardin (1845) was an oxyurid. Two specimens of *A. mustelarum* apparently existed at this time, the single specimen collected by Goeze from *Martes martes* and a second specimen, part of a single female collected by Rudolphi (1819), from *Martes foina.* Regarding the identity of the first specimen, Goeze was evidently of the opinion that it was nearly related to *Toxocara mystax.* This is shown by Rudolphi's (1809) observation under the heading *A. martis*: "Goezius hanc speciem Ascaridi mystaci n. 12 proximam esse refert, ut capite alato instructa videatur." As he later (1819) included his own specimen from the beech marten in the same species it seems likely that *A. mustelarum* Rudolphi had cervical alae. Diesing (1851) applied to *A.*

mustelarum the observation "Ascaridi mystaci proxima videtur" and gave as synonyms the following: *A. teres* Goeze; *A. martis* Gmelin; and *Fusaria martis* Zeder. The probability that *A. mustelarum* Rudolphi possessed cervical alae is further substantiated by the name *Ascaris alienata* given by Rudolphi (1819) to a parasite of the coati (*Nasua rufa*). According to Dujardin (1845) Rudolphi gave it this name "comme c'est la seule espèce, parmi les ascarides des carnassiers, qui soit dépourvue d'ailes membraneuses aux côtes de la tête, Rudolphi a voulu exprimer cette différence par le nom spécifique d'Alienata." Hence *A. alienata* must have been the only ascaris of carnivores which Rudolphi had seen which did not have cervical alae. Stossich (1896) included both *A. alienata* and *A. mustelarum* as synonyms of *Toxocara mystax.* He was evidently mistaken about *A. alienata.* As the parasite described in this paper has no cervical alae, the name *A. mustelarum,* although it has been used previously by Meyer and Chitwood (1951) and by the writer (Sprent, 1951a) for this parasite, does not seem to be applicable and should be discarded.

(2) *A. gulonis* according to Rudolphi (1810) was first collected but not described by Pallas from the intestine of the wolverine. Gmelin (1790) listed *A. gulonis* "habitat in gulonis intestinis" quoting Redi, but Rudolphi (1810) stated that Redi did not examine the wolverine and that the worms were actually removed from the skin and lungs of a beech marten. In the words of Dujardin (1845) "Rudolphi a montré qu'il s'agissait non d'un glouton, mais d'une fouine." The parasites collected by Redi and by Pallas evidently do not belong to the same species and it may be advisable to retain *A. gulonis* Rudolphi 1810 as the name of the parasite from the wolverine rather than *A. gulonis* Gmelin 1790 because Rudolphi gave measurements of the parasite. Recently Tiner (in press)* has examined some specimens of ascaris collected from the wolverine and it appears likely from his remarks that this species (*A. gulonis*) should be retained as distinct from the following species (*A. columnaris* Leidy 1856).

(3) Leidy (1851) first recorded an ascaris from the skunk (*Mephitis chinga*) and referred to it as *A. alienata* Rudolphi 1819, later (1857) because of a difference in size, he changed the name to *A. columnaris.* This parasite was re-described by Goodey and Cameron (1923). It has been recorded from the following members of the family Mustelidae: the skunks, *Mephitis mesomelas* (Canavan 1931), *Mephitis nigra* (Rankin 1946), *Mephitis mephitis* and *Spilogale putorius* (Erickson 1946); the weasels, *Mustela nivalis, Mustela erminea* and *Mustela* (*Putorius*) *putorius* (Petrov 1940); the wolverine, *Gulo gulo* (Petrov 1940); the martens, *Martes martes, Martes foina* (Petrov 1940) and *Martes caurina* (Marshall 1942); the badgers, *Meles meles* (Petrov 1940) and *Taxidea taxus* (Morgan 1943). It has also been recorded from the raccoon *Procyon lotor* (Olsen and Fenstermacher 1938). Linsdale (1946) recorded *A. columnaris* from *Citellus beecheyi,* but Tiner (in press) has shown that this parasite was probably *A. laevis* Leidy 1856. Though it is apparent from the foregoing that *A. columnaris* has a wide host range, it has not been conclusively established that a single species only is involved.

In the present paper ascaris parasites collected from *Martes* spp., i.e., the marten (*Martes a. americanus*) and the fisher (*Martes p. pennanti*), are compared with *A. columnaris* collected from the skunk, *Mephitis m. mephitis* and with the description of *A. columnaris* by Goodey and Cameron (1923).

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*The writer acknowledges his thanks to Dr. J. D. Tiner for sending him the typescript of this paper before its appearance in print.

The frozen carcasses of these animals were sent to the writer from the Chapleau Game Preserve, Ontario, through the Department of Lands and Forests. Particular thanks are due in this regard to Mr. A. deVos and Mr. V. Creighton.

On examination the worms from *Martes* spp. were found to correspond in most respects to the worms from *Mephitis* and to the description of *A. columnaris* by Goodey and Cameron (1923). However some anatomical differences were noted and are reported below:

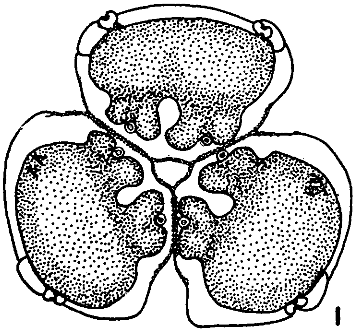
(a) The pulp of the lips (Fig. 1) consists of a basal part, which bears the external papillae, and an apical part. The latter arises as two lobes with a median cleft between, they pass towards the oral margin of the lip where each is subdivided into two labial processes more or less equal in size. The pulp also bears a median lobe on the internal aspect (Fig. 2). In Goodey and Cameron's figure the subdivision of the apical lobes is not shown. No difference in the lip pulp was detected between the parasites from the two host sources except that those removed from *Martes* spp. usually showed the basal part of the pulp over-lapping the apical part to a greater extent (Fig. 3).

(b) Two pairs of papillae occurred on the dorsal surface of the dorsal lip and one pair on the ventro-lateral surface of the subventral lips. Each pair consists of two unequal cuticular expansions, the smaller lying adjacent and internal to the larger. The smaller is concave while the larger is convex (Fig. 4). In addition the subventral lips each bear two single simple papillae on the lateral aspects (Figs. 1 & 2). The internal lip papillae are represented by six minute vesicles situated in the hilus formed by the subdivisions of the labial processes (Fig. 1). Each appears to be connected to the surface of the lip. No difference with regard to the lip papillae was detected between the worms from *Martes* and *Mephitis*. Goodey and Cameron regarded the lip papillae of *A. columnaris* as single, but their illustration shows that the structures were similar to what the writer has regarded as paired papillae. They did not mention or illustrate the lateral pair on the subventral lips.

(c) The shape and width of the denticles in the dentigerous ridges were distinctive features between the ascaris from *Mephitis* and *Martes* spp. When the internal surface of the lip was examined in glycerin, the denticles appeared to be more sharply pointed in the skunk parasite because the base of the denticle was shorter than the length, the denticles appearing as a row of tall triangles (Fig. 9). In the fisher and marten parasite the base of the denticle was usually about equal to the length, giving the appearance of a row of equilateral triangles (Figs. 10 and 11). When the lips were viewed en face especially in creosote the appearance of the denticles was altered, their points becoming less conspicuous. Nevertheless the width of the denticles at the base served to distinguish the two parasites (Figs. 12 and 13).

(d) The females from both sources bear two phasmids, one on each side of the tail (Fig. 5). They may correspond to the two slight lateral thickenings mentioned by Goodey and Cameron.

(e) The position of the vulva in relation to the total body length differed as follows: In 12 specimens from the fisher the distance between the vulva and the anterior end of the body varied from 29.6-40.7% of the total body length, the average ratio being 32.8%. In two specimens from the marten these ratios were 31.8 and 35.7%. In 17 specimens from the skunk the ratio varied between 18.8 and 27.8%. The average was 24.5%. Goodey and Cameron reported that the vulva of *A. columnaris* is situated "about the junction of the anterior and second quarter of the body." The origin of the



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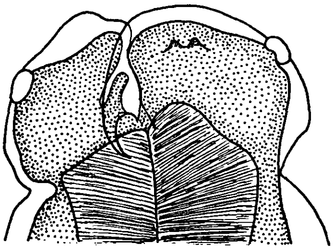

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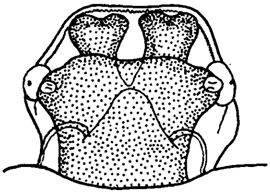

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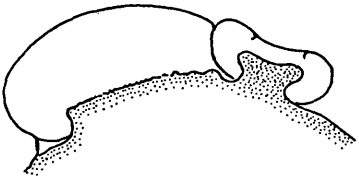

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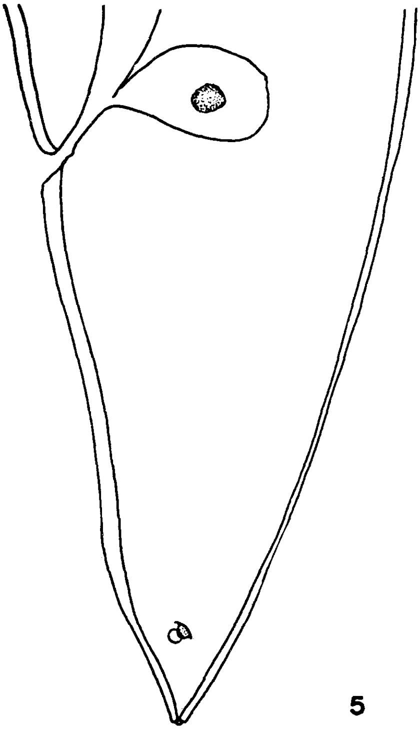

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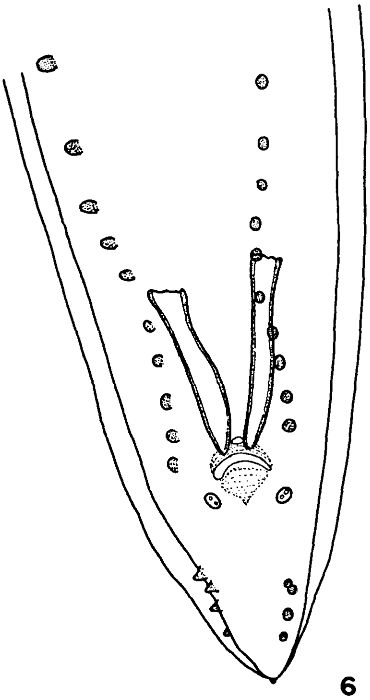

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1. En face view of lips.
2. Lateral view of lips.
3. Dorsal view of dorsal lip.
4. Double papilla on dorsal lip.
5. Female tail.
6. Male tail.

uterine branches from the vagina varies considerably in different individuals; there may be an undivided portion of uterus, the two uterine branches may arise directly from the vagina, or one branch of the uterus may arise at right angles to the vagina which continues smoothly into the other branch.

(f) The posterior end of the males from both sources fitted the description of Goodey and Cameron except that the median preanal papilla was considerably less conspicuous than they figured it and was situated in a slightly different position (Figs. 6 and 7). According to Goodey and Cameron the length of the spicules of *A. columnaris* is about 0.4 mm. In 20 specimens examined by the writer from the skunk, the spicules were found to vary from 0.46 mm. to 0.61 mm. In the measured series shown in Table 2, it is evident that relative to the total length of the worm, the spicules of the fisher parasite are shorter than those of the skunk parasite.

(g) The total length attained by the parasites from the fisher, marten and skunk are shown in Table 1. It is evident that the greatest length is reached in the fisher. Table 2 shows comparative measurements whereby the skunk and fisher parasites may be compared. These measurements were made after fixation in a mixture containing 4% formalin, 5% glycerin, 1% glacial acetic acid. Specimens were cleared in beechwood creosote.

TABLE 1.—*Length Attained by Ascaris Parasites (Fresh Specimens) From Three Different Hosts*

Host	No. specimens examined	*Length (mms)* Range	Average
Fisher (*A. devosi*)			
Females	33	105-285	185
Males	10	57-123	94
Marten (*A. devosi*)			
Females	8	105-200	133
Males	3	65-95	80
Skunk (*A. columnaris*)			
Females	34	90-180	120
Males	19	55-75	64

It was evident that the parasites from the fisher and marten were identical and that they differed from the skunk parasite in the following particulars: (1) the denticles of the dentigerous ridges were wider in relation to their length; (2) the position of the vulva was further caudad; (3) they had relatively shorter spicules; (4) they attained a greater maximum length. In view of these differences in the adult parasite and of the differences observed in the migratory behavior and development of the larvae (Sprent, in press) it has been decided to consider the ascaris parasite of the fisher and marten as a new species distinct from *A. columnaris*. It has been named *Ascaris devosi sp. nov.* in recognition of the co-operation of Mr. Antoon de Vos, Fish and Wildlife Division, Ontario Department of Lands and Forests.

Ascaris devosi sp. nov.

