# "A TAXONOMIC STUDY OF EYE WORMS (THELAZIIDAE) FROM BRAZILIAN BIRDS."

by

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

## INTRODUCTION

This study embodies the taxonomic aspects of the Thelaziidae (Eye worms) from a collection of Brazilian birds. These small thread-like worms approximately half an inch long, inhabit various sites of the eye. Some were found in the orbit of the eye, under the nictitating membrane, in the conjunctional sac or free in the eye.

The pathogenic effect of these nematodes in game birds has not yet been studied; the number of worms vary from few to many in each eye, and apparently their presence in the host's eyes cause no inconvenience. However, it seems that considerable irritation of the occular membranes would be produced by the movements of these worms. Undoubtedly the parasites must have some injurious effect merely from their presence as foreign bodies, but not too virulent an effect to cause extinction of their hosts.

In the preparation of this work, one notices the extent to which the Oxyspirura have been studied, because of their economic significance to domestic poultry. On the other hand, the Thelazia parasitize wild birds mainly and have not been as well studied either biologically or economically. One species, Thelazia callipaeda, primarily a parasite of dogs has been recorded four times from man in China, and Thelazia californiensis, normally a parasite of dogs, sheep and deer has been reported from man twice.(7) These are the only two species of Thelazia known to parasitize man abnormally. No species of Oxyspirura parasitize man.

The Eye worms considered in this study fall into two

superfamilies, the Spiruroidea and the Filarioidea and will be dealt with in this order. The majority were found to belong to the family Thelaziidae and included several species of the genus Thelazia, three of which are described for the first time; in the genus Oxyspirura, six species are described, one of which is new; and one species of the genus Ceratospira will be recorded. In the superfamily Filarioidea, one species of the genus Aprocta were collected and will be described.

The Reason for the Study.

The exotic Brazilian birds were collected by Dr. Helmut Sick in Central Brazil, in the following localities:-

Acampamento Jacaré, lower course of the Rio Kuluene, upper Xingú (= "Alto Xingú").

Acampamento Diauarúm, Alto Xingú, Mato Grosso.

Acampamento Garapú, Rio 7 de Setembro, Alto Rio Kuluene, Alto Xingú, Mato Grosso.

Acampamento Chavantina, Rio das Mortes, Mato Grosso.

Acampamento Pindaiba, Rio Pindaiba, tributary of the middle Rio das Mortes, Mato Grosso.

Acampamento Teles Pires, Rio Teles Pires, Alto Tapajós, Mato Grosso.

Acampamento Jacaré - acanga, Alto Tapajós, Pará.

Aragarças, Rio Araguaia, Goiás.

They were collected for the Museum of Comparative Zoology at Harvard College, Cambridge, Massachusetts. The nematode parasites were sent to Dr. T. W. M. Cameron, Institute of Parasitology, MacDonald College for identification, and the collection was placed in the hands of this worker as a taxonomic problem in partial fulfilment for the degree of Master of Science in Parasitology.

Due to the growing importance of the economic significance of game birds, a study of this nature is both invaluable and desirable.

The Nature of the Studied Material.

The collection included both ecto- and endoparasites of the Brazilian birds. The hosts of these parasites are mainly birds of prey and insectivorous in habit. The majority of the parasites were

Eye worms of the family Thelaziidae, superfamily Spiruroidea, which is the main topic of this thesis.

Nine different species of the type genus, Thelazia were studied and three new species, Thelazia anadorhynchi, T. sicki and T. spizaëti will be described. One specimen was classified down to genus, on the basis of the posterior end of one male. However, it could not be identified to species on an incomplete specimen.

In the genus Oxyspirura, five species were identified in the collection and one new species, Oxyspirura cameroni is described; and one species of Ceratospira thriponaxis was obtained.

All the eye worms were not from the superfamily Spiruroidea, but also from the superfamily Filarioidea, family Filariidae subfamily Aproctinae, genus Aprocta, of which one species is recorded and the other specimen was classified only to genus as no specific diagnosis could be made due to its state of preservation.

## HISTORICAL REVIEW

The family Thelaziidae was erected by Railliet in March, 1916,[33] and later that year in October, Skrjabin published a paper proposing the same name.[40] Skrjabin is one of the leading workers in this group; he reviewed the Thelaziidae of birds in 1922 and possibly other groups, but his papers are written in Russian and the publications are not available at the present time. In 1819, Bosc proposed the type genus, Thelazia.[11]

During the early part of the twentieth century various species of this genus were studied by Railliet and Henry in South America. Later, in 1918 the genus was studied more thoroughly by a native son of South America, Lauro Travassos,[48] who described several new species, from the little studied South American fauna.

While in Australia, Johnston reports a new species of Filaria, Filaria dacelonis from the laughing jackass,[19] and this species is synonymous with Thelazia dacelonis, several specimens of which were found in the Brazilian collection of birds studied, and will be described later.

In 1819, Rudolphi described the genus Spiroptera stereura,[37] which was re-examined by Ransom in 1904 and named Oxyspirura stereura.[32] Six years later, Railliet and Henry reclassified the genus and species as Thelazia stereura.[36] During the 1860's, Molin also described several species of Spiroptera[29] which are now all placed in the genus Thelazia.

The genus Oxyspirura was first referred to by Cobbold in 1879, when he named it Filaria mansoni, after the discoverer Dr. Manson of Amoy.[10] Cobbold classified this genus as a Filaria, infesting the eye

of fowls. In 1888 Magalhães recorded a similar genus in the eyes of 5 fowls and a peacock, collected in Brazil.(25) Later in 1895, he stated positively that these Brazilian forms were the same as the Chinese forms previously studied.

Emmerez and Mégnin (1901) observed an eye disease in chickens on the Island of Mauritius and examined the causal agent, which they found was Filaria mansoni, now Oxyspirura mansoni.(14) Nevertheless, Mégnin gives a short zoological description with figures and proposes to name the worm Spiroptera Emerezii, believing it to be a new species, but the description leaves no doubt as to its identity with the previously described Filaria mansoni. Ransom in 1904 also reviewed the nematodes parasitic in the eye of birds in his publication on Manson's Eye worm (Oxyspirura mansoni) of chickens.(32)

The earliest worker with the South American Oxyspirura is Natterer,(30) and the main modern investigators are Lauro Travassos in Brazil, South America and Eduardo Caballero y.C. who studies Oxyspirura in Mexican birds.(3) While in India, there is Singh,(39) in Formosa, Yamaguti and Mituango, and in China, Hsü.(17)

The genus Ceratospira was first proposed by Schneider in 1866,(38) and was found to be synonymous with Ancyracanthus described in part by Diesing in 1838.(11)

The last genus studied in this thesis is Aprocta after Linstow 1883,(21) synonymous with Lissonema (Linstow, 1903.) a new species from Centropus sinensis from Siam.(24)

One can see from this historical review that the taxonomic work of the twentieth century is a continuous refinement of the methods and

concepts developed in the nineteenth century, when techniques and equipment, particularly microscopes, were not as precise as they are today. The various species to be described in this work, will be defined not only in the purely morphological species definition, but also in the biological definition, which includes ecological as well as geographical factors.

## METHODS USED AND MATERIAL STUDIED

The nematodes were received in one inch vials containing a solution of glycerine alcohol and labelled according to bird host; and contained a number which corresponded to the number on the host check list. However, the glycerine alcohol had evaporated and the worms were dry, so they had to be saturated in trisodium phosphate for a fortnight.

### Preparation of Nematodes for Study.

The specimens were placed in two inch "shell vials" which contained a solution of glycerine alcohol composed of 80 parts of 70% alcohol and 20 parts of glycerine. The vials were not sealed in order to allow the alcohol to evaporate and hasten the clearing process. Therefore, the nematodes were left in a solution of glycerine and excess water from the alcohol.

If the worms were not transparent enough for immediate microscopic examination, they were placed in a solution of lacto-phenol overnight. The lacto-phenol was prepared thus:-

Formula:-

| | |
|---|---|
| Phenol . . . . . | 1 part. |
| Lactic acid . . . . . | 1 part. |
| Glycerine . . . . . | 2 parts. |
| Water . . . . . | 1 part. |

The nematodes were mounted temporarily in a drop of glycerine on a slide and examined microscopically. When identification was complete, they were replaced in the standard "shell vials" and filed.

Measurement of Nematodes for Classification.

The measurements were taken with the aid of a drawing prism and an elevated drawing board, and drawings were made of all the eye worms in the collection.

The microscope was calibrated with an occular micrometer and a stage micrometer. The stage micrometer was placed on the stage and scale drawings were made with the various eyepieces and the following scale composed:-

Scale.

H.P. x 5X . . . . . 0.25 m.m. = 58 m.m.

L.P. x 5X . . . . . 1.00 m.m. = 66 m.m.

3 X x 5X . . . . . 1.00 m.m. = 21 m.m.

H.P. x 10X . . . . . 0.25 m.m. = 82 m.m.

L.P. x 10X . . . . . 0.5 m.m. = 49 m.m.

3 X x 10X . . . . . 1.00 m.m. = 38 m.m.

First, an outline drawing was made to determine the length and width of each specimen. Then detail drawings of the anterior and posterior ends of the nematodes were done, showing all the outstanding morphological characters; like the buccal capsule, distance of nerve ring from the anterior end, length of oesophagus, distance of the vulva from the anterior end in the genus Thelazia, and head papillae in the anterior end of the eye worm. Similar drawings were also made of the posterior ends to show the length and width of the spicules, position of the caudal papillae and alae in the males; and the distance of the anus from the posterior end in both sexes.

A piece of ordinary wrapping twine was then placed on the drawing and cut at the required length of the structure to be measured. This length was measured on a millimetre ruler and converted into the exact length of the worm with the aid of the above conversion table. The measurements were recorded on mimeographed record sheets provided by the Institute of Parasitology.

Finally, the worms were classified to genus according to Yorke and Maplestone,(50) to species according to Eloise B. Cram,(11) and for the species described from 1927 to 1953, the Helminthological Abstracts were the main source of information.

I. The Superfamily Spiruroidea Railliet and Henry, 1915.

The Spiruroidea are filiform worms, usually parasitic in the respiratory tract, alimentary tract, orbital, nasal or oral cavities of their vertebrate hosts. The mouth of these nematodes is surrounded by two, four or six lips, but in the genus Thelazia there are no lips. The mouth opens into a chitinous buccal capsule and continues into an oesophagus, which is divided into a short muscular anterior portion followed by a glandular portion, which joins the simple intestine. There are no diverticula attached to the intestine.

The females are characterized by a vulva situated in the middle of the body or in the oesophageal region. The ova are embryonate at oviposition and are passed in the faeces of the host, developing later in a chewing-arthropod intermediate host. However, the life cycles are incompletely known. Their tails are blunt and round, while the males have spirally coiled tails, unequal and dissimilar copulatory spicules, numerous sessile and pedunculated anal papillae arranged in linear rows.

Caudal alae may be present or absent. Sexual dimorphism is not marked.

The Family Thelaziidae Railliet, 1916.

The Thelaziidae or Eye worms are Spiruroidea, having mouths without definite lips, or with two or six small lips. A short oval buccal capsule is always present, opening into an oesophagus consisting usually of an anterior muscular portion and a posterior glandular portion.

The males display more specific morphological features than do the females. The sessile preanal papillae are usually numerous and arranged in two linear rows on the ventral surface. Postanal and adanal papillae are also present. The tails are spirally coiled, with or without caudal alae. In the genus Oxyspirura, the posterior extremities of both sexes are finely pointed, but in the type genus Thelazia the posterior extremities are blunt. Caudal alae are absent in Oxyspirura and Thelazia but present and wide in Ceratospira.