DIAGNOSIS: Ascaridae Blanchard 1896, Ascaridinae Lane 1923. *Ascaris* Linnaeus 1758 (see Yorke and Maplestone, 1926. p. 255). Length of body shown in Table 1, other measurements in Table 2. Dorsal lip bears two pairs of papillae, the inner member of each pair is smaller. Subventral lips each

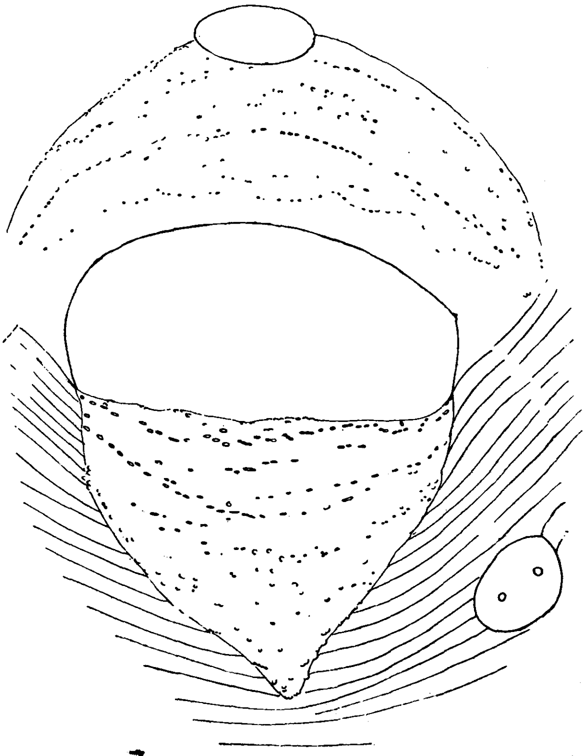
TABLE 2.—*Comparative Measurements of Two Species of Ascaris (mm.)**

	A. devosi (Fisher)		*A. columnaris* (skunk)	
	Males (8)	Females (7)	Males (8)	Females (8)
Length	80-120	115-182	60-70	150-175
Lips—Ventral—length	0.208-0.239	0.239-0.285	0.200-0.231	0.216-0.269
Ventral—width (both lips)	0.385-0.500	0.462-0.577	0.370-0.439	0.416-0.462
Dorsal—length	0.180-0.231	0.223-0.331	0.185-0.216	0.216-0.231
Dorsal—width	0.238-0.338	0.308-0.377	0.246-0.308	0.308-0.362
Denticles (Width of base)—range	0.0025-0.005	0.003-0.0085	0.002-0.0035	0.002-0.004
—average	0.0042	0.0059	0.0029	0.0032
Anterior end to cervical papillae	1.08-1.31	1.55-1.77	0.885-1.08	1.04-1.27
Anterior end to excretory pore	0.847-1.00	0.962-1.193	0.731-0.924	0.816-1.07
Oesophagus—width (anterior end)	0.231-0.270	0.290-0.45	0.231-0.293	0.300-0.370
—width (posterior end)	0.420-0.554	0.56-0.63	0.385-0.539	0.524-0.616
—length	4.16-4.50	4.00-4.83	3.10-3.87	4.34-4.95
Cloaca to hind end	0.346-0.450		0.346-0.385	
Spicules—left length	0.408-0.500		0.462-0.562	
left width	0.05-0.07		0.05-0.06	
Spicules—right length	0.393-0.540		0.431-0.554	
right width	0.04-0.07		0.05-0.07	
Anterior end to vulva		41.00-54.00		34.00-43.00
Vagina		2.00-2.90		1.69-2.70
Fused part of uterus		1.40-2.50		1.19-2.02
Anus to tip of tail		0.50-1.08		0.693-0.893
Phasmids to tip of tail		0.17-0.22		0.169-0.231

*Refers only to specimens in measured series bear two lateral single papillae, also a latero-ventral pair which resembles those on the dorsal lip, the smaller papilla of the pair being nearer the mid-ventral line. Lip pulp divided into apical and basal parts. Apical part consists of two bilobed labial processes divided by a deep cleft. Denticles of dentigerous ridges with the base about equal to the length. Six internal lip papillae.

Male: The cuticle for a distance of about 0.04 mm. in front and for about 0.07 mm. behind the cloacal opening is roughened by minute cuticular bosses. These are not continued into the cloaca. In the midline at the anterior margin of the precloacal rough area is an unpaired papilla. Spicules are subequal. There are 30-40 pairs of precloacal and five pairs of postcloacal papillae. The anterior pair of the latter lies close to the cloacal opening and is double. The remaining four pairs are subventrally placed on the tail. Their position is irregular, but the first two of the four pairs are usually closely associated. The tail is terminated by a minute spike.

Female: The vulva is situated in a shallow constriction near the junction of the anterior and middle thirds of the body. Vagina with muscular wall leads into the uterus which after a short distance divides into two branches. Tail bears two lateral phasmids. Rectal glands conspicuous.



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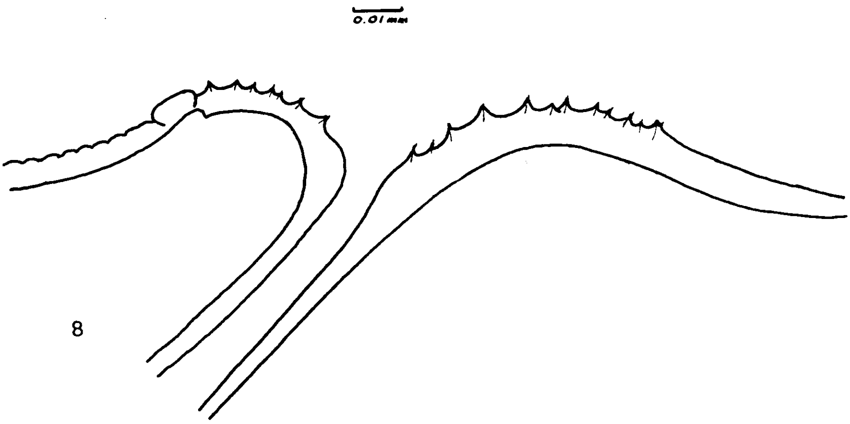
7. Pericloacal area of male. Ventral view.



8. Pericloacal area of male. Lateral view.

Type host: *Martes p. pennanti* Erxleben
Location: Small intestine
Type locality: Chapleau Game Preserve, Ontario, Canada
Type specimen: Ontario Research Foundation, Toronto, Canada

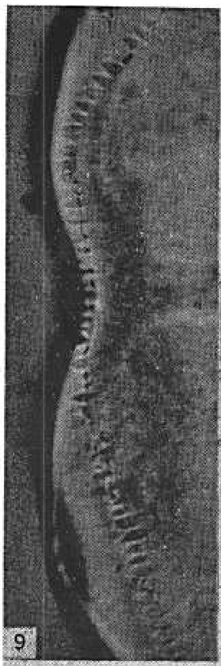
Other hosts: Wilkie (1930) compared some ascaris parasites from three Siberian mustelidae, namely: *Mustela nivalis, Mustela erminea* and *Mustela (Putorius) eversmanni,* with *A. columnaris* from the skunk. He found that in the arrangement of caudal papillae, length of spicules, precloacal cuticular structure, relative length of oesophagus and width of head there was no distinction. He did not mention the position of the vulva or the dentigerous ridges. It is therefore possible that the ascaris parasites of Siberian weasels and pole-cats may prove, after all, to differ from *A. columnaris* and may belong to the species here described. *A. devosi* was found in the eastern American marten (*Martes a. americanus*) as well as in the fisher. The latter was designated as the type host because the worms attained a greater size, the number of worms per animal was greater, and the incidence of infection was higher. Marshall (1942) recovered ascaris parasites from the intestine of the western American marten (*Martes caurina*). Although they were listed as *A. columnaris,* it is possible that they belonged to the new species.

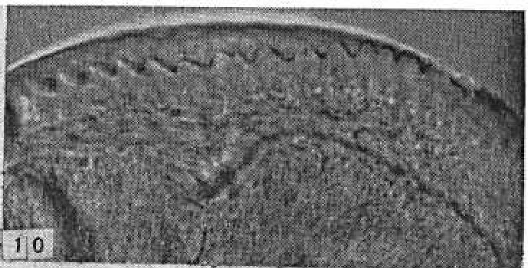
Experimental hosts: The striped skunk and the domestic ferret have been successfully infected with this parasite by feeding mice which had previously ingested embryonated eggs of *A. devosi* from the fisher. This work is to be reported in a separate publication. Specimens collected from these experimental hosts were identical in all respects to the parasites from the natural hosts (fig. 11).

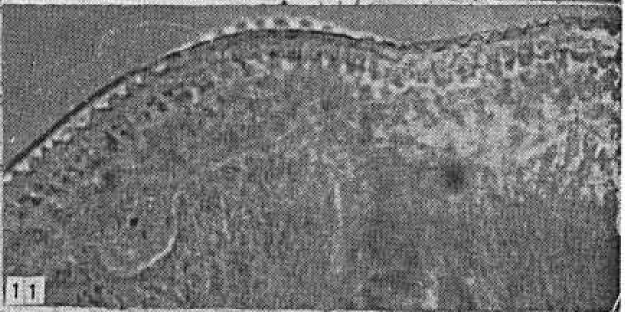
Affinities: Seven other parasites from terrestrial carnivora remain in the genus *Ascaris.* They are as follows:

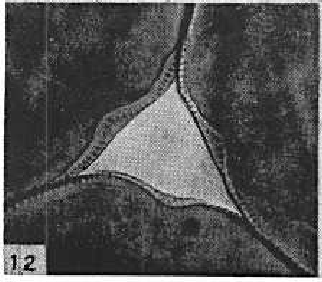
> *A. alienata* Rud. 1819 from the coati *Nasua rufa* and N. *socialis; A. columnaris* Leidy 1856 (see above); *A. gulonis* Rud. 1810 from the wolverine (*Gulo articus*); *A. globulus* v. Linst 1899 from *Felis moormensis; A. schroederi* McIntosh 1939 from the giant panda (*Ailuropoda melanoleuca*); *A. suricattae* Ortlepp 1940 from the Suricat (*Suricata suricatta hamilton*); *A. tigridis* Gmelin 1790 from the tiger (*Felis tigris*).

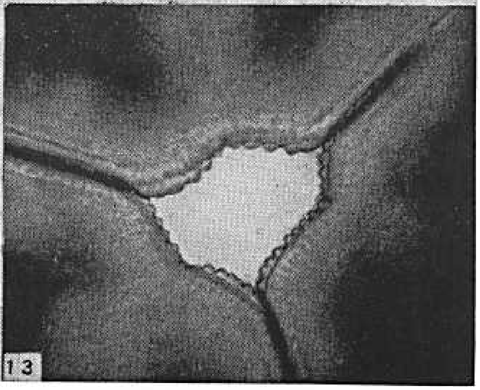
A. alienata has not been described since Rudolphi's original description, from which it is evident that it is a much smaller species. *A columnaris* is probably the nearest relative of the new species. It seems likely from McClure's (1932) description that this species from the raccoon has the vulva situated further caudad than it is in the skunk parasite. This evidence together with Tiner's (1951) observation that the migratory behavior of the larvae of the raccoon parasite differs from that of the larvae of the skunk parasite makes it seem likely that the raccoon ascaris may have to be considered as a different species from *A. columnaris,* in which case it may be











9. Ascaris columnaris (skunk)—internal aspect of dentigerous ridge.
10. Ascaris devosi (Fisher)—internal aspect of dentigerous ridge.
11. Ascaris devosi (skunk, experimental infection)—internal aspect of dentigerous ridge.
12. Ascaris columnaris (skunk)—en face aspect of dentigerous ridge.
13. Ascaris devosi (Fisher)—en face aspect of dentigerous ridge.

more nearly related to *A. devosi* than is *A. columnaris. A. gulonis* is to be redescribed by Dr. J. D. Tiner, its affinity with the new species will be doubtless discussed by him. *A. schroederi* is evidently closely related but differs from the new species in that the pericloacal cuticular bosses are more conspicuous, in that the oesophagus, the tail of the female and the spicules are relatively longer, and in that there are about twice as many precloacal papillae. *A. suricattae* appears to be quite different in having no pericloacal rough areas, in having single papillae on the lips, much longer spicules, and a probular male tail. In listing *A. tigridis* Gmelin quoted from Redi who collected this parasite from the intestine of a tiger, he neither described it nor gave any illustration. It is probably safe to consider it as a synonym of *Toxascaris leonina* or *Toxocara mystax. A globulus* has been included by Stiles and Baker (1935) under the genus *Toxocara.* The original description of this species showed that it possessed cervical alae and a probular tail in the male (von Linstow 1899).

SUMMARY

Two ascaris parasites of Ontario Mustelidae were compared. One was a parasite of the striped skunk, *Mephitis m. mephitis,* the other was a parasite of the marten, *Martes a. americanus* and of the fisher,*Martes p. pennanti.* The former was designated *Ascaris columnaris* Leidy 1856. The latter was found to differ from the skunk parasite in that the position of the vulva was further caudad, the spicules were relatively shorter, and the denticles of the dentigerous ridges had a wider base in relation to their length. It has been described as a new species and named *Ascaris devosi.* Experimental infection with mature specimens of *A. devosi* has been obtained in the skunk and the ferret by feeding experimentally infected mice.

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Thysanosoma Actinioides With Five Suckers

REX W. ALLEN and PATRICIA M. KYLES
U. S. Bureau of Animal Industry

While examining and measuring several immature specimens of *T. actinioides* from a domestic sheep which had been exposed to infection experimentally, the authors noted the occurrence of five suckers in one specimen. Each of six other specimens from the same sheep had the usual four suckers.

The anomalous tapeworm (fig. 1) was 7.5 mm. in length, and at its widest part the strobila measured 0.88 mm. There were 39 segments present, but the terminal segment and possibly a few others were missing. The fringes, which characterize the species, were beginning to form on the posterior segments. The scolex was 0.56 mm. wide. As may be seen in figure 2, all the suckers were approximately the same size. The fifth one, which seemed to be located laterally, appeared structurally normal. No other abnormality was observed in the specimen in question.

That the anomaly described here is not of frequent occurrence in *T. actinioides* is indicated by the fact that the writers of this article have examined 102 specimens, all immature, from 10 sheep from the same locality, with sufficient magnification to detect any anomalies. Only the one described in this paper was found.

Although this appears to be the first report of abnormal development of *T. actinioides*, similar anomalies have been reported many times for other species of cestodes. Clapham (1939) compiled a bibliography on the subject, and additional and more recent references have been reviewed by Kuntz (1948).

The type of abnormality described here is unusual in two respects. First, reports of numerical variation in the number of suckers refer comparatively rarely to odd numbers, but frequently to even numbers. Second, supernumerary suckers are usually accompanied by other abnormalities. Railliet (1899) pointed out, in reviewing earlier reports, that in most cases in which there were numerical variations in suckers, the number present was six. However, he observed numbers ranging from three to ten in *Coenurus serialis*.

Jones (1946) found a specimen of *Rhabdometra similis* with only three suckers.

Numerically, that type of abnormal development which gives rise to the polyradiate cestodes seems to outrank all others. In these forms the number of suckers is usually six, eight, or ten. The strobilae are flanged, with one flange for each pair of suckers. Thus there are tri-radiate, quadri-radiate, and penta-radiate forms.

The specimen described herein showed no evidence of a flange or any other abnormality, with the exception of a fifth sucker.

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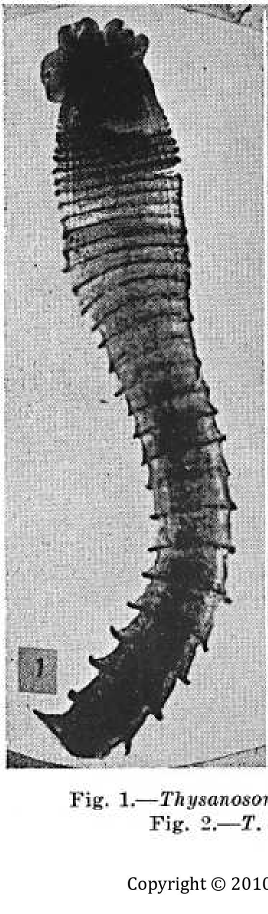

Fig. 1.—*Thysanosoma actinoides*, entire specimen with five suckers.
Fig. 2.—*T. actinoides*, scolex showing five suckers.

Parasites in a Bighorn Sheep in New Mexico

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On February 7, 1951, the writers had the opportunity to examine a bighorn sheep (*Ovis canadensis texiana*) from the San Andres Refuge of the U. S. Fish and Wildlife Service. This refuge is located about 25 miles northeast of Las Cruces, New Mexico, at an average altitude of about 6,000 feet. The animal in question, a male about 7 years of age and weighing 129 pounds, had been dead about one hour when examined. However, numerous external and internal parasites were found. The examination revealed no gross pathology of consequence. Since there are no previous reports in the literature which deal with the parasites of bighorn sheep in New Mexico, the writers considered the findings of sufficient importance to record. All identifications here reported, with the exception of the larval tapeworm, *Cysticercus tenuicollis,* were verified by Dr. G. Dikmans, Mr. A. McIntosh, and Mr. A. Goldberg, U. S. Bureau of Animal Industry, for whose assistance the authors are grateful.

Externally, there was heavy infestation with the winter tick, *Dermacentor albipictus.* A few larvae of the spinose ear tick, *Otobius megnini,* also were present. Internally, there were 4 *Cystericercus tenuicollis,* the larval stage of *Taenia hydatigena,* in the peritoneal cavity. The adult tapeworm occurs in carnivores. The nematodes, all of which were recovered from the intestines, consisted of about 50 *Nematodirus spathiger,* 5 *Trichuris* sp., and approximately 3,000 *Skrjabinema* sp.

All of the aforementioned parasites, or at least members of the same genus, have previously been reported from this host animal. However, reports of *O. megnini* are rare. Kemper (1947, U. S. D. A. Farmers' Bull. No. 980) lists the mountain sheep as a host, and through personal correspondence with this author, it was ascertained that he observed this parasite-host relationship near Roswell, New Mexico, in 1927. Interestingly, the host animal was encountered in a band of domestic sheep. A second report is that of Cooley and Kohls (1944, Amer. Midl. Nat. Monograph No. 1, The University Press, Notre Dame, Indiana) who recorded the parasite from *O. canadensis* in Montana.

Apparently, there is only one previous report of the occurrence of a member of the genus *Skrjabinema* in *Ovis canadensis.* Olson and White (1949, Colorado-Wyoming Acad. Sci. J. 4: 64-65) found *S. ovis* in the Colorado bighorn sheep. As was pointed out above, nematodes of this genus were more numerous than any of the other internal parasites found in the examination described herein.

A Revision of the Genera of the Subfamily Tetraonchinae*

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During a recent study of the monogenetic trematodes of the fishes of Westhampton Lake (a 12-acre pond on the campus of the University of Richmond) the necessity for a revision of the genera of the subfamily Tetraonchinae (Trematoda: Monogenea) became apparent. This paper is a result of intensive study of the literature on this group and the morphology of several hundred specimens of two species belonging to the genus herein considered. The taxonomic revisions follow:

GENUS *Haplocleidus* Mueller, 1937

Synonym: Urocleidus Mueller, 1934 in part, that part emended by Mizelle and Hughes (1938) to include the Muellerian genus *Haplocleidus.*

Diagnosis: Tetraonchinae, with body form elongate and flattened dorsoventrally. Haptor armed and somewhat set off from main part of body by a slightly constricted peduncle. Four eye spots present consisting of aggregations of melanistic granules. Eye spots are in pairs, one pair behind the other with the posterior slightly larger. Intestine bifurcate; its rami without diverticuli and confluent posteriorly. Gonads near middle of body. Cirrus a "chitinized" tube, usually undulate or spiraled. Accessory piece forked at distal end and often completely encircles distal end of cirrus, never basally articulated with cirrus. Vagina always present (the discovery of the vagina of *H. dispar* (Muller, 1936) Muller, 1937 during the course of this work makes this statement possible), opening on right body margin. Haptor armed with the usual four anchors and 14 haptoral hooks, two of which (pair No. 5) are situated between shafts of ventral anchors. Dorsal anchors consistently much larger than the ventral, by an average of 0.03-0.04 mm. in length, and possess a characteristic shape, with superficial root elongate and deep root virtually absent. Dorsal and ventral anchor bases not similar in shape, particularly the roots. Members of both anchor pairs connected by transverse bars which are not articulated with each other. The members of this genus are parasitic on the gills of fresh-water fishes.

Type species: Haplocleidus dispar (Mueller, 1936) Mueller, 1937.

The history of this genus is as follows: Mueller (1937) erected it to include those tetraonchids with "anchors strikingly unequal, ventral anchors only half as large as the dorsal, but similar in shape". Mizelle and Hughes (1938) then reduced it to synonymy with *Urocleidus* Mueller, 1934. This reduction was made on the basis of several studies which the authors decided were conclusive, but which are shown below not to have been; therefore, it is herein re-erected and emended, see above, to strengthen its position.

The studies on which Mizelle and Hughes (1938) based their action are outlined as follows and the reasons why they are considered inconclusive are also given. The work of Seamster (1938) on *Cleidodiscus pricei* Mueller, 1936 was cited. This work showed anchor differences which were thought to be striking enough to lend validity to the reduction of *Haplocleidus*. A re-

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*Contribution from the Biological Laboratories of the University of Richmond, Virginia.

view of this paper shows that some difference exists, but not the necessary half-size. (Also, *C. pricei* is definitely a species of *Cleidodiscus* and cannot be construed to be a *Haplocleidus* form, although it may be an intermediate type.) The greatest difference found by Seamster (1938) was, dorsal anchor —0.054 mm. and ventral anchor—0.046 mm. which is a variation of only 0.008 mm. It can be seen, therefore, that Seamster (1938) does not support the reduction of *Haplocleidus*. Mizelle and Hughes (1938) also state, "Moreover if this feature" (the difference in length between the dorsal and ventral anchors) "is of generic importance, *Cleidodiscus brachus*, in which (Muller, 1938, Pl. 2, Figs. 1 and 2) the ventral anchors are much larger than the dorsals, should be placed in a new genus." An inspection of the measurements mentioned and the accompanying figures reveals that this difference is not great ("Greatest length of anchor—0.46 mm.", a discrepancy of 0.004 mm.). In this case not only are the ventral anchors the larger, but the difference is thought to be too slight to be of importance.

The above studies were the reasons for reduction of *Haplocleidus* to synonymy, but later Mizelle and Cronin (1943) further corroborated this action with the following measurements for *C. pricei* from Tennessee: "Ventral anchor length 0.044 mm. (0.034—0.054 mm.), width 0.011 mm. (0.008—0.016 mm.). Dorsal anchor length 0.048 mm (0.035—0.074 mm.) width 0.012 mm. (0.008—0.017 mm.)." The figures in that work (Figs. 66, 68, 69 and 71, particularly the last) show some similarity in shape between the dorsal anchor of *C. pricei* and the *Haplocleidus* type dorsal anchor; however, it can be seen that the sizes quoted are not significant because the average sizes do not, even closely, approximate those that are diagnostic of *Haplocleidus*. The shape, also, is insignificant because it is so variable among the specimens of this one species in the collection. Then, too, the above mentioned possibility that *C. pricei* is an intermediate form must be reckoned with.

Other reasons for re-erecting this genus are as follows: This investigation dealt with 586 specimens of two different species of *Haplocleidus*, including the type species, and the size and shape differences of the anchors and other structures of the body have been found to be characteristic and constant throughout the entire collection. A review of all literature dealing with the other species of this genus shows the same constancy of size and shape difference. These differences coupled with other structural variations are thought to be significant due to the fact that they occur so strikingly and consistently in the "hard" taxonomically important structures of at least four sharply defined species. Mueller (1937) regarded them as of generic importance, and in addition the grounds for reduction of this genus by Mizelle and Hughes (1938) have been shown herein to be insufficient to support such action; therefore, the genus *Haplocleidus* Mueller, 1937 has been re-erected above.

Because re-erection of this genus alters the constitution of the subfamily Tetraonchinae, the following key has been prepared. It is the first complete key to the genera of North American Tetraonchinae.

A REVISED KEY TO THE GENERA OF NORTH AMERICAN TETRAONCHINAE

1. With rhabdocoele gut, 1 haptcral bar .... *Tetraonchus* Diesing, 1858
   With the gut bifurcate, 2 or 3 bars 2
2. Gut bifurcate, bars 3 .... *Murraytrema* Price, 1937
   Gut bifurcate, bars 2 3

3. Anchor shafts nearly vestigial and anchor bases almost covering the face of the haptor .... *Anchoradiscus* Mizelle, 1941
   Anchor shafts not vestigial, anchor bases do not obscure the haptor face 4
4. Haptoral bars articulate .... *Actinocleidus* Mueller, 1937
   Haptoral bars non-articulate 5
5. Vagina, if present, on left body margin, cirrus and accessory piece basally aritculate (possibly not in *C. alatus*) ... *Cleidodiscus* Mueller, 1934
   Vagina, if present, on the right body margin, cirrus and accessory piece never basally articulate 6
6. Dorsal anchors consistently much larger (around one-half) than ventral anchors and of characteristic shape .... *Haplocleidus* Mueller, 1937
   Dorsal and ventral anchors regularly equal or subequal, shapes usually similar .... *Urocleidus* Mueller, 1934

Due to the preceding taxonomic revisions it is advisable to present a revised list of the species of *Haplocleidus* Mueller, 1937 in which the North American and European species are handled separately for convenience.