The vulva of the females is generically characteristic. In the genus Thelazia it is in the oesophageal region or close behind it, while in Oxyspirura it is situated just in front of the anus, and in Ceratospira it is anterior and near the posterior end of the oesophagus.

The Thelaziidae are parasites of the orbital, nasal or oral cavities of mammals and birds, the air-sacs of birds, or of the intestine of fishes. The Thelaziidae considered in this work will be confined to three genera, Ceratospira, Oxyspirura and Thelazia, which were found in the eyes of a collection of Brazilian birds.

The genera may be identified as follows:-

1.(11) Male with large caudal alae . . . . . Ceratospira

2. Male without caudal alae . . . . . 2.

2. Vulva in anterior part of body . . . . . Thelazia.

Vulva in posterior part of body . . . . . Oxyspirura.

The Thelaziidae are here assigned to the Spiruroidea after, Railliet, 1919, Yorke and Maplestone 1926 and Cram 1927, rather than to the Filarioidea as done by Travassos and suggested by Chandler.(7)

A. Genus Thelazia Bosc, 1819.

These worms were obtained from the eyes of several Brazilian birds. They are small fragile striated white worms, and the tails of the males are spirally coiled. The females have blunt, conical caudal extremities, no caudal alae and papillae are rare. The buccal cavity, supported by chitinous structures opens to the exterior by a mouth which lacks lips and may be surrounded by two lateral and four submedian cephalic papillae.

The characteristic caudal papillae pattern of the male is, numerous preanal papillae, one or two pairs of adanal papillae and three or four pairs of postanals. The two copulatory spicules are dissimilar and unequal. Both are chitinised, the long spicule is delicate and slender and retracts sometimes as far into the body as the level of the posterior end of the oesophagus. The short spicule is usually located in the region of the cloaca and is stouter and has two definite chitinous walls.

The vulva of the female occurs in the oesophageal region of the worm and the two uteri are directed posteriorly. The embryos hatch in the uterus.

Thelazia butenois Herde, 1942.

A single male and a fragment of a male of Thelazia buteonis

were received from the eye of Pipile cumanensis cumanensis, Jacquin.[31] This worm is slightly larger than those described by Herde, which were obtained from a Falconiform bird.

The studied male was 11.6 m.m. long by 0.38 m.m. at its widest point. The long flexible spicule measured 1.86 m.m., and the short spicule with a rugged surface 0.22 m.m. (Fig. 1 B.). The specimen described by Herde had spicules of length 1.658 m.m., and 0.204 m.m.; the body length is recorded as 11.1 m.m. The papillae pattern is identical with that of the original Thelazia buteonis. The tail coils once and bears 7 pairs of postanal, one right adanal, 8 pairs of preanals and one right median preanal papilla. (Fig. 1 B.).

The mouth is circular and opens into an oval buccal capsule 0.04 m.m. long by 0.05 m.m. wide, slightly larger than that described by Herde. On the external surface 4 cephalic papillae surround the oral orifice. (Fig. 1 A.).

Thelazia buteonis.

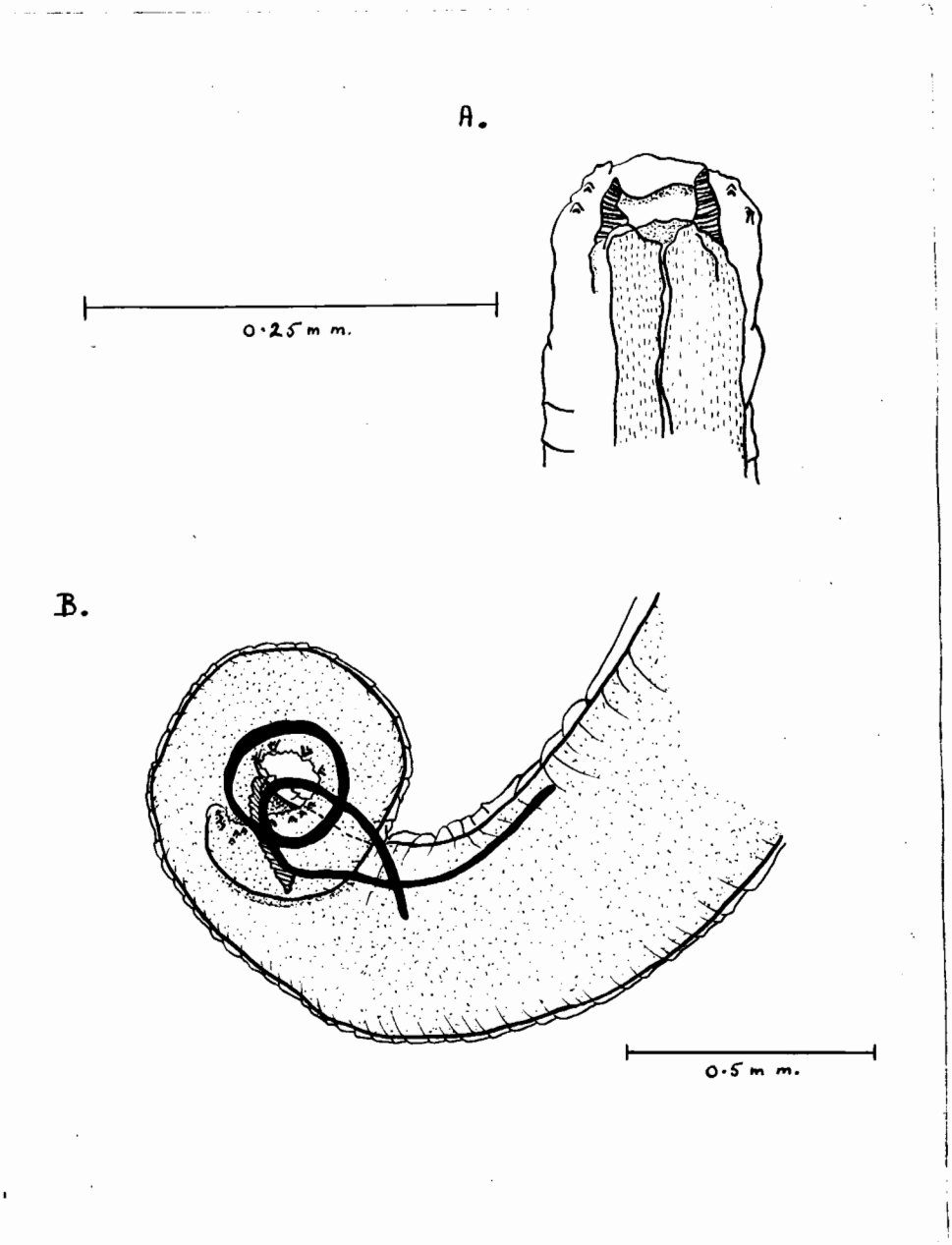


Fig. 1. A. T. buteonis, lateral view of head of male, showing cephalic papillae and chitinous buccal capsule.

B. T. buteonis, tail of male, spicules, and papillae.

This is a new host-parasite and area record of Thelazia buteonis. This species was first described in a diurnal bird of prey and is now recorded in a Gallinaceous scratching bird which is insectivorous in its habits, and its eye worm tends to be larger.

Thelazia campanulata (Molin,1858) Railliet and Henry, 1910.

Three mature females of this species were studied from The Tinamiform host Crypturellus strigulosus strigulosus, Jemminck.(31)

The following table shows the pertinent comparative measurements:-

| Females | I | II | III | Average | T.campanulata. |
|---|---|---|---|---|---|
| Length | 16 mm. | 16.2 mm. | 17.9 mm. | 16.7 mm. | ø 15 - 23 mm. |
| Width | 0.46 mm. | 0.50 mm. | 0.57 mm. | 0.51 mm. | ø 0.500 - 0.600 mm. |
| Ova length-embryonated. | 0.060 mm. | 0.057 mm. | 0.060 mm. | 0.059 mm. | ø - |
| Ova width-embryonated. | 0.036 mm. | 0.030 mm. | 0.033 mm. | 0.033 mm. | ø - |
| Vulva from posterior end. | 0.37 mm. | 0.38 mm. | 0.32 mm. | 0.36 mm. | ø 0.350 mm. |
| Anus from posterior end. | 0.36 mm. | 0.23 mm. | 0.27 mm. | 0.29 mm. | ø 0.300 mm. |
| Depth of buccal capsule. | 0.040 mm. | 0.040 mm. | 0.070 mm. | 0.050 mm. | * 0.011 - 0.017 mm. |
| Width of buccal capsule. | 0.049 mm. | 0.039 mm. | 0.068 mm. | 0.052 mm. | * 0.028 - 0.035 mm. |
| Length of oesophagus. | 0.500 mm. | 0.571 mm. | 0.580 mm. | 0.550 mm. | * 0.460 - 0.600 mm. |

* Measurements according to Travassos.(11)

ø Measurements according to Cram.(11)

Thelazia campanulata.

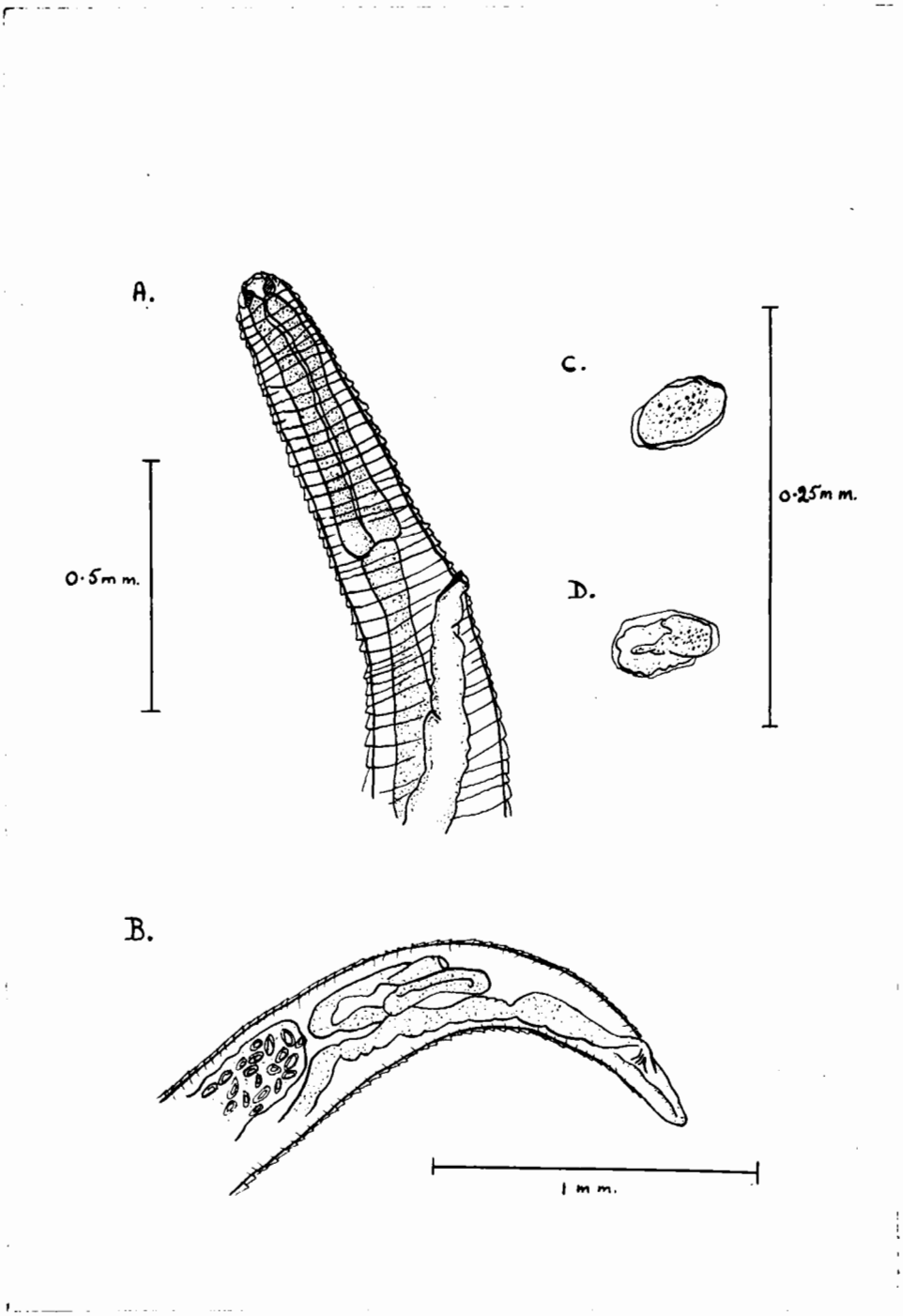


Fig. 2. A. Thelazia campanulata, anterior end of female, showing vulva and oesophagus.