NORTH AMERICAN SPECIES

Haplocleidus affinis Mueller, 1937 (synonym *Urocleidus affinis* (Mueller, 1937) Mizelle and Hughes, 1938).

Haplocleidus dispar (Mueller, 1936) Mueller, 1937 (synonyms *Onchocleidus dispar* Mueller, 1936 and *Urocleidus dispar* (Mueller, 1936) Mizelle and Hughes, 1938).

Haplocleidus furcatus Mueller, 1937 (synonym *Urocleidus furcatus* (Mueller, 1937) Mizelle and Hughes, 1938).

Haplocleidus parvicirrus (Mizelle and Jaskoski, 1942) *nobis* (synonym *Urocleidus parvicirrus* Mizelle and Jaskoski, 1942).

EUROPEAN SPECIES

During the study of the papers of Price (1937) and Mizelle and Hughes (1938) it was noticed that several European forms had been incorporated into *Haplocleidus* by the former and subsequently placed in *Urocleidus* by the latter. The original papers were consulted and a strong possibility that they do not belong in *Haplocleidus* Mueller, 1937 arose. The reasons are as follows: *Urocleidus monticelli* (Cognetti de Martiis, 1925) Mizelle and Hughes, 1938 (synonyms *Ancyrocephalus monticelli* Cognetti de Martiis, 1924 and *Haplocleidus monticelli* (Cognetti de Martiis, 1924) Price, 1937) may not belong in *Haplocleidus* because it is the ventral anchors of this species that are largest. However, if the original investigator did mistake dorsal and ventral as Price (1937) suggests this worm may be a species of this genus, but until that possibility can definitely be established it seems wiser to leave it in *Urocleidus* to avoid confusion. *Urocleidus siluri* (Zandt, 1924) Mizelle and Hughes, 1938 (synonyms *Ancyrocephalus siluri* Zandt, 1924 and *Haplocleidus siluri* (Zandt, 1924) Price, 1937) has a cirrus which does not resemble that of the definitely *Haplocleidus* species, and several extra pieces situated at the bases of the dorsal anchors. Zandt (1924) also shows a separation of the middle of the ventral bars which is not found in the members of this genus. For future clarity's sake this worm is also left where it is. *Urocleidus vistulensis* (Siwack, 1932) Mizelle and Hughes, 1938 (synonyms *Ancyrocephalus vistulensis* Siwack, 1932 and *Haplocleidus vistulensis* (Siwack, 1932) Price,

1937) is left in *Urocleidus* for much the same reasons as *U. siluri* above. Price (1937) says, "The species described by Siwack (1932) as *Ancyrocephalus vistulensis* does not differ from *H. siluri* (Zandt), except in the number of marginal hooklets and in the character of the vagina. . . . In spite of the differences mentioned above the two species are identical in other respects, and both are from the same host and from the same region (Poland)." A cursory study of Siwack (1932) does not negate this possibility, but actual establishment of synonymy must await a more thorough study.

The action above has been taken in order to avoid further confusion of the literature since there is also the possibility that at least two if not all of these trematodes may not belong to either genus.

GENUS *Urocleidus* Mueller, 1934

The re-erection of *Haplocleidus* Mueller, 1934 and the subsequent removal of its natural species from *Urocleidus* Mueller, 1934 necessitates several slight changes in the characteristics of *Urocleidus*.

SYNONYMS: *Onchocleidus* Mueller, 1936, in part; *Tetracleidus* Mueller, 1936, in part; *Aristocleidus* Mueller, 1936, in part; and *Pterocleidus** Mueller, 1937, in part.

DISCUSSION: The diagnosis remains as set forth by Mizelle and Hughes (1938) except the dorsal and ventral anchors are equal or subequal in length and the anchor bases are usually closely similar in shape. This strengthens the genus and excludes the natural members of *Haplocleidus*.

The species of *Urocleidus* Mueller, 1934 stand as listed by Mizelle and Hughes (1938) and subsequent descriptive and taxonomic papers with the exception of the four species which have been removed and replaced in the genus *Haplocleidus* Mueller, 1937.

SUMMARY

The genera *Haplocleidus* Mueller, 1937 and *Urocleidus* Mueller, 1934 have been reviewed and emended, and a revised, complete key to the genera of North American Tetraonchinae has been presented.

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*There is some question in the minds of several students of this group concerning the propriety of the reduction of this genus to synonymy by Mizelle and Hughes (1938).

The author wishes to express thanks to Dr. John D. Mizelle of Notre Dame University for his advice and help, to Dr. J. F. Mueller of Syracuse University for his papers, to Dr. Aaron Seamster of Del Mar College for his papers, and to Dr. Emmett W. Price, Assistant Chief of the Zoological Section, U. S. Bureau of Animal Industry, for assistance, advice and aid in preparing the manuscript.

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Observations on the Genus *Meloidogyne* Goeldi 1887

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The transfer of the root-knot nematodes to the genus *Meloidogyne* Goeldi 1887 and the species concept proposed by Chitwood (1949) has stimulated new interest in this group. Christie and Albin (1944) and Christie (1946) presented data from controlled greenhouse experiments indicating that certain root-knot nematode populations are characterized by differences in their ability to reproduce on various plants. Chitwood (1949) has indicated that some of these populations as well as others can be recognized on a morphological basis. The writer has encountered a number of interesting problems relative to the identification of root-knot nematode species. These concern certain variations in the morphological characters used in identification and the host plant specificity of several populations of a species of root-knot nematode collected from cotton in California.

MORPHOLOGY OF THE LIP REGION

In 1924 Dr. N. A. Cobb placed the root-knot nematode in a new genus *Caconema*. This generic name was later synonymized with *Heterodera* Schmidt 1871 and more recently with *Meloidogyne* Goeldi 1887. However, Cobb made a number of observations concerning the morphology of the lip region of the male that have been overlooked by subsequent authors. He called attention to the amphids and gave a detailed drawing showing the head in a dorso-ventral position. In this illustration the amphid apertures are visible in profile and are properly designated. Cobb also shows a face view of the male head in which the various morphological features are illustrated and labelled. Chitwood (1949) in his generic diagnosis of the genus *Meloidogyne* describes the male head as follows, "male head bearing two lateral cheeks." No mention is made of the amphids. The term "cheek" was used by Cobb (1924) to describe the lateral lips. He indicated that the amphids were protected by the "cheeks." Careful observation of the head structures of *Meloidogyne* males, females and larvae indicates that certain of the morphological features have not been accurately described in the literature.

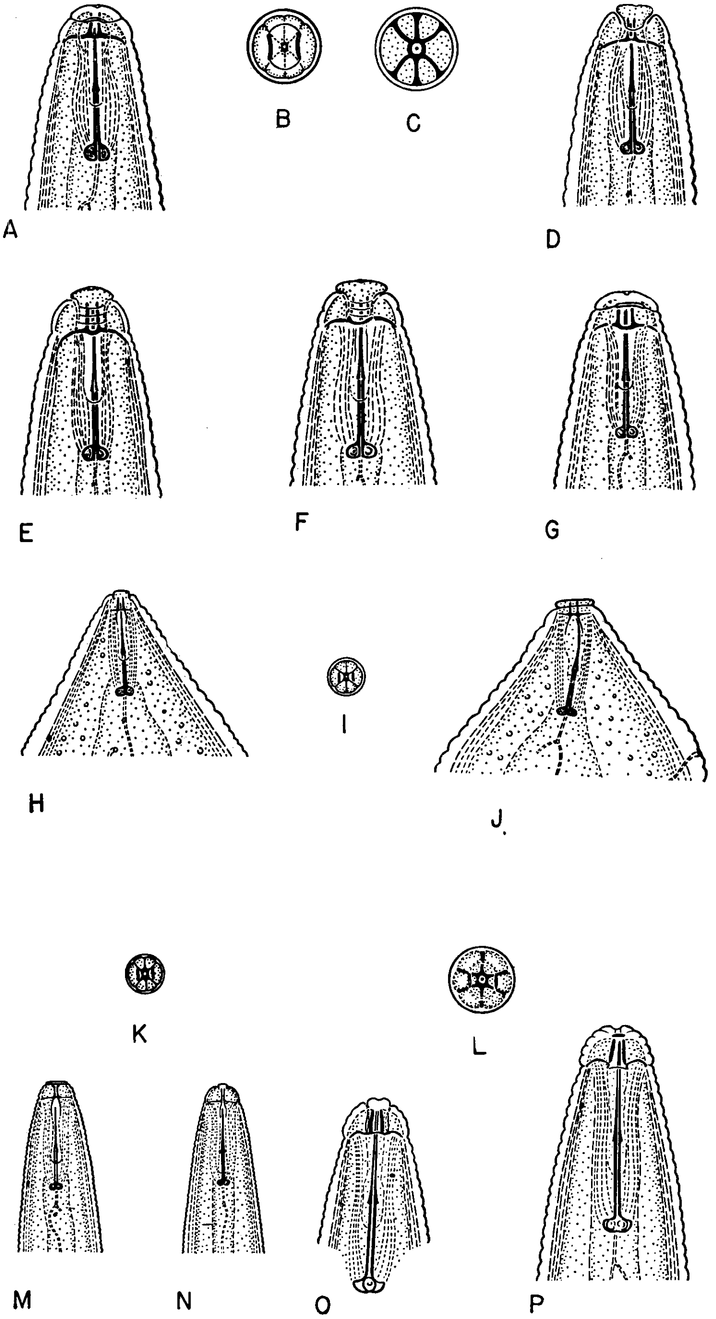

FIG. 1. A-D, *Meloidogyne hapla*, A—Male head lateral view, B—face view male, C—basal framework of male lip region, D—Male head dorso-ventral view. E-G, *M. incognita* var. *acrita* male heads, E and F—dorso-ventral, G—lateral. H-J, *M. incognita* var. *acrita* female heads, H—dorso-ventral, I—face view, J—lateral. K, M and N, *M. incognita* var. *acrita* second stage larvae, K—face view, M—lateral, N—dorso-ventral. L, O, P—*Heterodera schachtii* males, L—face view, O—dorso-ventral, P—lateral. All × 1000.

Male head.—A large number of males of *Meloidogyne hapla* Chitwood 1949 collected from strawberry in California were examined. The head in lateral view (Fig. 1-A) shows the amphid apertures to be slightly crescent shaped and located at the juncture of the labial cap and lateral lips. The amphid pouch is circular in outline and may under certain circumstances give the viewer the impression that it is a circular "cheek." However, careful examination indicates that the "cheeks" referred to and illustrated by Chitwood (1949) as circular structures on the lip region are actually the amphid pouches. The amphid apertures are readily visible in properly prepared face views (Fig. 1-B). In face views, the shape of the labial cap and the six-radial, arched, circumoral lip sclerotization are conspicuous features of the head. The lateral lip sectors are considerably larger than those of the sub ventral and subdorsal lips. The characteristic structure of the basal sclerotized framework of the male head is illustrated in Fig. 1-C. In dorso-ventral view the amphid apertures of the male appear as openings between the labial cap and the lateral lips (Fig. 1-D). The amphids of male *Meloidogyne* are more conspicuous and larger than those found in most other genera of the order Tylenchida.

Heads of male *M. incognita* (Kofoid and White), appearing to be the variety *acrita* Chitwood 1949, originating as progeny from a single egg mass collected from cotton, illustrate the variation in lip annulation that can occur among males of a root-knot nematode species (Fig. 1-E, F, G). The head shown in Fig. 1-E has no annulation on the lateral lips and three annules on the submedians. In another head the lateral lips have two annules (Fig. 1-F). A third head has two annules on the submedian lips (Fig. 1-G). Since these males are progeny of the same female they are unquestionably of the same species. The variation in the number of annules on the lips of these males indicates that this morphological character is of doubtful value as an aid in specific determinations.

Female head.—Dorso-ventral and lateral views of female heads of *M. incognita* var. *acrita* from cotton also show the cap-like lip structure to be present. The amphid aperatures are frequently visible in dorso-ventral views (Fig. 1-H and J). The typical six-radial symmetry can be see in face views (Fig. 1-I). The amphid aperatures are rather large and are located at the juncture of the lateral lips and the lip cap. It should be pointed out here that the extreme forward position of the excretory pore in female *Meloidogyne* (Fig. 1-J) is unusual in the Tylenchida and this fact should be incorporated into the generic diagnosis. In males and second stage larvae the excretory pore opens posterior to the nerve ring.

Larval head.—In face views of second stage larvae the six-radial circumoral sclerotization dividing the head into six sectors can be seen (Fig. 1, K, M and N). Chitwood (1949) states, "hatched larvae with rather plain head, (i.e., with no distinct striations or with 2-3 faint striations and no hexagonal markings)." The statement is not completely accurate on the basis of observations made by the writer. The larvae also possess the labial cap typical of males and females. The amphid apertures are visible as elongate slits at the juncture of the labial cap and the lateral lips.

Examination of the head structures of *Meloidogyne* males, females and larvae indicates that the generic diagnosis presented by Chitwood (1949) is inadequate in some respects. It is therefore proposed to emend the diagnosis to the extent necessary to properly characterize the genus.

GENUS *Meloidogyne* Goeldi 1887
TYPE SPECIES—*Meloidogyne exigua* Goeldi 1887
SYNONYM—*Caconema* Cobb 1924

Diagnosis emended.—*Heteroderinae* with marked sexual dimorphism. Adult females pear-shaped to spheroid with elongate neck. Body not transformed into cyst-like structure. Six lips marked by six-radial circumoral sclerotization. Lateral lips markedly larger than submedians. Cap-like structure present on lips. Amphid apertures slit-like. Spear slender with weakly developed basal knobs. Excretory pore located anterior to median bulb, usually 12 to 25 annules posterior of lip region. Vulva terminal or subterminal. Anus opening on border of slight depression occupied by vulva. Cuticle of female with simple cross annulation, forming a variable more or less circular pattern in perineal region. Eggs not retained in body but deposited in a gelatinous matrix. Females usually endoparasitic, causing formation of galls or knots on roots of most hosts. Obligate plant parasites.

Males elongate cylindrical. Lip region with or without distinct annulation, bearing a cap-like structure. Amphid apertures slit-like, conspicuous, leading to broad pouches in lateral lips. Six-radial circumoral cephalic framework present. Lateral lips much larger than submedians. Spear strongly developed with well-developed basal knobs. Bursa absent. Spicules and gubernaculum present. One or two testes, outstretched anteriorly, sometimes reflexed at distal end.

Second stage infective larvae with well-defined lip region, plain or with one to three annulations. Amphid apertures slit-like. Lip region bearing a cap-like structure. Six lips marked by distinct six-radial cephalic framework. Lateral lips markedly larger than submedians. Spear slender with well-defined basal knobs.

Heterodera.—Heads of *H. schachtii* Schmidt 1871 males are shown in Fig. 1-O and P. The morphology of the lip region of this species is similar in many respects to that of *Meloidogyne* males. The amphid apertures are slit-like, but somewhat smaller than those of root-knot nematode males. The lateral lips are equal in size, or smaller, than the submedians. There is little or no evidence of the presence of a lip cap although occasional specimens have been seen with what appears to be faint outline of a lip cap. It has also been observed that the lip annulations in sugar-beet nematode males are probably not continuous and specimens frequently appear to have four annulations on one side of the head and two or three on the other. It is the writer's belief that the transverse annulations are interrupted by very obscure longitudinal striae. Evidence of this has been seen in face view but the longitudinal striae are extremely obscure and observed only with difficulty. The six-radial, sclerotized, basal framework of the male head is shown in Fig. 1-L.

In face view the lip region of *H. schachtii* females has no obvious six-radial symmetry. The sclerotized supporting framework of the head is completely absent and there is no evidence of the presence of a lip cap. These observations on *H. schachtii* are presented for the purpose of pointing out differences between *Heterodera* and *Meloidogyne* other than the obvious differences in gross morphology of the females.

ROOT-KNOT NEMATODE POPULATIONS

The identification of *Meloidogyne* species is at present based upon the pattern of the cuticular annulation in the female perineal region, distance of the

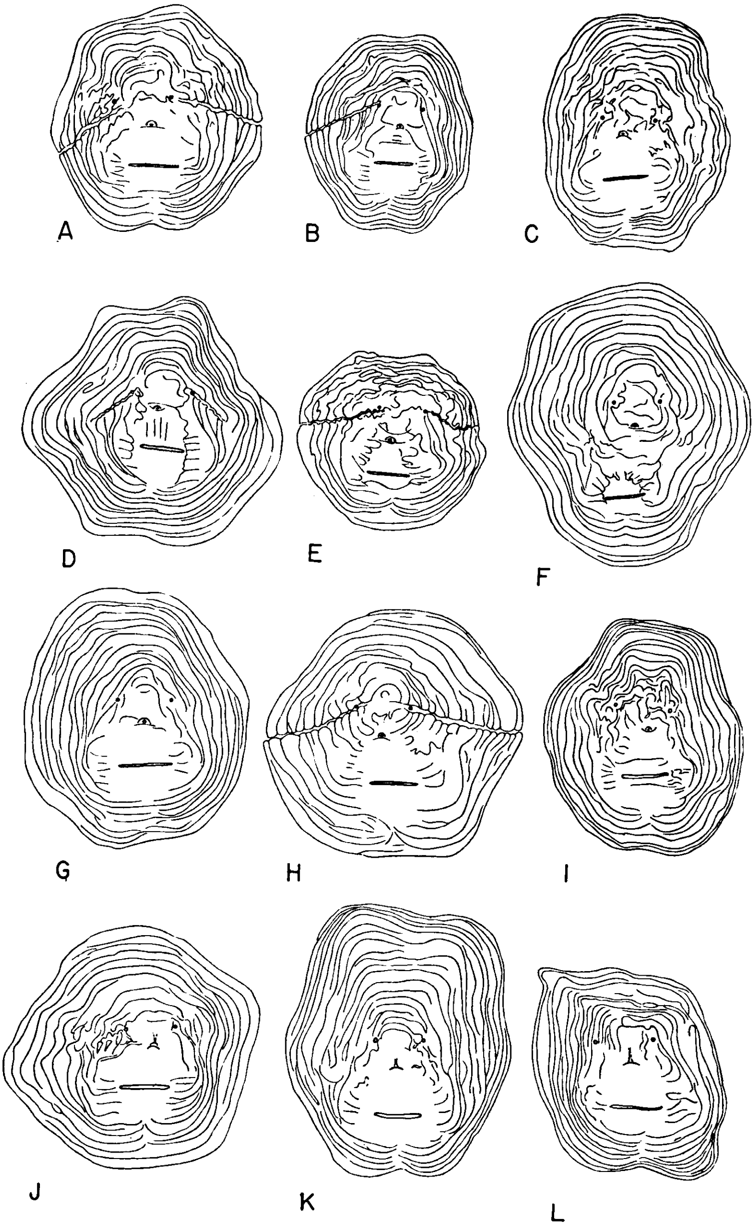

FIG. 2. A-L, perineal patterns of *Meloidogyne incognita* var. acrita females originating from a single egg mass population. A-G reared on cotton. H-J reared on alfalfa. K-L reared on sugar beet. All × 330.

dorsal gland orifice from the base of the spear, length of spear, character of spear knobs, length of spicules and other more or less obscure characters. Satisfactory identifications are made only with difficulty due to the extreme individual variation that may be present in certain populations, even those originating from the progeny of a single female. Therefore, it would seem worthwhile to point out some of these variations having in mind the possible significance of these variations with respect to the present species concept in the genus.

In 1948 a root-knot nematode population was started in the greenhouse by transferring a single egg mass from cotton to tomato. After several months of reproduction on tomatoes portions of the population were transferred to cotton, alfalfa, sugar beets and Atlas barley by planting seed in lots of the infested soil. This population has been maintained on these hosts to the present time. Consequent upon Chitwood's (1949) publication revising the genus *Meloidogyne* a large series of female perineal sections were obtaind from the nematodes infesting each of the four host plants. Some of the variations in perineal pattern that have been found to occur in this single egg mass population are illustrated (Fig. 2). The majority of the patterns observed appear to be the type illustrated by Chitwood (1949) for *M. incognita* var. *acrita*. However, if each section is examined individually, and identified by Chitwood's key to the *Meloidogyne* species, certain difficulties are encountered due to individual pattern variation within the population. Certain patterns are characterized by having distinct lateral ridges in the immediate perineal area (Fig. 2-A, E and H). These particular patterns closely resemble the perineal patterns illustrated for *M. javanica* (Treub 1885) by Chitwood (1949). Because these variants can occur in sibling populations it appears that specific identification of root-knot species should involve examination of a fairly large series of perineal sections when field collected populations are involved. It may be extremely difficult to determine if one is dealing with individual variation within a species or if two or more species are actually present. Host plant studies might aid in the separation of mixed species when they are encountered, but here again it is advisable to proceed with caution.

In greenhouse studies with six populations of root-knot nematode collected from cotton plants in six fields in the vicinity of Bakersfield, California, several points worth consideration have been noted. Infested Acala cotton roots were collected from each of six fields, carefully washed under a strong force of tap water to remove soil and free larvae, and then chopped and used as inoculum in sterilized greenhouse soil. The population from each field was increased on tomatoes for several months. Egg masses were then collected from the tomato plants in each series. Second stage larvae hatching from these egg masses were used to inoculate a series of plants to determine if any differences in host plant reaction existed between the six cotton populations. Three seedling plants of each kind tested were each inoculated with approximately 100 larvae. Forty-eight hours after inoculation the plants were washed free of soil and transferred to sterilized soil in six-inch pots for a period of six weeks. The plant roots were then stained and examined for the presence of root-knot nematodes. Counts were made of all nematode stages present, but for purposes of comparison only the number of adult females is shown (table 1).

The inoculation data recorded (table 1) show that differences in host plant reaction existed among the six cotton populations. It is interesting to observe

Table 1.—*Total number of adult female root-knot nematodes observed in 3 replicates of 12 kinds of plants, each inoculated with 100 larvae of cotton populations from six fields in the vicinity of Bakersfield, California.*

Plant inoculated	Number of adults—cotton field					
	1	2	3	4	5	6
Acala cotton	57	42	56	116	6	56
Alfalfa	7	0	33	20	1	0
Tomato	113	96	192	74	84	240
Pepper	71	37	193	257	66	172
Black-eye bean #5	3	27	3	37	0	23
Baart wheat	2	1	7	8	0	10
Atlas barley	3	4	3	9	0	16
Club barley	1	0	2	9	0	1
Ventura oat	1	0	0	5	0	0
Palestine oat	0	0	0	0	0	0
Lycopersicum peruvianum	0	0	6	5	0	0
African marigold	0	0	0	0	0	0

that populations from fields 3 and 4 reproduced rather readily on alfalfa in contrast to those from 2 and 6 which did not reproduce on alfalfa. The populations from fields 3 and 4 were the only ones of the six that were observed to reach maturity on *Lycopersicum peruvianum.* The population from field 5 differed particularly in its inability to reach maturity on grains. This characteristic was also present in other populations but not to the extent observed with the population from field 5 where no adults were observed on grains.

The results of this experiment were obtained prior to the publication of Chitwood's revision of the *Meloidogyne* and most of the infested plant roots had been discarded. However, some material was available from tests made with populations from fields 1, 2, 4, and 5. Examination of female perineal sections from this material indicates that only a single species of root-knot nematode was present in these four populations. The species has been identified as *M. incognita* var. *acrita* which is so far the only root-knot nematode species that has been observed on cotton in California. In view of the data obtained in experiments with these cotton populations it appears that the host range of *M. incognita* var. *acrita* may be subject to considerable within species variation. The possibility that host plant reaction may be influenced by previous cropping practices should be given consideration. In the author's opinion it would be impossible, for example, to determine the host range of *M. incognita* by the observation of a population collected in one area or from a few fields. In our present state of knowledge it is not possible to predict the host plant range of a root-knot nematode species by the simple expediency of giving the population a specific name. What is true with a species from California is not necessarily true with the same species from some other part of the United States. It is probably unreasonable to expect that a species of root-knot nematode would exhibit the same host plant reaction throughout the range of its distribution when one considers environmental changes to which populations are constantly exposed. Changes in host plant or cropping practices could conceivably exert a selective influence upon any given root-knot nematode population. Such selective action may then be the explanation for the existence in nature of populations of the same species which are characterized by differences in host plant reaction.

SUMMARY

The diagnosis of the genus *Meloidogyne* is emended to place emphasis upon certain structures in the male, female and larval heads. The form and position of the amphids and the six-radial symmetry of the lips and sclerotized structures are shown in illustrations. The male *Meloidogyne* head is compared with the head of the male of *Heterodera schachtii*. The basic differences in these heads are the well-developed lip cap, larger amphids and larger lateral lips in the male of *Meloidogyne*. The adult females of *Meloidogyne* differ from those of *Heterodera* in the anterior position of the excretory pore, absence of a cyst stage, and the presence of six radial sclerotized ribs dividing the lip region into six sectors.

The variation in the perineal pattern of females originating from a single egg mass is shown and it is suggested that consideration be given to the possibility that variation within a species is greater than previously indicated. Data is presented showing that differences in host plant reaction can occur in populations of the same species collected from cotton in different fields.

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***Psilenchus duplexus* n. sp. and *Psilenchus terextremus* n. sp., two additions to the Nematode Genus *Psilenchus* de Man 1921**

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These species of *Psilenchus* were fairly common in soil samples collected in a meadow in Strawberry Canyon, Berkeley, California. Thorne (1949) characterizes the genus *Psilenchus* as follows: "Members of this genus are immediately distinguished by the elongated, slit-like amphid apertures; slender, frequently clavate tails of both sexes; prominent deirids and phasmids; elongated spears; absence of a sclerotized labial framework and by the fact that the distance from the anterior end to the center of the median bulb is equal to or greater than the distance from the center of the bulb to the base of the esophagus." The last character needs to be modified in order to include *Psilenchus duplexus* n. sp. This species agrees with Thorne's diagnosis of the genus except for the esophagus which has the distance from the anterior end to the median bulb much shorter than the distance from the median bulb to the base of the esophagus.