B. Thelazia campanulata, posterior end of female, showing anus.

C. Thelazia campanulata, unembryonated egg.

D. Thelazia campanulata, embryonated egg.

Although no males were collected from the host, these worms were undoubtedly Thelazia campanulata, from the measurements given above and the gross morphology. However, the buccal capsules of my specimens are larger than those previously described. The embryonated ova were not described in the original description and are here recorded and illustrated in Fig. 2 D.

Thelazia cholodkowskii Skrjabin, 1922.

From the eye of Otus choliba decussatus, Lichtenstein,(31) two adult female worms were identified as Thelazia cholodkowskii. The males of this species are unknown. The slender worms with rounded extremities measured from 14.9 m.m. to 18.1 m.m. in length, and 0.36 m.m. to 0.45 m.m. in width. The depth of the buccal capsule measures 0.035 m.m. to 0.045 m.m., and is more flattened than those of the other species of Thelazia. The nerve ring is not as outstanding as illustrated in the European Russian forms described by Skrjabin (1922). The vulva is situated between 0.32 m.m. and 0.39 m.m. from the anterior end and the anus is located between 0.13 m.m. and 0.13 m.m. from the posterior end. The mature ova are from 0.045 m.m. to 0.054 m.m. in length by 0.020 m.m. to 0.030 m.m.

This sausage-shaped Thelazia, with flat close striations has a Russian distribution and has been recorded from a Caprimulgiform bird. Here it is now recorded from the closely related order Strigiformes, host Otus choliba decussatus, the "Brazilian Screech Owl" of South America.

Thelazia chungkingensis Hsü, 1933.

Three adult worms, two males and one female, were found in the eye of Mitu mitu, Linné.(31)

The measurements are as follows:-

| Male | Species. | T.chungkingensis. | T.anolobiata. |
|---|---|---|---|
| Length | 10.90 - 13.30 mm. | 6.88 - 8.44 mm. | |
| Width | 0.35 - 0.52 mm. | 0.29 - 0.35 mm. | Male |
| Length of buccal capsule | 0.037 - 0.049 mm. | 0.037 - 0.038 mm. | |
| Width of buccal capsule | 0.043 - 0.049 mm. | 0.043 - 0.045 mm. | Unknown |
| Left spicule | 0.891 - 0.922 mm. | 0.900 mm. | |
| Right spicule | 0.021 - 0.124 mm. | 0.122 mm. | |
| Postanal papillae | 2 pairs | 2 pairs | |
| Preanal papillae | 6 - 7 pairs | 6 - 8 pairs | |
| Length of tail | 0.11 - 0.12 mm. | 0.11 - 0.12 mm. | |
| Female | | | |
| Length | 17 mm. | 8.85 - 9.83 mm. | 8 - 17 mm. |
| Width | 0.62 mm. | 0.43 - 0.44 mm. | 0.40 mm. |
| Length of buccal capsule | 0.043 mm. | 0.041 - 0.045 mm. | - |
| Width of buccal capsule | 0.048 mm. | 0.048 - 0.051 mm. | - |
| Vulva from anterior end | 0.42 mm. | 0.44 - 0.49 mm. | - |
| Length of tail | 0.11 mm. | 0.093 - 0.11 mm. | - |
| Length of ova | 0.021 mm. | 0.021 - 0.022 mm. | - |
| Width of ova | 0.048 mm. | 0.035 - 0.093 mm. | - |

From the table above, it can be seen that both the male and female are larger and wider than the forms described by Hsü, but similar in the measurements of the buccal capsules and the male caudal extremities. The length of the female falls into the South American species Thelazia anolobiata (Molin, 1860) Railliet and Henry 1910, but only the length and width of this worm are recorded and the male is unknown. Furthermore, Thelazia anolobiata has been found in the host, Crax fasciolata, which belongs to the same family as Mitu mitu, the host of the specimens under study.

Hsü pointed out,(17) "the oesophagus is muscular throughout and does not show two different muscular portions, as Railliet stated to be the case in his definition of the family characters of Thelaziidae (1916)." I have verified this and agree with his observation.

Two similar South American species, Thelazia anolobiata (Molin, 1860) Railliet and Henry, 1910, and Thelazia papillosa (Molin, 1860) Railliet and Henry, 1910, are completely described and are to be regarded as nomina nuda, so this worker's specimens have been identified as Thelazia chungkingensis.

Hsü has recorded the distance of the nerve ring from the anterior end, but I have found that this characteristic is not specific in the Thelaziidae, but variable.

Here is a Chinese species occurring in Brazil, South America; an internal parasite displaying the effects of environmental selection on animal distribution, in which certain similarities are produced, larger males and females, but convergent traits are also introduced, for example, similar buccal capsules, in a different environment. The suggests

speciation, but it appears to be adaptation to the environment.

Thelazia dacelonis (Breinl, 1913.) Travassos, 1918.

From Trogon melanurus melanurus, Swainson,(31) four mature male worms were studied and found to be Thelazia dacelonis, first recorded from Queensland, Australia.(11) The males are larger than the original specimens and range from 11.9 m.m. to 12.5 m.m., but are of the same width, 0.390 m.m. to 0.422 m.m., as the Australian forms. The preanal papillae vary from 6 pairs to 10 pairs; in one male there is one pair of postanals and in the other three males there are 2 pairs. The long copulatory spicule is similar in structure and length to that of the Australian form, 2.1 m.m. by 0.021 m.m. The short spicule, funnel-shaped at the proximal end and rounded at the distal end is longer than that of Breinl's form, measuring 0.250 m.m. to 0.320 m.m. in length.

The natural classification used throughout this study is on the basis of structure and measurement. When one classifies animals on this basis, he does no more than recognize and apply the principles of comparative anatomy and embryology. Such a classification expresses the degree of structure resemblance and merely summarizes evidence for evolution that is derived from morphology.

Several South American birds show adaptive radiation, replacing birds of the most diverse families in other parts of the world, resulting in varied appearance, and differ in size, in the form and size of the bill, in length of limbs and toes, and in the length and form of the tail. This precept is exemplified in the parasites of these birds. The South American Thelazia dacelonis differs from the Australian variety in that the papilla pattern is variable within a certain range

and the spicules are of the same shape but differ in size.

However, the South American forms of this genus were found in the Order Trogoniformes of birds, and the Australian forms are recorded from a closely related Order Coraciiformes.

A single female specimen probably Thelazia dacelonis was obtained from Tinamus tao tao, Temminck.(31) This specimen was in a very bad state of preservation. The vulva is between 0.520 m.m. and 0.555 m.m. from the anterior end, and the anus which is supported by a band of muscles is 0.256 m.m. from the posterior end. These were the only morphological features that could be observed. The internal organs were dark and indistinguishable. It was placed in lacto-phenol for one week, and did not clear. Obviously, there was some error in the fixing of the worm, and the cuticle was torn in several places.

Thelazia lutzi Travassos, 1918.

Six males and one female of Thelazia lutzi were collected from the host, Penelope superciliaris superciliaris, Temminck.(31) One male and two females of the same species were also found in the eye of another host of the same genus and species as above.

The caudal extremity of the males is incurved, obtuse and rounded. It bears 10 pairs of preanal papillae, 1 unpaired papilla anterior to the cloacal aperture, 2 pairs of postanal papillae and 1 unpaired papilla. (Fig. 3.D). The copulatory spicules are unequal and very dissimilar. The long spicule is delicate and filiform and the short one boat-shaped and apparently twisted.

In the females the vulva is in the oesophageal region and

and very obvious, projecting above the transverse striations of the cuticle. (Fig. 3 A).

This species has previously been recorded from Penelope, species in South America (Brazil.,(11)

Thelazia lutzi.

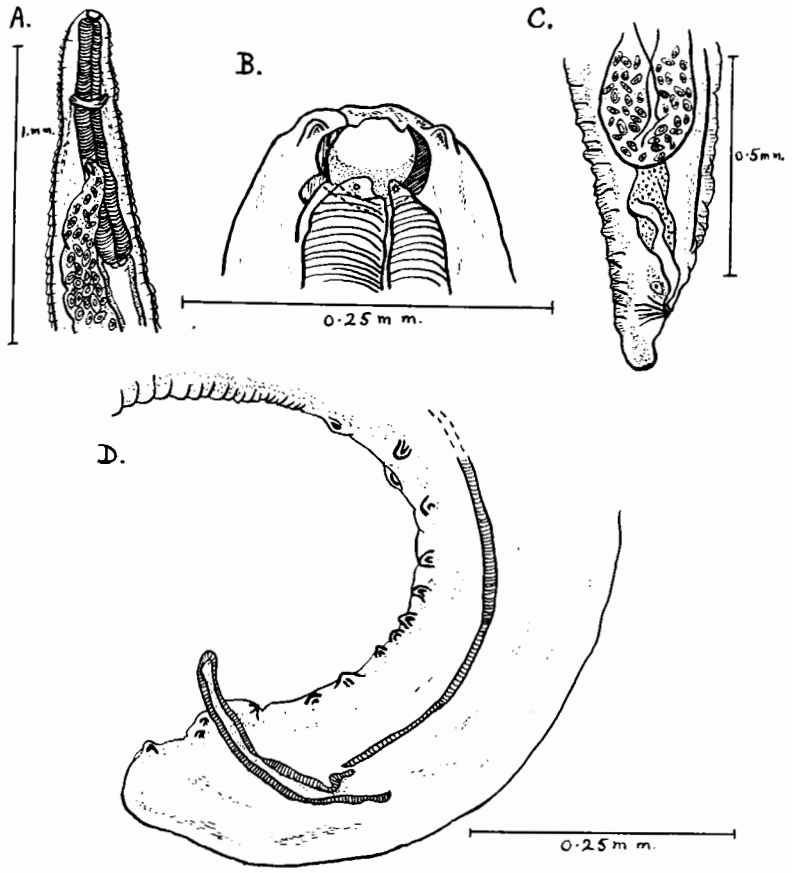


Fig. 3. A. Thelazia lutzi, anterior region of female showing vulva and oesophagus.

B. T. lutzi, head showing buccal capsule and cephalic papillae.

C. T. lutzi, tail of female.

D. T. lutzi, tail of male, showing spicules and papillae.

Thelazia sicki sp. nov.

From Otus sp., family Strigidae, several specimens of Thelazia sicki sp. nov. were found. The males are approximately 12 m.m. long and the females 7 m.m. The vulva is in the oesophageal region, anterior to the posterior end of the oesophagus. Surrounding the salient orifice of the vulva there is a circular lip which is striated. A single unpaired deirid is situated in the oesophageal region. In her posterior extremity there is a single terminal papilla and the anus is supported by 2 strong bands of muscles. (Fig. 4 B).