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There are now eight species in the genus *Psilenchus* and the authors believe there are many more yet to be described. In view of this and the wide divergency already found among species of this genus, the authors prefer to let the genus stand as Thorne (1949) described it. A key to the species is also included in this paper.

Psilenchus duplexus, new species

DESCRIPTION: Adult female (Fig. 1, A-D): Length 0.90-1.10 mm.; a = 30-35; b = 6.2-7.0; c = 6.2-12; Vulva = 64-71%; Spear length = 11-13 μ. Body assuming an open "C" form when killed by gentle heat. Cuticle marked by transverse striae averaging about 1 micron in width near the middle of the body. Subcuticle marked by duplex striations (two for each one of the external cuticle) except the tail and near the head. Lateral fields about 1/3 to 1/2 the body width and bearing four incisures. Deirids easily observed, located opposite the excretory pore just posterior to the nerve ring. Amphid apertures obscure, about 1/4 as wide as the head and located near the base of the lip region. Lip region without transverse striae. Spear slender with small but distinct basal knobs and a fairly wide lumen. Median bulb of the esophagus ovate with a well-developed valve, posterior bulb elongate-pyriform with the usual three gland nuclei. Distance from the anterior end of the esophagus to the median bulb much less than the distance from the valve to the base of the esophagus. Cardia conoid, submerged in the anterior end of the intestine. Lumen of the intestine narrow with distinct walls. Intestinal granules of variable size. Tail elongate with an acute terminus. Annules on the tail gradually decreasing in width toward the terminus, finally becoming indistinct. Phasmids located about two anal body diameters posterior to the anus. One ovary present, the vulva a transverse slit. Post uterine branch about 4/5 as long as body width at vulva. Egg about three times as long as body width.

No males found.

DIAGNOSIS: *Psilenchus* with the above general description and measurements. Immediately distinguished from the other single ovary forms by the greater body length, small amphid aperture, straight, knobbed spear, the head to median valve distance being less than the distance between the valve and the base of the esophagus, and the lateral field which is comparatively wide and bearing four incisures.

HABITAT: Type specimens found in Strawberry Canyon, Berkeley, California, at the top of a grassy bank. (Collection C-6) 8 females.

HOLOTYPE: female, Catalogue No. 11, Univ. of Calif. collection.

PARATYPES: 7 females, Univ. of Calif. collection.

Psilenchus terextremus, new species.

DESCRIPTION: Adult female (Fig. 1, E-F): Length 0.84-0.97 mm.; a = 37-44; b = 6.5-7.5; c = 5.1-5.4; V = 45-46%; Spear length = 11 μ. Adult male: Length = 0.73-0.90 mm.; a = 36-38; b = 5.8-6.8; c = 5.1-7.0. Body assuming an almost straight position when killed by gradual heat. Cuticle marked by transverse striae averaging about one micron apart near the middle of the body. Subcuticle marked in the same manner as the cuticle. Lateral field about 1/4 to 1/3 the body width and consisting of a plain refractive band. Deirids conspicuous, located opposite the excretory pore just posterior to the nerve ring. Amphid apertures elongate, slit-like, about 1/2 as wide as the head and located below the contour of the lips. Head without transverse striae. Spear slender with a wide lumen and without basal knobs. Dorsal

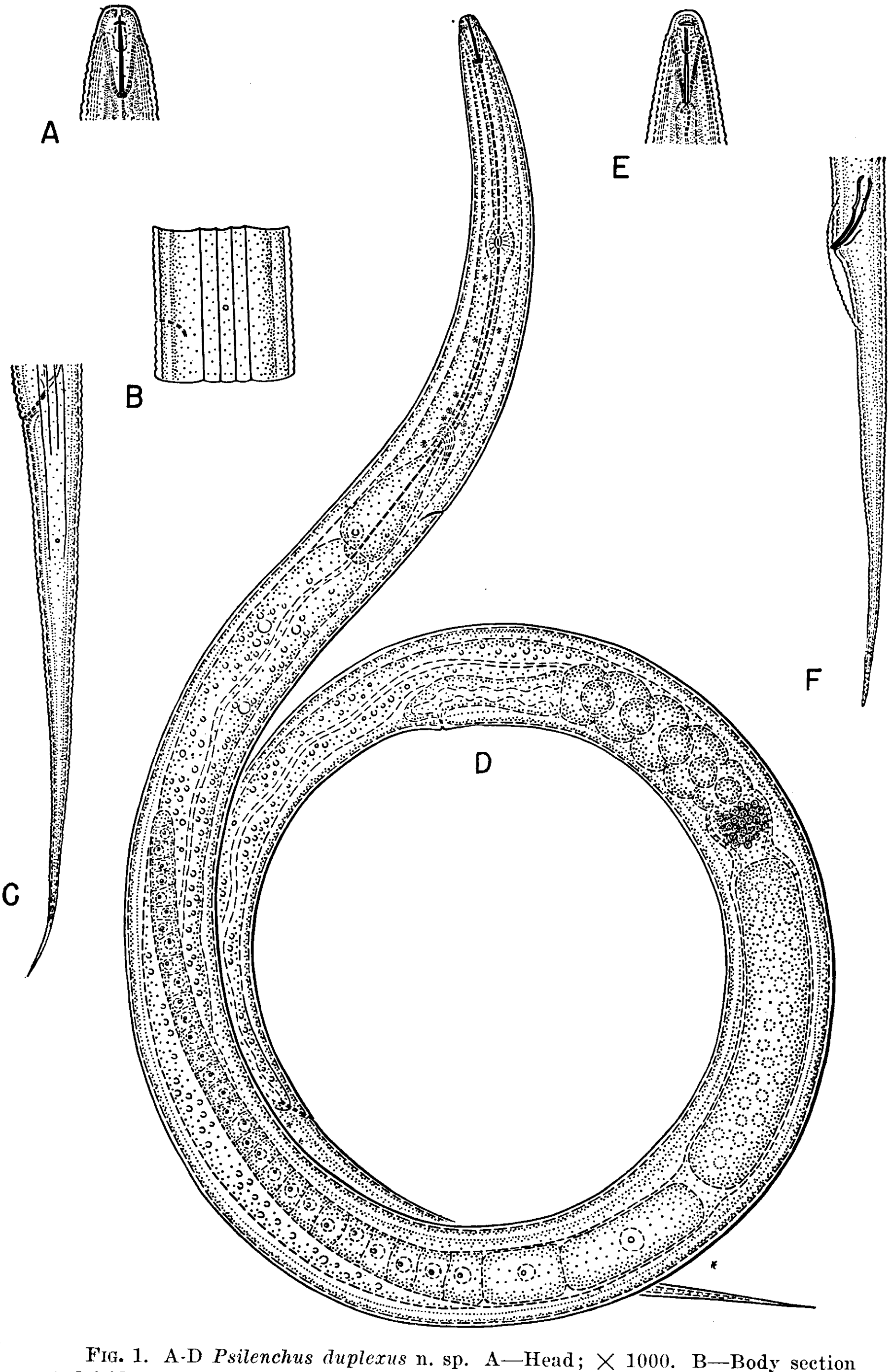

FIG. 1. A-D *Psilenchus duplexus* n. sp. A—Head; × 1000. B—Body section at deirid; × 1000. C—Female tail; × 500. D—Female; × 500. E-F—*Psilenchus terextremus* n. sp. E—Head; × 1000. F—Male tail; × 500.

esophageal gland opens into the lumen of the esophagus at the base of the spear. Median bulb of the esophagus ovate with a well-developed valve, posterior bulb pyriform containing the three gland nuclei. Distance from anterior end of the esophagus to the valve of the median bulb slightly greater than the distance from the valve to the base of the esophagus. Cardia conoid submerged in the anterior end of the intestine. Lumen of the intestine narrow with well-defined walls. Intestinal granules of variable size. Tail elongate, tapering to a finely rounded terminus. Phasmid difficult to observe. Vulva a transverse slit, ovaries paired, outstretched. Spicula curved and cephalated, resting on a narrow slightly curved gubernaculum. Bursa rising just posterior to the proximal ends of the spicula and extending back about 1½ anal body diameters past the elevated anus. Terminus of the male finely rounded.

Diagnosis: *Psilenchus* with the above general description and measurements. Distinguished from the other didelphic forms by the finely rounded terminus of the tail and the unstriated lip region.

Habitat: Type specimens found in Strawberry Canyon, Berkeley, California, at the top of a grassy bank. (Collections C-6 and C-8) 3 females, 2 males.

Holotype—female, Catalogue No. 12, Univ. of Calif. collection.

Allotype—male, Catalogue No. 13, Univ. of Calif. collection.

Paratypes—2 females, 1 male, Univ. of Calif. collection.

Key to the species of *Psilenchus* de Man 1921

1.	Two ovaries present	2
	One ovary present	5
2.	Spear with small basal knobs, tail clavate	*clavicaudatus* (Micol. 1922) Thorne (1949)
	Spear without basal knobs	3
3.	Tail terminus filiform, lip region not striated	*terextremus* n. sp.
	Tail terminus bulbous or clavate	4
4.	Lip region striated	*striatus* Thorne 1949
	Lip region plain, not striated	*hilarulus* de Man 1921
5.	Spear plain without basal knobs	*magnidens* Thorne 1949
	Spear with distinct basal knobs	6
6.	Spear curved, knobs asymmetrical	*aberrans* Thorne 1949
	Spear straight, knobs symmetrical	7
7.	Length around 1 mm., lateral field ⅓ to ½ body width, bearing 4 incisures	*duplexus* n. sp.
	Length around 0.6 mm., lateral field ¼ body width appearing as a plain refractive band	*gracilis* Thorne 1949

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A Note on the Genus *Metathelazia* Skinker, 1931 (Nematoda: Metastrongylidae)

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Dr. C. B. Gerichter of Jerusalem, Israel, has recently (1948) published descriptions of three new species, which he places in the genus *Metathelazia* Skinker, 1931. When described thus in juxtaposition, it is particularly striking that these species present a remarkable variability of cephalic characters —of the stoma and labia—and should, in my estimation, be placed in three separate genera. I have drawn Dr. Gerichter's attention to this point (*in litteris*), but he clings to the opinion expressed in his paper that the genus *Metathelazia* as conceived by him is so uniform in other characters that cephalic structure should not be used to allocate component species to more than one genus. However, I believe that important deviations in cephalic structure are always of generic consequence in nematode systematics. Particularly evident does this point become upon inspection of the monograph on certain groups of the order Spirurida by Chitwood and Wehr (1934), who based a consistent phylogeny of the spirurides on cephalic structure. It is further emphasized by Chitwood (1950) in his chapter on "Cephalic structures and stoma" in the new edition of *An Introduction to Nematology;* therein the phylogenetic importance of the labia and stoma is constantly emphasized.

In 1943 I reviewed briefly the genus *Metathelazia* and referred a number of species to it, sinking into synonymy two nominal genera and one nominal subgenus. For some time thereafter it was my intention to monograph the *"Filaroides* group," of the family Metastrongylidae, to which I assigned *Metathelazia,* but a shift in research interests renders the realization of this rather unlikely. Nevertheless, I should like to reassess the species of *Metathelazia* to see how they would fit into an expanded scheme, including three separate genera for Gerichter's species; the suppressed names must thus be considered as candidates for the restricted genera. Gerichter has provided a key to the species of *Metathelazia* and on studying this and the original descriptions of the eight species accepted by him (which I also consider as valid), I am satisfied that three genera will suffice to separate the species in appropriate groupings. All of these have been named—*Metathelazia* Skinker, 1931 (type *M. californica* Skinker, 1931), *Vogeloides* (Orlov, Davtian, and Liubimov *in* Skriabin, 1933), gen. nov.—originally a subgenus (type *V. ascaroides* (von Linstow, 1879), comb. nov.), and *Pneumospirura* Wu and Hu, 1938 (type *P. hainanensis* Wu and Hu, 1938). Diagnoses, synonymies, and lists of species are to be found at the end of this paper. Two other species must also be recognized, and a third at least tentative. The two definite species are *Metathelazia servalis* Chabaud and Biocca, 1950, and a species being described by Biocca and Chabaud in a paper now in press, of which Dr. Chabaud has very kindly sent me the manuscript (see Biocca and Chabaud, in press). Both of these belong in *Vogeloides.* The third species, *Hartertia zorillae* Seurat, 1919, which Chabaud (1949) has transferred to *Metathelazia,* is known only from larval material and also belongs in *Vogeloides.* Possibly *M. servalis* is the same species.

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My selection of *Vogeloides* as a generic name is based upon highly technical nomenclatorial reasons, which are explained in an appendix to the present paper.

Dr. Gerichter informs me that the helminthological collections of the Hebrew University, in which his specimens of *Matathelazia* (*sensu lato*) are stored, are in that part of Jerusalem now occupied by the troops of Hashemite Jordan. For the time being ,at least, they are inaccessible to him and are thus unavailable for restudy. He has described as a consistent feature of his three species a papillary pattern not encountered elsewhere in the family Metastrongylidae, namely, one in which the inner circle of six cephalic papillae are lacking and the outer circle consists of four submedian pairs only, the ventrolaterals being lacking; other metastrongylids (*cf.* Chitwood, 1950, fig. 56) possess the inner circle and, with the exception of *Dictyocaulus* Railliet and Henry, 1907, ventrolaterals. However, Chabaud and Biocca (1950) have described an internal papillary circle in the species called by them *Metathelazia servalis* and in Gerichter's *M. oesophagea,* and it appears that the six tooth-like structures described by Gerichter as occurring on the inner side of the labial in two of his species represent modified papillae of that circle. But in certain other species it does appear that there is no vestige of the inner six papillae.

The fact of stomatal and labial variation in *Metathelazia* and allied genera, suggests the possibility of a rather isolated position phylogentically in the family Metastrongylidae as treated by me (Dougherty, 1949, 1951a). Gerichter has suggested that "*Metathelazia* will [probably] have to be separated from Metastrongyloidea" (= Metastrongylidae). It is possible that such a separation will ultimately prove necessary. However, there are a number of morphological features that suggest metastrongylid affinities—*e.g.,* the partly doubled gubernaculum, the expanded body cuticle (which Gerichter has named the *teguminal sheath*), and the larval tail. There is also similarity in lung parasitism. The life cycle of *Metathelazia* and its allies is as yet unknown, however. Moreover, the fact that most of the species of the *Metathelazia*-group occur in carnivores, along with the possession of the partly doubled gubernaculum, is strongly suggestive of close affinities to the Filaroidinae.

It is nevertheless true that *Metathelazia* and its relatives demonstrate certain features that are difficult to reconcile with their placement in the family Metastrongylidae (suborder Strongylina, order Rhabditida)—in fact that suggest affinities to the order Spirurida (specifically to the superfamily Spiruroidea of the suborder Spirurina). This fact understandably led Skinker (1931) to assign *Metathelazia* to the spiruroid family Thelaziidae. Wu and Hu (1938) later proposed for *Pneumospirura* a new family Pneumospiruridae in the Spiruroidea; they were apparently ignorant of *Metathelazia.* Skriabin (1933, 1941), however, indicated metastrongylid affinities for the *Metathelazia*-group, although he did not know of the existence of the nominal genus *Metathelazia.*

Chabaud and Biocca (1950) have taken the view that the metastrongylid features of *Metathelazia* are in truth the result of evolutionary convergence and that actually the *Metathelazia*-group separated itself from the early spiruroids. If one examines the array of morphological features, one is indeed impressed by their conflicting nature and by the reasonableness of Chabaud and Biocca's suggestion. In certain respects *Metathelazia* shows striking resemblance to spiruroids of the primitive family Thelaziidae. In cephalic structure the reduction or loss of the inner cephalic papillae and the loss of the ventrolateral papillae and the loss of the ventrolateral papillae of the external circle agree with the spiruroids. (However, *Dictyocaulus*, an aberrant metastrongylid also lacks ventrolaterals, and the well-developed labia of certain species of *Metathelazia sensu lato* is a strongyline rather than a spiruroid character.) In the male there is a complete absence of the typical strongyline bursa and the papillae are not recognizably grouped into a pattern suggestive of bursal rays; instead they tend to be scattered along either side of the anus in a spiruride patern. In the female the terminal section of the reproductive tract as figured by Chabaud and Biocca (1950) resembles that of certain spiruroids as figured by B. G. and M. B. Chitwood (1950, fig. 118). A point of particular importance is that the paired subventral glands of the excretory system, characteristic of the strongylines, are apparently lacking, their place seemingly being taken b ya single, small, subspherical gland; this differs, however, from the structure characteristic of the order Spirurida, so far as known, in which an inverted U-shaped excretory system occurs without a distinct, ventrally located gland or glands (M. B. Chitwood and B. G. Chitwood, 1950, p. 131).

The conflict between metastrongylid and spiruroid affinities of *Metathelazia* and degenerate members of the Filaroidinae has long plagued a systematic consideration of this assemblage of forms. In a sense it reached its ultimate expression in the hypothesis of Skriabin (1941), who sought in effect to resolve the problem by suggesting that the whole order Spirurida arose from the Filaroidinae. I have dismissed this notion in previous publications (Dougherty, 1944, 1949, 1951b) as illogical, but it must be admitted that on purely morphological grounds there has been a remarkable convergence between the suborder Strongylina and the order Spirurida. It is my feeling that nothing known at present about the structure of *Metathelazia* and allied genera specifically excludes them from the Strongylina, and at the same time nothing makes impossible their inclusion in the superfamily Spiruroidea near the primitive Thelaziidae. It is evident that this stuation of uncertainty can only be an expression of our deficient knowledge of the fundamental structure of the groups and forms involved.

Nevertheless, on the same basis of logic that I reject Skriabin's hypothesis of spiruride origin from the Metastrongylidae, I tend, although less positively, to adhere to my placement of *Metathelazia* in the Strongylina. My reasoning in these two problems is the following:

As regards the Spirurida they constitute a large order of archaic and uncertain origin with representatives in all the vertebrate classes. The Strongylina on the other hand are obviously modified rhabditides that must have arisen after the tetrapods (to which they are restricted) made their appearance. It is not reasonable to assume that the former group could have arisen from the latter, especially from the Metastrongylidae, which give evidence of having arisen after the establishment of the class Mammalia (to which they are restricted), and most particularly from the aberrant and degenerate subfamily Filaroidinae.

As regards the *Metathelazia*-group these forms are restricted, so far as known, to Mammalia and show a striking parallel biologically and morphologically (as already has been pointed out) with the Metastrongylidae, especially the Filaroidinae. The Thelaziidae, which are generally considered the most primitive spiruroids, are scattered in fish, birds, and mammals. It seems unlikely that a group as restricted in host distribution as the genus *Metathelazia* and its allies should represent primitive spiruroids.

In summary I take the view that *Metathelazia* represents a degenerate group of the suborder Strongylina (order Rhabditida) that have converged remarkably with members of the superfamily Spiruroidea of the suborder Spirurina (order Spirurida). But I believe that further morphological and biological evidence is necessary to substantiate this stand, and I am prepared to be proved wrong.

The several species placed here in three genera present a combination of features at once highly varied as regards the stomatal and labial characters and very similar as regards cephalic papillary pattern. For the time being it seems preferable to leave them in the Metastrongylidae.[2] But subfamilial rank seems definitely justified. The group shows at least as great stomatal and labial variation as do the rest of the Metastrongylidae. The genus *Vogeloides* rivals *Metastrongylus* in the extent of labial development, and the stoma in *Pneumospirura* is the best developed in the family.

On the basis particularly of cephalic variability and unique patterns of cephalic and male genital papillae, I propose that *Metathelazia, Vogeloides,* and *Pneumospirura* be removed from the Filarioidinae, wherein I have previously placed the broad genus *Metathelazia* (Dougherty, 1943), and be assigned to a subfamily Vogeloidinae Dougherty, 1951. This group has been raised in a paper (Dougherty, 1951b). I have selected *Vogeloides* as type genus because it is the only name free of undesirable connotation with the order Spirurida; moreover, the six well developed species in *Vogeloides* are presumably a primitive feature. Of the ten already named vogeloidin species recognized here, eight occur in carnivores, one in primates, and one in an insectivore; Biocca and Chabaud's undescribed species also occurs in a carnivore.

The following diagnosis of the subfamily Volegoidinae is modified from that of Dougherty (1951b), in particular by correction of the earlier indication that the internal circle of cephalic papillae is uniformly lacking in the group.

VOGELOIDINAE Dougherty, 1951. Metastrongylidae: stoma small or lacking, if present sometimes well sclerotized; labial pattern variable, six well or weakly developed lips, or none; cephalic papillae consisting always of four submedian pairs of the external circle, but with the six of the internal circle either present or absent and ventrolaterals always obsent; esophagus tending to show differentiation into narrow anterior and wide posterior segments; paired subventral glands of the excretory system apparently lacking, their place being taken by a single, small subspherical gland; male: bursa lacking; rays papillary and strung along either side of the anus in nonstrongyline pattern; unpaired preanal papilla present; female: provagina lacking.

GENERA.[3]—

Vogeloides (Orlov, Davtian, and Liubimov *in* Skriabin, 1933), gen. nov. (originally a subgenus). Vogeloidinae: stoma vestigial; six well-developed labia, with the six papilla of the internal circle, or six small tooth-like structures (apparently representing the internal circle), present on inner sides.

SYNONYMY.—*Filaria* Müller, 1787 (*partim*); *Filaroides* van Beneden, 1858 (*partim*); *Oslerus* Hall, 1921 (*partim*); *Metathelazia* Skinker, 1931 (*partim*); *Osleroides* Orlov, Davtian, and Liubimov,

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[2] The family name Pneumospiruridae Wu and Hu, 1938, is available if a familial separation is to be carried out.

1933 (*non Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933).

TYPE SPECIES.—*Vogeloides ascaroides* (von Linstow, 1879), comb. nov. (subjective synonym of *Oslerus cynopitheci* Vogel, 1928, type by indication (monotypy)).

SPECIES (including one not listed here, of which the description is at present in press (Biocca and Chabaud, in press).—

Vogeloides ascaroides (von Linstow, 1879), comb. nov.

SYNONYMY.—*Filaria ascaroides* von Linstow, 1879; *Metathelazia ascaroides* (von Linstow, 1879) Dougherty, 1943; for other synonyms see Dougherty (1943).

TYPE HOST.—Mona guenon, *Cercopithecus mona* (Linné) (Primates: family Cercopithecidae).

Vogeloides massinoi (Davtian, 1933, emend. Dougherty, 1949), comb. nov.

SYNONYMY. *Osleroides massino* Davtian *in* Skriabin, 1933, nom. nud.; *Osleroides* (*Osleroides*) *massino,* of Skriabin, 1933; *Osleroides massino* Davtian, 1933; *Metathelazia massino* (Davtian, 1933) Dougherty, 1943; *Metathelazia massinoi,* of Dougherty, 1949.

TYPE HOST.—Domestic cat, *Felis catus* Linné (Carnivora: family Felidae).

Vogeloides servalis (Chabaud and Biocca, 1950), comb. nov.

SYNONYMY.—*Metathelazia servalis* Chabaud and Biocca, 1950.

TYPE HOST.—*Felis serval* Schreber (probably Ferrari's serval, *Felis serval ferrarii* de Beaux—Carnivora: family *Felidae*).

Vogeloides oesophagea (Gerichter, 1948), comb. nov.

SYNONYMY.—*Metathelazia oesophagea* Gerichter, 1948.

TYPE HOST.—Mongoose, *Herpestes ichneumon Linné* (?subsp.) (Carnivora: family Viverridae).

Vogeloides zorillae (Seurat, 1919), comb. nov.

SYNONYMY.—*Hartertia zorillae* Seurat, 1919; *Metathelazia zorillae* (Seurat, 1919) Chabaud, 1949.

TYPE HOST.—Vaillant's zoril, *Poecilictis libyca vaillanti* (Loche) (Carnivora: family Mustelidae).

Pneumospirura Wu and Hu, 1938. Vogeloidinae: stoma small but wel-sclerotized, with six small, tooth-like structures (apparently representing the internal papillae) sometimes (?always) present on inside of stomatal walls; labia small.

SYNONYMY.—*Metathelazia* Skinker, 1931 (*partim*).

TYPE SPECIES.—*Pneumosprirura hainanensis* Wu and Hu, 1938 (by indication (monotypy)).

SPECIES.—

Pneumospirura hainanensis Wu and Hu, 1938.[3]

SYNONYMY.—*Metathelazia hainanensis* (Wu and Hu, 1938) Dougherty, 1943.

TYPE HOST.—Eastern Chinese otter, *Lutra lutra chinensis* Gray (Carnivora; family Mustelidae).

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[3] In keying out this species Gerichter (1948) has overlooked that it has a stoma very similar to his *Metathelazia capsulata;* in the key in question the two species should be placed next to one another.

Pneumospirura capsulata (Gerichter, 1948), comb. nov.

SYNONYMY.—*Metathelazia capsulata* Gerichter, 1948.

TYPE HOST.—European badger, *Meles meles* Linné (?subsp.) (Carnivora: family Mustelidae).

Metathelazia Skinker, 1931. Vogeloidinae: stoma vestigial or lacking; labia lacking.

SYNONYMY.—*Oslerus* Hall, 1921 (*partim*); *Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933 (*non Osleroides* Orlov, Davtian, and Liubimov, 1933).

TYPE SPECIES.—*Metathelazia californica* Skinker, 1931.