The mature females contained both embryonated and unembryonated eggs. The eggs are large, twice as long as broad and rounded at the ends. (Fig. 4 C). The vagina is large and muscular and enters the large uterus filled with eggs.

The male is larger and wider than the female. The characteristic deirid is also present in the oesophageal region. (Fig. 5 A). The buccal capsule is wider than it is deep in both sexes. Two cephalic papillae are present in the posterior region of the buccal capsule. These papillae are absent in the females. In the caudal extremity of the male, there are no preanal papillae, but 1 pair of small adanal papillae just anterior to the cloaca and 3 pairs of postanals. The spicules are dissimilar and unequal.. The short spicule is boat-shaped, the distal end is rounded and the proximal end wider, ending with the two tips slightly incurved. (Fig. 5 B).

Thelazia sicki sp. nov.

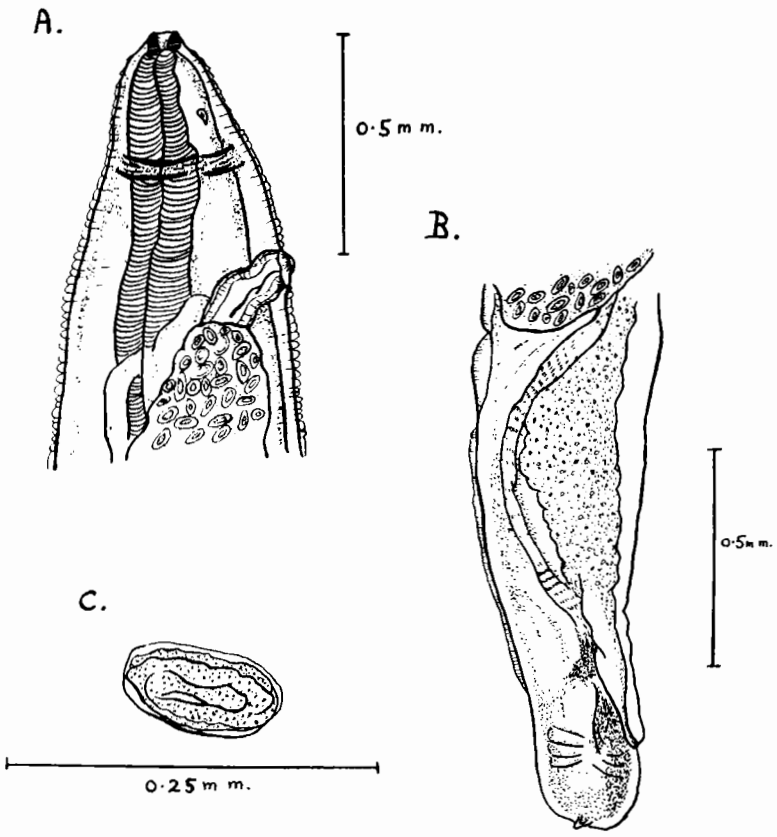


Fig. 4. A. Thelazia sicki, anterior end of female, showing vulva and oesophageal deirid.

B. T. sicki, posterior end of female showing anus.

C. T. sicki, embryonated ovum.

The measurements of Thelazia sicki are:-

| | Male | | Female |
|---|---|---|---|
| Length | 12.7 mm. | | 7.1 mm. |
| Width | 0.47 mm. | | 0.19 mm. |
| L. of oesophagus. | 0.92 mm. | | 0.9 mm. |
| Nerve ring from anterior end. | 0.17 mm. | | 0.20 mm. |
| L. of buccal capsule. | 0.03 mm. | | 0.03 mm. |
| W. of buccal capsule. | 0.05 mm. | | 0.04 mm. |
| Left spicule. | 0.948 mm. | L. of ova | 0.107 mm. |
| Right spicule. | 0.306 mm. | W. of ova | 0.051 mm. |
| Tail | 0.183 mm. | Tail | 0.408 mm. |
| Postanal papillae | 3 pairs | Vulva from anterior end | 0.59 mm. |

This new species, Thelazia sicki is similar to Thelazia lutzi Travassos, 1918. However, it differs in the length and width of the worms, a single terminal papilla on the tail of the female, the papillae pattern of the males and the ratio of the size of the spicules, which are 3:1 and 4:1 in the plesiotype. A single azygous deirid, occurs outside the oesophagus in both males and females of Thelazia sicki, but on the external surface of the oesophagus of Thelazia lutzi.

This species is named in honour of Dr. Helmut Sick of Central Brazil, who collected the bird hosts of this collection of Eye worms.

Thelazia sicki sp. nov.

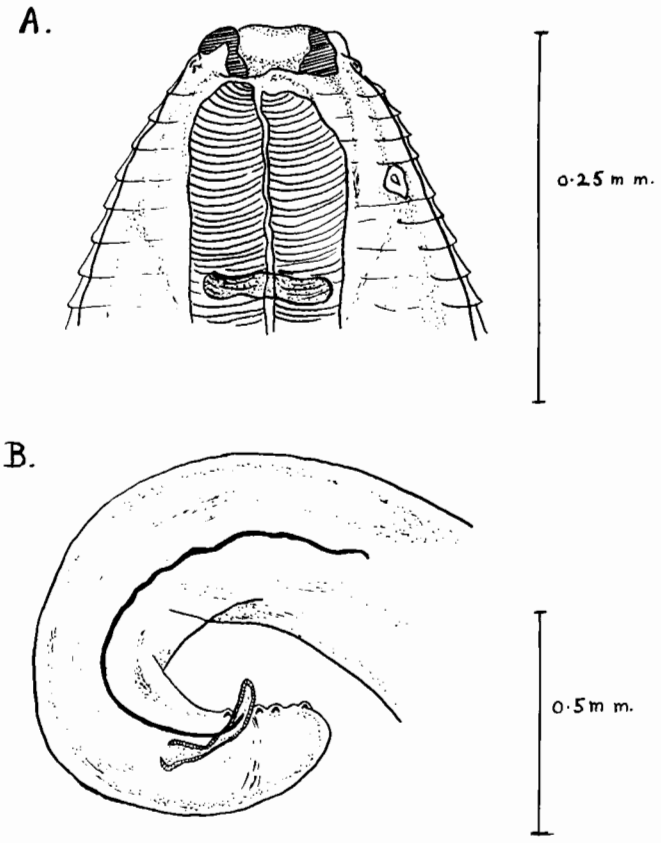


Fig. 5. A. Thelazia sicki, anterior end of male, showing buccal capsule, deirid and nerve ring.

B. T. sicki, posterior end of male, showing spicules and papillae.

Thelazia pittae Johnston and Mawson, 1941.

From the host, Spizastur melanolencus, Veillot[31] a single male of the species Thelazia pittae was collected. The male is 16 m.m. long and 0.48 m.m. at its widest part. The tail is 0.28 m.m. long and incurved ventrally, bearing 7 pairs of sessile preanal papillae and 4 pairs of postanals. The spicules are subequal and dissimilar. The long fine copulatory spicule is blunt at its distal end, well chitinised and 0.236 m.m. long, while the short spicule, measuring 0.167 m.m. is large and strongly chitinised.

The description recorded by Johnston and Mawson of this species is rather sketchy, and the drawings even more so. The long delicate spicule lies close to the short massive spicule, and only on close observation and continuous change of focus can it be determined that the long slightly chitinised spicule lies next to the short spicule.

The head bears 6 cephalic papillae in the region of the buccal capsule. This species has been recorded from Pitta mackloti,[20] family Pittinae,[15] but this is a new host and area record, of an Australian form in South America.

Thelazia spizaëti sp.nov.

On the basis of one female and three males this new species, Thelazia spizaëti is erected. The specimens were obtained from Spizaëtus ornatus Daudin, family Accipitridae[31] from Brazil.

The long slender female is 19.5 m.m. long by 0.05 m.m. wide. The vulva is located 0.70 m.m. from the anterior end, posterior to the nerve ring and approximately in line with the middle of the muscular oesophagus (Fig. 6A). The long straight intestine opens to the exterior 0.26 m.m.

from the rounded tail (Fig. 6 B). The anus is controlled by a conical band of muscle. The eggs are oval and unembryonated. The head bears 8 cephalic papillae in the region of the posterior buccal capsules (Fig. 6 C).

The males are slightly smaller than the females, and measure 14 to 14.50 m.m. in length and from 0.333 to 0.570 m.m. in width. The head is surrounded by 8 cephalic papillae (Fig. 7 B). In the caudal region, there are 8 pairs of preanal papillae; the second and third pairs anterior to the cloaca are close together and very characteristic. There are 4 pairs of postanal papillae, the most anterior of which are very small and near the subequal spicules. The spicules are similar in shape; the long spicule is 0.240 m.m. long and chitinised; the short, slightly chitinised spicule is 0.142 m.m. long (Fig. 7 A).

Thelazia spizaëti sp. nov.

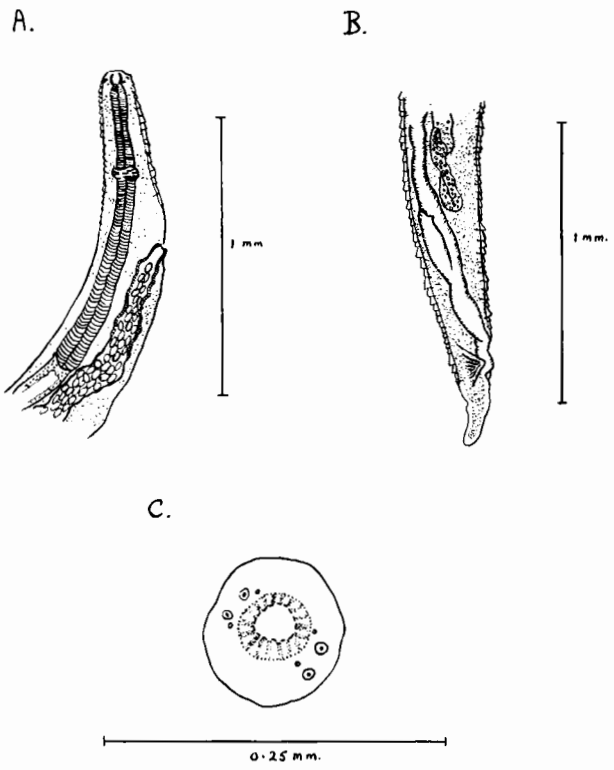


Fig. 6. A. Thelazia spizaëti, anterior end of female, showing vulva, nerve ring and oesophagus.

B. T. spizaëti, posterior end of female, showing intestine and anus.

C. T. spizaëti, en face view of A.

Thelazia spizaëti sp. nov.

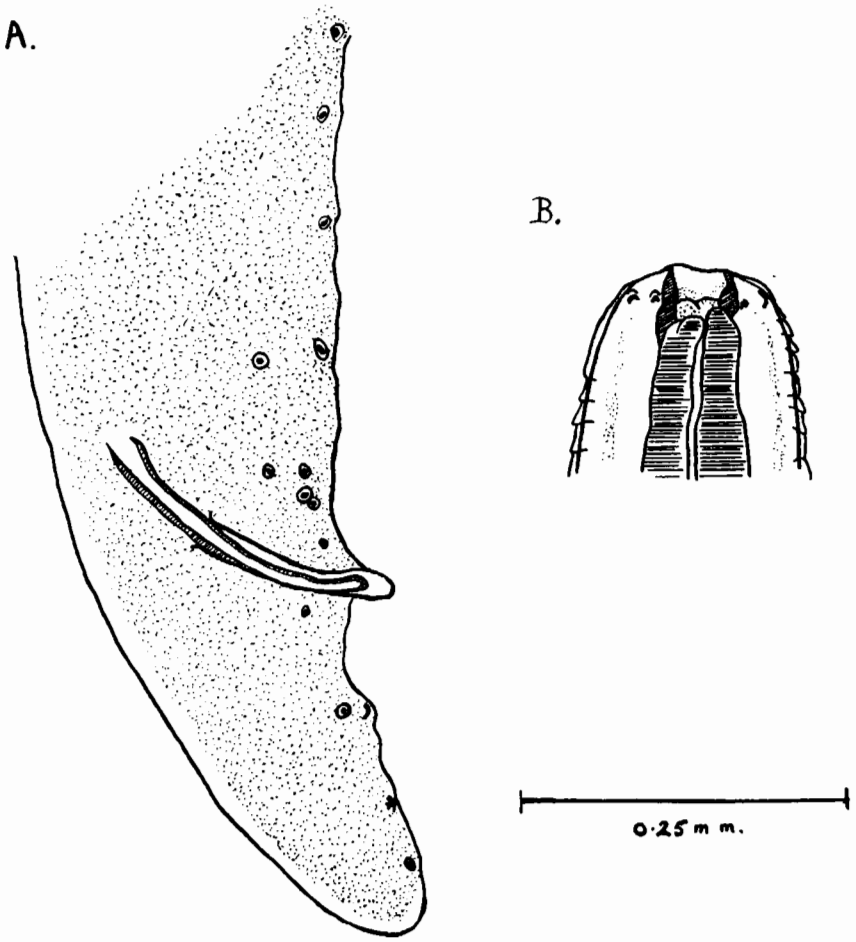


Fig. 7. A. Thelazia spizaëti, tail of male showing spicules and papillae.

B. Thelazia spizaëti, head of male showing cephalic papillae.

The measurements of Thelazia spizaëti sp. nov. are as follows:-

| | Male | | Female |
|---|---|---|---|
| Length | 14 - 14.5 mm. | | 19.5 mm. |
| Width | 0.333 - 0.57 mm. | | 0.500 mm. |
| L. of oesophagus. | 0.90 - 1.2 mm. | | 1.20 mm. |
| Nerve ring from anterior end. | 0.31 - 0.39 mm. | | 0.30 mm. |
| L. of buccal capsule. | 0.034 - 0.041 mm. | | 0.025 mm. |
| W. of buccal capsule. | 0.039 - 0.043 mm. | | 0.047 mm. |
| Tail | 0.28 - 0.30 mm. | | 0.26 mm. |
| Left spicule. | 0.240 - 0.25 mm. | L. of ova unembryonated | 0.031 mm. |
| Right spicule. | 0.142 - 0.150 mm. | W. of ova unembryonated | 0.021 mm. |
| Preanal papillae | 8 pairs | | |
| Postanal papillae | 4 pairs | Vulva from anterior end | 0.7 mm. |

This species closely resembles Thelazia pittae Johnston and Mawson, 1941,(20) but is distinguished from it by the number and arrangement of the preanal papillae, the number of cephalic papillae and the similar subequal spicules. In addition, Thelazia spizaëti sp. nov. occurs in South America.

Thelazia tonkinensis Hsü, 1935.

One male and one female were found in the host, Cephalopterus ornatus, family Cotingidae. The male tail is blunt with 10 pairs of preanal papillae arranged in linear rows, and one unpaired papilla situated anterior to the cloaca, and required rolling the worm, to make this

observation. The postanal papillae consist of 5 pairs not arranged in linear row, the most posterior of which are very small. (Fig. 8 B,C). The copulatory spicules are unequal and dissimilar. The long filiform spicule is 2.60 m.m. and the short styloid one 0.196 m.m. long.

The female tail is also blunt, with caudal alae. The vulva is in the oesophageal region and is situated 0.326 m.m. from the anterior end. (Fig. 8 A.). The parasite is viviparous and larvae were observed in the uterus.

Externally the cuticle of the worms is serrated. The striae are approximately 0.025 m.m. apart. The mouth is surrounded by two circles of cephalic papillae. The inner circle is situated near the mouth orifice and consists of six papillae, two lateral and four submedian. The outer circle is situated outside the region of the buccal capsule and consists of eight papillae.

The presence of the Indo-Chinese, Thelazia tonkinensis in Cephalopterus ornatus, family Cotingidae is a new host-parasite and area distribution record. The Chatterers (Cotingidae) are a group of birds confined to America, and almost entirely to its southern portion.(15)

Thelazia sp.

A single male specimen of the genus Thelazia was found in the eye of Daptrius americanus americanus, Boddaert,(31) commonly known as the "American Falcon." As the specimen was in a poor state of preservation, no specific identification could be made.

Thelazia anadorhynchi sp. nov.

Two males and six females were collected from Anadorhynchi hyacinthinus Latham, family Psittacidae.(31) The males are between 13

Thelazia tonkinensis.

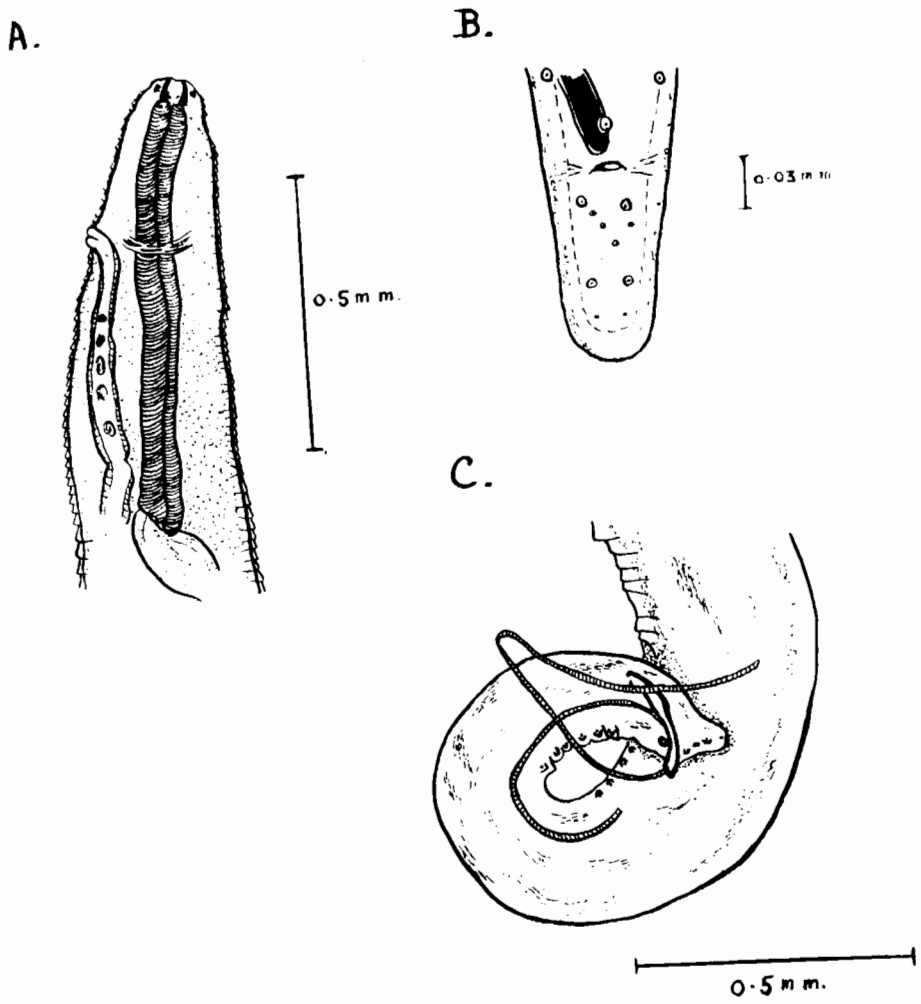


Fig. 8 A. Thelazia tonkinensis, lateral view of female anterior end showing oesophagus and vulva.

B. T. tonkinensis, ventral view of tail of male.(After Hsü, 1935.)

C. T. tonkinensis, lateral view of tail of male.

and 15.5 m.m. long by 0.47 m.m. and 0.57 m.m. wide. The oesophagus is characteristic, divided into a muscular and glandular portion. The spicules are dissimilar and unequal; the ratio of the long, heavily chitinised, canoe-shaped hollow spicule to the short thick, oval shaped spicule is 4 : 1. The shapes of the copulatory spicules are specifically characteristic. The tail is short and alate bearing two pairs of prominent postanal papillae, and a third pair just posterior to the cloaca. Anterior to the cloaca, there are 8 pairs of well defined sessile papillae. (Fig. 9A).

The female body is 19.5 m.m. to 23.4 m.m. in length by 0.57 m.m. to 0.7 m.m. in width. The vulva opens to the exterior by a short narrow tube, located 0.53 m.m. in the shortest to 0.73 m.m. in the longest worm, from the anterior end. (Fig. 10.A). The tail is short, blunt and rounded with caudal alae on its dorsal surface. The intestine opens to the exterior just below the surface of the worm; hence the anus appears to lie in a cavity, and it is controlled by a strong band of muscle (Fig. 10 B.). The ova are massed in the uterus, and are almost spherical in shape. The muscular oesophagus is clavate and its most posterior portion protrudes into the glandular oesophagus (Fig. 10 A.). No cephalic papillae are present in either sex.

Measurements of Thelazia anadorhynchi sp. nov. are:-

| | Male | | Female |
|---|---|---|---|
| Length | 13 - 15.5 mm. | | 19.5 - 23.4 mm. |
| Width | 0.47 - 0.57 mm. | | 0.57 - 0.67 mm. |
| L. of oesophagus | 0.76 - 0.84 mm. | | 0.9 - 0.93 mm. |
| Nerve ring from anterior end | 0.24 - 0.31 mm. | | 0.23 - 0.36 mm. |
| L. of buccal capsule | 0.041 - 0.045 mm. | | 0.039 - 0.047 mm. |
| W. of buccal capsule | 0.049 - 0.054 mm. | | 0.042 - 0.052 mm. |
| Tail | 0.112 - 0.269 mm. | | 0.15 - 0.20 mm. |
| Left spicule | 0.396 - 0.591 mm. | L. of ova | 0.030 - 0.043 mm. |
| Right spicule | 0.085 - 0.153 mm. | W. of ova | 0.021 - 0.025 mm. |
| Preanal papillae | 8 pairs | Vulva from anterior end | 0.53 - 0.73 mm. |
| Postanal papillae | 3 pairs | | |

This species does not resemble any of the other known species of Thelazia, and the characteristics of this author's holotypes, are the dissimilar spicules of the male, especially the absence of the filiform spicule, 3 pairs of postanal papillae, 8 pairs of preanal papillae, the structure of the vulva and vagina, the presence of caudal alae in the female and the absence of cephalic papillae in both sexes. Accordingly, the Brazilian forms are regarded as belonging to a new species for which the name Thelazia anadorhynchi sp. nov. is proposed.

Thelazia anadorhynchi sp. nov.

A.

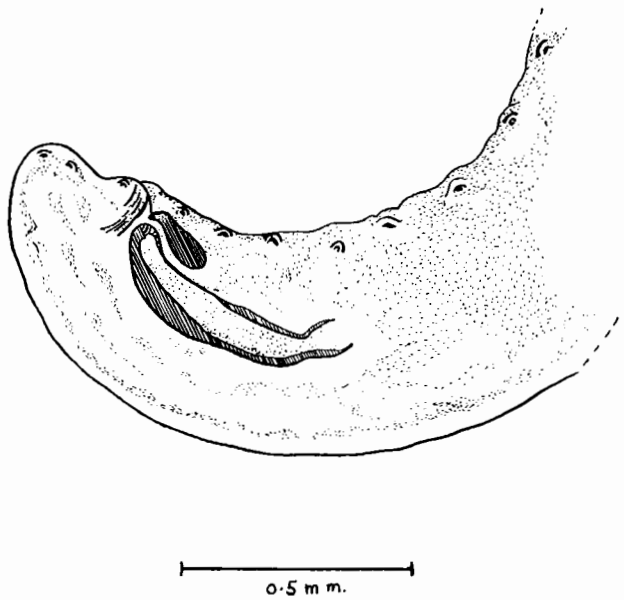


Fig. 9 A. Thelazia anadorhynchi, posterior end of male, showing spicules and papillae.