SPECIES.—

Metathelazia californica Skinker, 1931.

SYNTYPE HOSTS.—California wild cat, *Felis rufas californicas* (Mearns); Rocky Mountain lion, *Felis concolor hippolestes* Merriam (Carnivora: family Felidae).

Metathelazia felis (Vogel, 1928) Dougherty, 1943.

SYNONYMY.—? *Filaria felis-mellivorae* (*pulmonalis*) Molin, 1858; for other synonyms see Dougherty (1943).

TYPE HOST.—Ocelot or tiger cat, *Felis pardalis* Linné (? subsp). (Carnivora: family Felidae).

Metathelazia multipapillata Gerichter, 1948.

TYPE HOST.—Palestinian hedgehog, *Erinaceus europaeus sacer* Thomas (? = *Erinaceus europaeus transcaucasicus* Satunin) (Insectivora: family Erinaceidae).

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APPENDIX

In elevating the nominal subgenus *Vogeloides* to generic rank I am rejecting the generic name *Osleroides*, which first appeared in the same paper as *Vogeloides* —that is, in a note by Skriabin (May,[1] 1933), who recognized a genus *Osleroides*, with subgenera *Osleroides* (containing two species, "*O.* (*O.*) *massino* Davtian, 1933," and "*O.* (*O.*) *felis* Vogel, 1928") and *Vogeloides* (containing the single species "*O.* (*V.*) *cynopitheci* (Vogel, 1928)"). This genus and its two subgenera were all attributed by Skriabin to Orlov, Davtian, and Liubimov; diagnoses were given by Skriabin, but no types were designated. Moreover, the species referred to by him as "*O.* (*O.*) *massino* Davtian, 1933" had not been described at the time of his paper, nor was a description, definition, or indication given by him. The first description actually appeared the month following Skriabin's paper —by Davtian (June, 1933). Finally the paper by Orlov, Davtian, and Liubimov to which Skriabin obviously had been referring did not make its appearance until August (1933).

The determination of the exact status of *Osleroides* involves some rather complicated reasoning, but it is possible, I believe, to dispose of it in a manner in harmony with the current *Règles* as exhaustively emended at Paris in 1948 (see *Bull. Zool. Nomencl.*, 1950, vol. 4).

Article 25, rule (c)3, of the *Règles Internationales de la Nomenclature Zoologique* as amended at Budapest in 1927 and modified at Paris in 1948 by the XI and XIII International Congresses of Zoology respectively (see *Bull. Zool. Nomencl.*, 1950, vol. 4, pp. 71-72, 177, for discussion of the provision in question) requires that for a new genus, published on or after January 1, 1931, to be valid it must be accompanied "with a type species designated or, as the case may be, indicated in accordance with one or another of the rules prescribed for determining the type species of a genus or subgenus solely upon the basis of the original publication (*i.e.* Rules (a) to (d) in Article 30)" (Bull. Zool. Nomencl., *op. cit.*, p. 72). Let us analyze *Osleroides* as used by Skriabin, particularly in connection with Article 25, rule (c)3.

At first glance *Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, would appear to be without nomenclatorial standing, for Skriabin designated no

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[1] Skriabin's note appeared under "séance du 14 mars 1933" in the Bull. Soc. Zool. France, vol. 58, 1933; the fascicle (no. 2) in which it was published bears the date "20 mai 1933."

type, and with three species in the genus and two species in the subgenus *Osleroides* Orlov, Davtian, and Liubimov in Skriabin, 1933, no species can be construed to have been *indicated* as type of the nominal genus *Osleroides* of Skriabin under Article 30, rules (b)-(d). (See Schenck and McMasters, 1948, for the text of these and other rules discussed herein). Davtian (1933) in describing "*Osleroides massino*" (the trivial name of which I have recently emended (Dougherty, 1949 to *massinoi*) also made no type designation for the genus; he compared his new species with "*Osleroides felis*" (= Oslerus felis Vogel, 1928). Type designation was finally done formally by Orlov, Davtian, and Liubimov (1933), who provided a diagnosis for *Osleroides* and designated "*O. massino* Dautjan 1933" as type. The nominal genus *Osleroides* under these circumstances would seem logically to acquire nomenclatorial availability from the date of Orlov, Davtian, and Liubimov's paper; in its earlier use my Skriabin it would be a *nomen nudum.*

However, a closer inspection of the nominal genus *Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, as opposed to *Osleroides* Orlov, Davtian, and Liubimov, 1933, brings to light an interesting situation. Despite the fact that Skriabin cited *two* species in the subgenus *Osleroides,* one of these—*O. massinoi*—was, as has already been indicated, a *nomen nudum* at the time. Consequently, in effect, Skriabin cited only one available species—originally described as *Oslerus felis* by Vogel (1928)—in his nominal subgenus *Osleroides,* which under Article 30, rule (d), is therefore to be construed as type thereof by indication. The type species of the typical subgenus is automatically the type of its genus in view of Article 6 which states "generic and subgeneric names are subject to the same rules and recommendation, and from a nomenclatorial standpoint they are coordinate . . ." Therefore, the nominal genus *Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, does appear to have nomenclatorial status after all. Its type, *Oslerus felis* Vogel, 1928, I consider to be congeneric with *Metathelazia californica* Skinker, 1931, type of the genus *Metathelazia* Skinker, 1931, by designation; and consequently *Osleroides* as used by Skriabin becomes a subjective synonym of *Metathelazia.*

Support for my contention that Skriabin may be regarded under Article 30, rule (c), as having indicated the type of the nominal subgenus *Osleroides* despite his having apparently cited two species thereunder comes from action taken at Paris in connection with the incorporation of the decision in *Opinion* 47 into the *Règles.* It was decided that "where a genus is established without a designated or indicated type species and only one nominal species is cited as being referable to that genus, the nominal species so cited is the type species of the genus by monotypy, irrespective of whether or not the author concerned regarded the genus as monotypical" (see, 1950, *Bull. Zool. Nomencl.* 4: 153). Inasmuch as one of the two specific names cited under the subgenus *Osleroides* was a *nomen nudum,* it follows that Skriabin cited only one "nominal species" thereunder.

On this interpretation *Osleroides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, is a different genus from *Osleroides* Orlov, Davtian, and Liubimov, 1933, since the two have different type species; and the latter falls as a homonym of the former.

The nominal subgenus *Vogeloides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, must now be considered. As used by Skriabin, it contained but *one* species, which by Article 30, rule (c), as clarified at Paris (see 1950, *Bull. Zool. Nomencl.* 4: 71-72) is to be construed as type by indication. Thus the nominal subgenus *Vogeloides* as used by Skriabin was also validly constituted and must date from his paper.

The type species of *Vogeloides* Orlov, Davtian, and Liubimov *in* Skriabin, 1933, being *Oslerus cynopitheci* Vogel, 1928 (a subjective synonym of *Filaria ascaroides* von Linstow, 1879), by indication and the type species of *Osleroides* Orlov, Davtian, and Liubimov, 1933, being *Osleroides massinoi* Davtian, 1933, emend. Dougherty, 1949, by designation, the status of the two names in relation to one another may now be considered. I regard these two type species as clearly congeneric, and therefore *Osleroides* of Orlov, Davtian, and Liubimov (1933), as opposed to *Osleroides* of Skriabin (1933), must be regarded as a subjective synonym of the earlier *Vogeloides* of Skriabin, 1933. Subgeneric division of *Vogeloides* seems to me unnecessary.

The foregoing confused situation eloquently demonstrates the desirability of making sure that names have been properly published by their rightful authors before using them in other publications!

Parasites of Swine, Horse, and Cattle from Unusual Hosts

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Although the majority of internal parasites of animals usually occur in only one host species or in a few closely related ones occasionally they are found in unusual hosts, especially when the animals are malnourished or in a weakened condition. During the past ten years the writer has observed two cases of aberrant parasitism of cattle with nematodes commonly parasitic in swine, one case of parasitism of swine with an arthropod parasite of horses, and one case of infestation of a domestic cat with an arthropod parasite of bovines. The main facts relative to the observations are as follows:

SWINE PARASITES IN BOVINES: In November 1941 a calf, and in November 1947 a cow, both belonging to the herd of the Coastal Plain Experiment Station, Tifton, Georgia, and both in a weakened condition, were slaughtered. On postmortem examination, one male swine kidneyworm, *Stephanurus dentatus,* was recovered from the body cavity of the calf. An immature female of the same species was recovered from the same location in the cow. The calf also harbored in the abomasum an immature female spirurid. *Ascarops strongylina,* normally parasitic in the stomach of swine. At intervals during their life, the bovines in question had been maintained on pastures used for swine harboring infections of the parasites named, which probably accounts for the aberrant parasitic infections observed.

So far as the writer is aware, there is but one previous undisputed record of the occurrence of *A. strongylina* in cattle. Sugimoto (1939, Catalogue of Parasites of Domestic Animals from Formosa, Tokyo) reported this parasite from a bovine host. The swine kidneyworm, on the other hand, is of fairly frequent occurrence in cattle. Reports of finding this parasite in the bovine host have been made by Hall (1921, Jour. Parasitol. 8: 95); Schwartz and Alicata (1929, ibid., 15: 286); Spindler (1930, ibid. 17: 52); Schwartz and Price (1932, Jour. Am. Vet. Med. Assoc. 81, n. s., 34: 325-347); Roberts (1934, Queensland Agric. Jour. 42: 674-689); Sugimoto (1939, Catalogue of Parasites of Domestic Animals from Formosa, Tokyo); Swanson (1941, Proc. Helm. Soc. Wash. 8:62-63);and Seddon (1947, Serv. Public (Div. Vet. Hyg.), Aust. Dept. Health 41: 10, 13).

HORSE BOTS IN A HOG. In August 1950, Dr. M. B. Johnson, Inspector in Charge at a meat slaughtering establishment in Tifton, Georgia, called the writer's attention to a pig stomach containing a number of insect larvae. The latter identified them as larvae of the horse bot fly, *Gastrophilus intestinalis.* When first examined, the larvae were alive and firmly attached to the mucosa. Numerous lesions in the stomach wall indicated that the larvae frequently had changed their position while living in this unusual host. So far as the writer is aware, the only previous report in the literature of the recovery of this parasite from the stomach of pigs is that of Raffensperger (1925, Vet. Med. 20: 225).

HEEL FLY LARVA IN A CAT. In November 1950, Dr. R. C. Rackley, a veterinarian of Dothan, Alabama, sumbitted for identification to the Animal Disease Department of the Georgia Coastal Plain Experiment Station an insect larva which had been removed from beneath the skin under the left eye of an alley cat. This larva was found to be the third instar of the common heel fly, *Hypoderma lineatum*, which normally is parasitic on cattle. The occurrence of heel fly larvae in the cat was reported by Lager (1946, Middlesex Vet. 5: 62), the larva having been removed from beneath the skin of the back.

Eimeria spinosa Recovered from Swine Raised in Maryland and Georgia

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Four species of coccidia of the genus *Eimeria* occur in swine in the United States. One, *Eimeria spinosa*, is apparently rare, having been reported only from Michigan and California by Henry (1931, Univ. Calif. Pub. in Zool. 36 (6): 121) and from the Territory of Hawaii by Alicata (1946, Jour. Parasitol. 32: 514). In 1933, one of us (LAS) observed transient infections of *E. spinosa* in four pigs of the Zoological Division herd at Beltsville, Maryland. In the fall of 1942 the other author recovered this parasite from a pig in the herd of the Georgia Coastal Plain Experiment Station, Tifton, Georgia. These findings, so far as the writers are aware, are the first of this species in the regions named, although other species occur there with more or less regularity. The main facts relative to the findings are as follows:

Infections of *E. spinosa* encountered in the pigs in Maryland, as determined by the dilution count technique, were heavy, the maximum numbers of oocysts passed by the infected pigs ranging from about 1 to 4 million per gram of feces. The duration of the infections was short, however, occysts being passed only during a period of about one to two weeks.

In Georgia, *E. spinosa* was observed in only one pig during routine examinations, by the Stoll dilution egg counting technique, of the feces of a group of 45 pasture-raised pigs. All the animals began passing oocysts at about the same time. In the pig infected with *E. spinosa*, the number of oocysts increased rapidly for about a week to a maximum of 7 million per gram of feces, whereas the infections harbored by the other pigs remained relatively low. An examination of oocysts eliminated by the pig in question at about the peak of production revealed a practically pure infection of *E. spinosa*. Oocysts washed from the feces and cultured in one percent potassium dichromate solution at room temperature (68°F.) sporulated in 11 days. Following the peak of infection, the number of oocysts passed in the feces declined rapidly and, in about a week, the organisms disappeared. No diarrhea or other symptoms that could be ascribed to the infection were observed.

Reasons for the sporadic appearance of *E. spinosa* are a matter for conjecture. The species may be more widespread than is known, the infections being so light, transient, and symptomless as to escape detection. Perhaps, also, it is only through a fortuitous combination of circumstances that the organisms became so numerous as to be detected by routine fecal examination.

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