Thelazia anadorhynchi sp. nov.

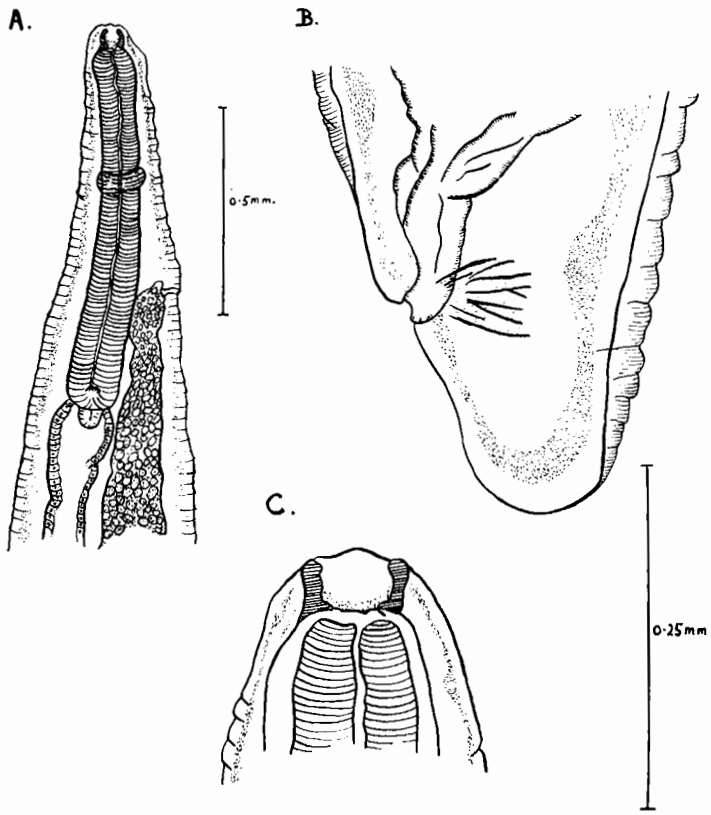


Fig. 10. A. Thelazia anadorhynchi, anterior end of female showing vulva and oesophagus.

B. T. anadorhynchi, posterior end of female showing anus.

C. T. anadorhynchi, buccal capsule.

B. Genus Oxyspirura Drasche in Stossich, 1897.

This genus is also a member of the family Thelaziidae, and is characterized by a mouth without lips, followed by a short buccal capsule. The head bears 2 lateral and 4 submedian papillae. The posterior extremity of both sexes is acutely conical.

The male tail is incurved and tends to be spiral; caudal alae are absent. The preanal papillae are variable, from 2 pairs to 28 pairs; the postanals, 1 pair to 8 pairs, usually asymmetrical; and all the papillae are sessile. The copulatory spicules are unequal and dissimilar, the long spicule is filiform and the short one saber-shaped.

In the females, the vulva is just anterior to the anus and the caudal extremity is straight. The typical niche of these parasites is under the nictitating membrane of birds.

Skrjabin has divided this genus into three subgenera, Oxyspirura, Yorkeispirura and Cramispirura.(12) These taxa will be excluded from consideration, because this is merely an attempt to express small differences nomenclaturally.

Oxyspirura anacanthura (Molin, 1860) Stossich, 1897.

Several specimens of this form were recovered from the following hosts, Ramphastos culminatus, family Ramphastidae, and Guira guira, family Cuculidae.

The body of the female is straight, slender and tapers gracefully to a sharp point. They vary in length from 10 m.m. to 16.5 m.m. by 0.29 to 0.38 m.m. The anterior end supports 4 lateral cuticular membranes, (Fig. 11 A) as described by Molin,(29) and not 2 as Drasche

recorded. The large circular mouth is surrounded by 6 small lobules and 4 submedian papillae. The buccal capsule is short and the cuticle has fine transverse striations. The vulva is situated in the posterior region of the worm, 0.46 m.m. anterior to the anus, which is 0.7 m.m. from the tip of the tail (Fig. 11 B). At the most posterior end of the tail, there is a single unpaired papilla and the tail is terminated by a knob-like process (Fig. 11 C).

The only male was in a bad state of preservation, and the papillae pattern could not be determined. Only the short boat-shaped spicule was distinguishable and measured 0.27 m.m. The long filiform spicule was broken and destroyed in several sections, so adequate measurements could not be made. The male is 9.9 m.m. long and 0.33 m.m. at its widest point.

Oxyspirura anacanthura has previously been recorded from Brazil, South America, in Crotophaga ani and C. major, family Cuculidae.

Oxyspirura anacanthura

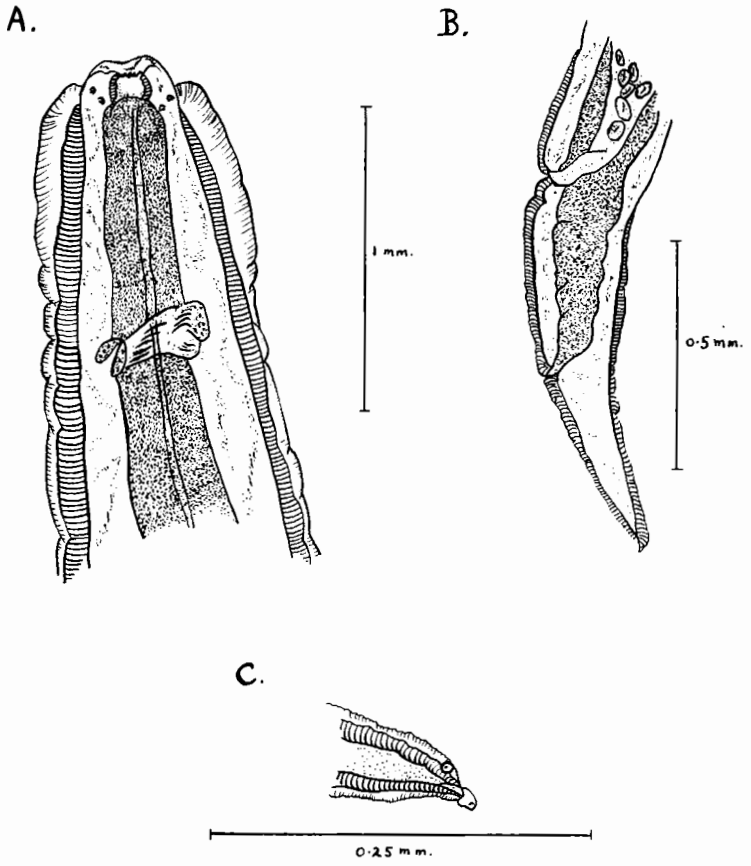


Fig. 11 A. Oxyspirura anacanthura, anterior end of female showing cuticular expansions, buccal capsule and nerve ring.

B. O. anacanthura, posterior end of female, showing vulva and anus.

C. O. anacanthura, showing enlarged tip of tail.

Oxyspirura brevisubulata (Molin, 1860) Stossich, 1897.

A single female specimen of this species was obtained from the eye of Nyctidromus albicollis, family Caprimulgidae.(31) This small white filiform worm measuring 14.2 m.m. by 0.43 m.m., is gradually attenuated anteriorly, with two well defined lateral cuticular expansions. The head bears 2 pairs of lateral papillae and 4 pairs of submedian papillae. The buccal capsule is 0.054 m.m. deep by 0.051 m.m. wide, and is surrounded by an internal circular groove.

Singh in 1948, described a new species O. buccosulcata,(39) on the basis of one male and stated his species is similar to Oxyspirura brevisubulata and it's only distinguishable features are the characteristic buccal capsule and its smaller size. The female specimen under study is approximately 7 m.m. smaller than Molin's and Stossich's species, but it has more similarities with O. brevisubulata than with O. buccosulcata, which has no description of a female.

The prominent vulva is located 0.67 m.m. from the truncate apex of the tail, and the anus is 0.62 m.m. posterior to the vulva. The embryonated ova are large, oval and one and one-half times as long as wide; length of ovum = 0.088 m.m., width of ovum = 0.054 m.m.

Oxyspirura brevisubulata has a known South American (Brazil) distribution, in the host Strix atricapilla, family Strigidae (Owls) which are a closely related group of the Caprimulgidae (Nightjars).

Oxyspirura octopapillata Caballero, 1942.

Two female eye worms were received from a bird, which was not named but listed as a member of the family Accipitridae. These worms have two features in common with Oxyspirura brevipenis, a prominent vulva with a swollen posterior lip and a tail with a thickened tip; but, Ransom

(1904) has noted that the absence of the buccal capsule and the presence of short spicules, makes the position of this species in the genus questionable. These female worms are undoubtedly Oxyspirura octopapillata and have been identified as such, after Caballero, 1942.(3)

The females are between 18.4 m.m. and 19.7 m.m. long by 0.52 m.m. and 0.53 m.m. wide, and were immature because they contained no embryonated ova. No cervical papillae were present on the rounded anterior end. The mouth is surrounded by 6 papillae, 2 median, and 4 towards the external surface of the worm. When viewed laterally the buccal capsule is "key-hole" shaped and appears to be divided into 2 portions; its dimensions are 0.036 m.m. at its widest point and 0.044 m.m. deep. The unusual shape of the buccal cavity possibly led Ransom to assume that it was absent. The caudal extremity is pointed and is terminated by a "teardrop-like" process, which is characteristic. The conspicuous vulva is located 1.5 m.m. from the extreme posterior end, and the anus is 0.83 m.m. posterior to the salient posterior lip of the vulva.

Caballero classified this species of Oxyspirura from the Mexican bird, Polyborus cheriway, the "Northern Caracara"(15), (family Accipitridae) which extends over a range from Northern Lower California, southwestern Arizona, Texas and southern Florida to western Panama; and now we see this parasite occurring in the same family of birds as far south as Brazil. It has also been recorded from Buteo borealis of the Mexican valleys.

Oxyspirura cameroni sp.nov.

Three males and twelve females worms were obtained from the

eye of Tityra cayana, of the South American family Cotingidae. The males range from 6.13 m.m. to 7.08 m.m. in length, and 0.26 m.m. to 0.35 m.m. in width. The tail is not coiled, and bears a small cuticular expansion on the dorsal surface extending from the region of the cloaca to the apex of the tail; the ala is 0.193 m.m. in length. There are 4 pairs of postanal papillae and 3 pairs of preanal papillae arranged in linear rows along the ventral surface (Fig. 12 C). The long spicule is twice the length of the short, stout concave spicule. Both spicules are rounded at their distal ends and incurved at their proximal ends. The long spicule is not filiform, but slender and rectangular in shape (Fig. 12 A).

The graceful S-shaped females are from 11 to 13 m.m. in length by 0.31 m.m. to 0.42 m.m. in width. The tail is straight, slender and conical with a rounded tip, and measures 0.428 m.m. The vulva is 0.38 m.m. anterior to the anus, and opens to the exterior with a salient posterior lip (Fig. 13 B). The ova are 0.057 m.m. by 0.039 m.m. and oval in shape (Fig. 13 C).

The mouth is surrounded by 6 lobules and 4 papillae. In the most anterior region of the oesophagus there are 4 large cephalic papillae and 4 smaller papillae. In toto the head bears 12 cephalic papillae. The oesophagus is encircled by a nerve ring 0.22 m.m. from the anterior end, approximately one-fourth the length of the oesophagus. Encompassing the nerve ring, are two glandular-like organs (Fig.13 A).

Oxyspirura cameroni sp. nov.

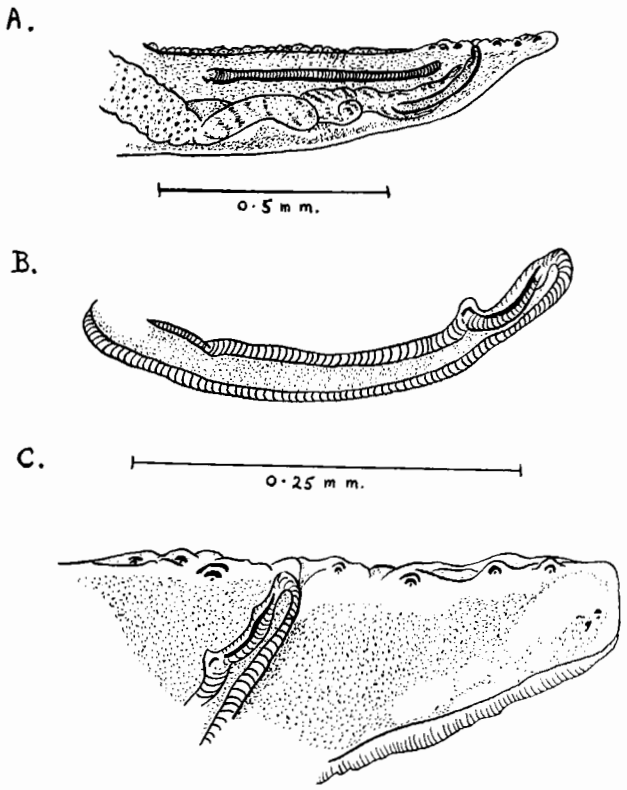


Fig. 12 A. Oxyspirura cameroni, posterior end of male showing spicules.

B. O. cameroni, short spicule.

C. O. cameroni, enlargedcaudal region showing papillae pattern.

Oxyspirura cameroni sp. nov.

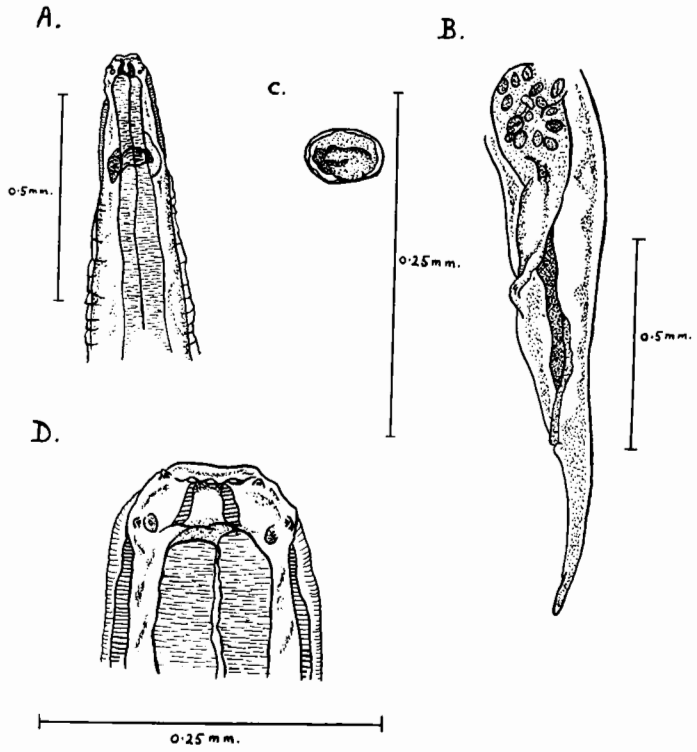


Fig. 13. A. Oxyspirura cameroni, lateral anterior end of female, showing oesophagus, nerve ring and glandular-like organs.

B. O. cameroni, posterior end of female showing uterus, vulva and anus.

C. O. cameroni, embryonated ovum.

D. O. cameroni, enlarged buccal capsule with cephalic papillae.

Table of measurements of O. cameroni sp. nov.

| | Males | | Females |
|---|---|---|---|
| Length | 6.13 - 7.1 mm. | | 11.0 - 13.0 mm. |
| Width | 0.26 - 0.35 mm. | | 0.31 - 0.42 mm. |
| L. of oesophagus | 0.77 - 0.93 mm. | | 0.89 - 0.95 mm. |
| Nerve ring from anterior end | 0.19 - 0.22 mm. | | 0.21 - 0.22 mm. |
| L. of buccal capsule | 0.30 - 0.33 mm. | | 0.036 - 0.38 mm. |
| W. of buccal capsule | 0.29 - 0.30 mm. | | 0.024 - 0.27 mm. |
| Tail (anus-tip) | 0.17 - 0.21 mm. | | 0.42 - 0.48 mm. |
| Left spicule | 0.54 - 0.57 mm. | Length of ova. | 0.051 - 0.057 mm. |
| Right spicule | 0.26 - 0.29 mm. | Width of ova. | 0.034 - 0.039 mm. |
| Preanal papillae | 3 pairs | Vulva from posterior end | 0.79 - 0.85 mm. |
| Postanal papillae | 4 pairs | Cephalic papillae | 12 |

This species is similar to Caballero's new combination of O. navali, O. toroi and O. crassa, which he has named O. octopapillata,(3) in the presence of the oesophageal glands, relative position of the vulva, and the structural nature of the spicules. But it is distinguished from it, in that the head of both sexes have 12 papillae and the papillae pattern of the male consist of 3 pairs of preanals and 4 pairs of postanals. Oxyspirura petrowi Skrjabin, 1929.

From the Caprimulgid host, Setopagis parvula Gould (31), 2 mature eye worms of Oxyspirura petrowi were collected.

The male is 11.7 m.m. long by 0.33 m.m. wide. The head has

two large lateral papillae on either side of the buccal capsule, and 4 pairs encircling the mouth. The caudal extremity is rolled and terminates conically. The spicules are unequal but similar in shape, 0.50 m.m. and 0.27 m.m. in length. The caudal papillae pattern consists of 4 pairs of postanals and 3 pairs of preanals. Anterior to the preanal papillae there are numerous fan-shaped cuticular expansions (Fig. 14 B.).

The female is 14.3 m.m. long and 0.48 m.m. wide at the level of the oesophagus. Two asymmetrical deirids occur in the lateral central region of the oesophagus. The vulva is in the caudal region, 0.33 m.m. anterior to the anus. The tail ends in a well developed phasmid, which is absent in the males. The thick-shelled embryonated ova are approximately 0.04 m.m. by 0.026 m.m. when measured in the vagina.

These 2 specimens are larger than those described by Skrjabin, but from their anatomical structures they are Oxyspirura petrowi. Cram in 1937 (12) substantiated this statement in recording that American specimens show differences in the comparative size of some of the structures. Skrjabin describes the fan-shaped cuticular expansions mentioned above, as "papilla-like" structures, which function as clasping organs, but in these individuals studied they appear to be merely irregular outgrowths of the cuticle on both sides of the mid-ventral line of the worm. This species was first recorded in a Passeriform bird from the Golodnaia Step (Russia), and more recently from Coraciiform, Galliform and Passeriform birds in Michigan and now from a Caprimulgiform bird in Brazil, South America.

Oxyspirura petrowi

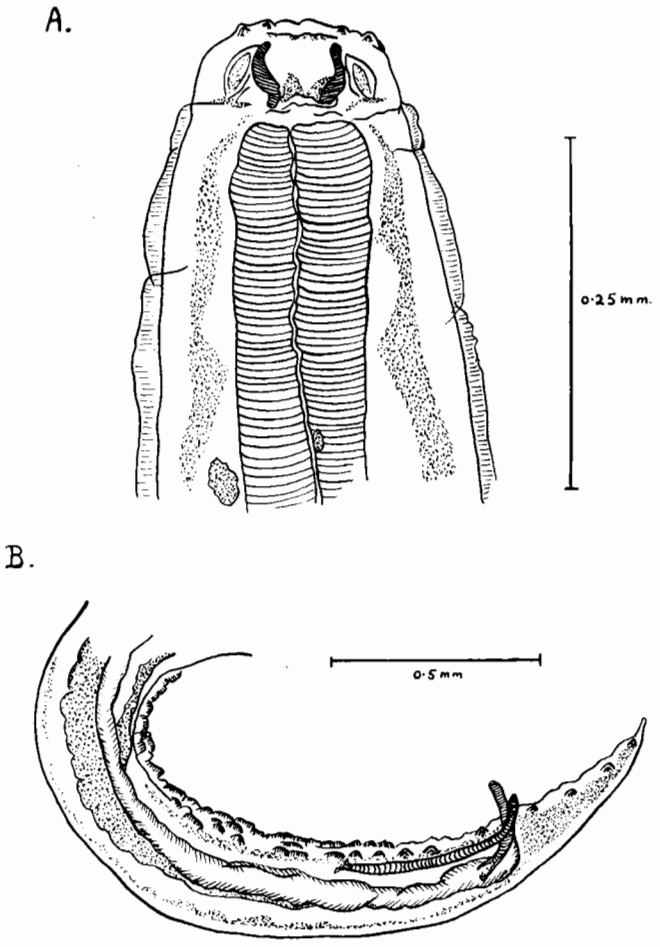


Fig. 14 A. Oxyspirura petrowi, anterior end showing buccal capsule and cephalic papillae.

B. O. petrowi, posterior end of male showing, spicules, papillae and cuticular expansions.

Oxyspirura sygmoidea (Molin, 1860) Stossich, 1897

Three specimens, two males and one female were recovered from Ramphastos cuvieri, family Ramphastidae.(31)

The sigmoid body of both sexes is attenuated posteriorly and the anterior portions end abruptly as if cut off at the tips. The mouth is large and discoid, encircled by 4 submedian cephalic papillae. The males vary in length from 10 m.m. to 11 m.m. and are 0.40 m.m. to 0.43 m.m. wide. The tail coils once and there are no cuticular expansions. Molin(29) and Stossich(46) claim that the preanal papillae are apparently absent, but 6 pairs of very small sessile preanal papillae are present in these Brazilian specimens. The unequal spicules are identical with those of the previously described species. The long pointed filiform spicule is two and one-half times as long as the short thick somewhat curved right copulatory spicule.

The delicate graceful females 14 m.m. long are curved like the uncial sigma, and are approximately 500 microns wide at their widest point. The vulva was difficult to see as noted by the original describers, but it is situated in the posterior region near the anus.

This species has been recorded from Europe (Austria (Vienna)) and Asia (Russian Turkestan) in the Corvidae. Here it is recorded for the first time in Brazil, in the family Ramphastidae (Toucans).

C. Genus Ceratospira Schneider, 1866.

Ceratospira belongs to the family Thelaziidae. The mouth is surrounded by papillae and enters a short buccal capsule. The tail of the male is very short and bears large caudal alae. The sessile preanal papillae number 9 to 11 pairs, and the copulatory spicules are very unequal and dissimilar.

The vulva of the females is in the anterior region near the posterior end of the oesophagus. Her tail is also very short and blunt. They are either oviparous or viviparous, and inhabit the orbital, nasal and oral cavities of birds.

Ceratospira thriponaxis Wehr, 1930.

Two females of Ceratospira thriponaxis were collected from Ramphastos culminatus, family Ramphastidae. The distinctly striated bodies of the females are from 15.4 m.m. to 16.5 m.m. long by 0.48 m.m. to 0.52 m.m. wide. The vulva opens to the exterior 0.50 m.m. to 0.53 m.m. from the anterior extremity of the body, in line with the posterior end of the oesophagus. The anus is between 0.13 m.m. and 0.14 m.m. from the posterior end. The tail is round with 2 lateral alae, one extending along the dorsal surface of the worm as far as the most posterior tip, the other runs anteriorly from the anus along the ventral surface, and is absent between the anus and caudal extremity.

In the anterior region, the short wide buccal capsule opens exteriorly via the discoid oral orifice, which is surrounded by 6 cephalic papillae.

Wehr(49) described this species from a black woodpecker, Thriponax sp., found on the Philippine Islands. The eye worm Ceratospira thriponaxis is now identified in a closely related family Ramphastidae (Toucans) and is a new area record.

II. The Superfamily Filarioidea Weinland, 1858; Stiles, 1907.

The Filarioidea are also filiform worms parasitizing the circulatory, lymphatic, muscular or connective tissues, or the serous cavities, of vertebrates. The mouth is simple and without lips, occasionally surrounded by chitinous structures or by small insignificant lateral lips. The buccal capsule or vestibule is absent or very rudimentary. The oesophagus is frequently divided into two parts, and extends practically to the anterior extremity. The intestine is simple and sometimes atrophied posteriorly.

The females are usually much longer than the males, and the vulva is almost always in the oesophageal region. The ova are embryonated and hatch either in utero or shortly after deposition. The microfilaria are found in the blood, lymphatics, or tissues of the host.(1) The completion of the life cycles of these worms requires bloodsucking arthropod intermediate hosts such as mosquitoes, in which the microfilaria undergo metamorphosis before becoming infective.

The males have very unequal and dissimilar copulatory spicules and caudal alae are rarely present, but papillae are always present. The tails are spirally coiled.

The Family Filariidae. (Cobbold, 1864.) Claus, 1885.

These nematodes are Filarioidea, in which the females are about three times as long as the males. The vulva does not atrophy in the gravid worm and is always situated in the oesophageal region. They are oviparous or viviparous.

Both sexes have simple mouths rarely bounded by insignificant lateral lips and sometimes by chitinous structures. The cuticle is usually smooth or finely striated transversely, but sometimes it is reinforced by annular thickenings or with bosses.

The males may or may not have caudal alae. The copulatory spicules are usually quite dissimilar and very unequal, but rarely similar and equal or subequal. A gubernaculum may be present or absent.

The Subfamily Aproctinae York and Maplestone, 1926.

These filiform worms are Filariidae, in which the mouth is simple and not bounded by a peribuccal chitinous ring. The cuticle is smooth or transversely striated. No trident-like structures occur on either side of the anterior end of the oesophagus. The vulva is in the oesophageal region or just posterior to it. In the males the copulatory spicules are equal or subequal and similar.

Genus Aprocta Linstow, 1883.

In this genus, the extremities of the body are rounded and the anterior extremity slightly attenuated. The cuticle has fine longitudinal striations. The mouth is simple and not surrounded by lips and rarely papillae. Rarely, three insignificant flat lips are present. There is no definite buccal capsule. The oesophagus is short and simple and joins the intestine, the posterior end of which is atrophied or absent along with the anus.

In the males, caudal alae and papillae are usually absent, occasionally one to three postanal papillae occur. The vulva of the female is in the oesophageal region. The females are oviparous, the eggs are

small, thick-shelled and contain embryos at deposition. The Aprocta are parasites of the orbital and nasal cavities of birds.

Aprocta nyctidromi Caballero and Peregrina, 1938.

One male, 2 females and a fragment of a female of Aprocta nyctidromi were collected from a bird of the family Picidae (Woodpeckers).

The male is 11.5 m.m. long and 0.32 m.m. wide, with a rounded tail that coils once. The heavily chitinised spicules are similar and equal and measure 0.3 m.m. (Fig. 15 C). The papilla pattern consist of 3 pairs of sessile postanals and one azygous terminal papilla. There is a single large preanal papilla just anterior to the cloaca. (Fig. 15 C). No gubernaculum is present.

At the anterior end of the males, there is no buccal capsule, but the mouth is surrounded by 4 slightly pedunculated papillae. The oesophagus is short and straight and joins the intestine. A nerve ring is close to the anterior end of these filiform worms, which have a cuticle with fine striations.

The rounded anterior extremity of the females is the same as the males. The females are from 12 to 15 m.m. long and 0.48 to 0.53 m.m. wide. The anus opens to the exterior 0.11 m.m. from the posterior end (Fig. 15 B). The vulva is situated in the anterior portion of the body 0.30 m.m. from the extreme anterior end. The vagina is muscular and opens to the exterior with 2 large salient lips (Fig. 15 A). The unembryonated ova are ovoid and measure 0.048 by 0.032 m.m. (Fig. 15 D).

Caballero and Peregrina described this species from a Caprimulgid host in Mexico. Here it is found in a Brazilian woodpecker. In their summary they point out that many of the Mexican nematodes of vertebrates have been previously isolated in Brazilian hosts, and this leads them to

Aprocta nyctidromi.

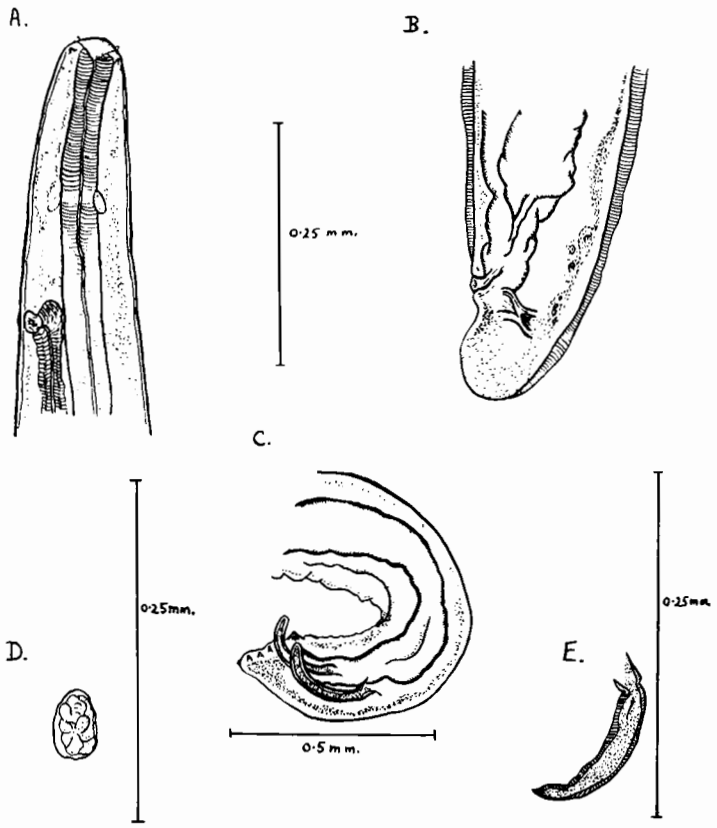


Fig. 15 A. Aprocta nyctidromi, anterior lateral view of female.

B. A. nyctidromi, posterior lateral view of female.

C. A. nyctidromi, posterior end of male.

D. A. nyctidromi, ovum, unembryonated.

E. A. nyctidromi, spicule.

believe in a possible migration of these parasites from South America to North America thus establishing a close relation between the Helminthological fauna of South America and Central America(5). These specimens were smaller than those described by Caballero and Peregrina suggesting that the parasites tend to become larger in a new environment of both host and geographical distribution.

Aprocta sp. Linstow, 1883.

Two males and two females of this species were collected from the orbit of the eye of a bird of the family Falconidae. These specimens were dry, so adequate measurements could not be obtained. They were obviously filarial worms of the genus Aprocta, but a specific diagnosis as to species could not be made on the specific anatomical structures, papillae or position of the vulva.

Several species of this genus have been recorded from the Falcons such as A. orbitalis Linstow, 1901, in Falco fuscoater, of an unknown locality(35, 23); A. opthalmophaga Stossich, 1902, in Falco sp. in Abyssinia(35, 47); and A. anthicola Linstow, 1903 in Buteo borealis borealis in Nuevo Leon, Mexico(4).

## DISCUSSION

The systematic position of the Thelaziidae adhered to in this work, is in the Superfamily Spiruroidea and not in the Filarioidea as classified by Travassos. These two superfamilies are doubtlessly closely related and the line of demarcation very thin.

The Thelaziidae, taxonomically dealt with here, as far as their life cycles are known are carried by chewing arthropod intermediate hosts like cockroaches, while the Filarioidea are dependent on blood-sucking arthropods for the dissemination of their progeny. As regards their morphology, the Spiruroidea, more specifically the Thelaziidae, have 2, 4, or 6 lips and a chitinised buccal capsule, which does not allow the oesophagus to approach the anterior end of the worm. The Filarioidea have no lips, no buccal capsule and the oesophagus extends to the anterior extremity of the worm. Furthermore, if one adheres to the antique method of classification, which uses habitat as a means of separating forms, the Spiruroidea inhabit the respiratory tract, alimentary tract, oral, nasal and orbital cavities, while the Filarioidea are tissue inhabiting parasites.

Having established the systematic position of the family Thelaziidae, we turn to the genus. The controversial question of generic limits is largely a matter of individual preference. In the recognition of genera I have endeavoured to adhere to the view that the genus should be used for expressing relationships, and that minor structural differences should be considered as of specific value only, and not of subgeneric worth, as done by Skrjabin in splitting the genus Oxyspirura into subgenera.

In working with this group, I have found that the most

important morphological characteristics for separating species are the caudal and cephalic papillae patterns; the ratios of the lengths of the spicules and their structure; the position and external nature of the vulva; and the length and width of the buccal capsule. The erection of the four new species has been proposed with reference to the above characteristics in that order. The length and width of the oesophagus of these syntypes are variable within individuals of the same species and are therefore of little taxonomic importance. Throughout this collection, the lengths and widths of the South American parasites tend to be larger than the other tropical forms, such as the Australian and Indian parasites, but the ratios of the other diagnostic morphological features are similar; but where the South American parasites have migrated to new areas, the parasites of the new environment are larger than the original ones, as seen in Aprocta nyctidromi.

The taxonomist often tends to burden his descriptions with measurements and figures, which is only one step in taxonomic research. The pertinent taxonomic characters have been tabulated throughout this paper for easy reference. The evaluation and analysis of the data is the important phase of systematics, because genera and species have generic and specific characters but these are not absolute values.

On looking into the chorology of the Thelaziidae, one is impressed by their wide geographic distribution. This is possibly due to periodical and seasonal migrations of their hosts. The fundamental cause of bird migrations is obviously the waxing and waning of food supply. The bird hosts prior to their migration undergo physiological changes, which may be detrimental to them and beneficial to their parasites, which increase in number, by giving rise to a large number of eggs. These eggs

are dependent on some arthropod vector for development, and at the same time, it must not be forgotten that these arthropods are the main diet of the insectivorous hosts. The habitat of all these birds is the jungle, where the possibilities of their meeting an intermediate host are great. Birds follow more or less definite routes to and from their breeding grounds, which may be nests in tree tops or wood patches, thus becoming targets for the vectors of their parasites.

In this collection, there was some correlation between certain families of hosts and various genera of the Thelaziidae. In four genera of the family Cracidae, all the parasites were of the genus Thelazia, similarly in the family Caprimulgidae, the parasites were of the genus Oxyspirura. But among the Accipitridae (Hawks and Falcons) both genera of parasites were collcted, suggesting that the parasitic population is dependent upon the habits of their hosts. The Oxyspirura tend to be more host specific and restricted in their distribution than the Thelazia, which are found all over the tropics and even as far north as Russia.

Having discussed the systematic position of the Thelaziidae, their morphology and ecology, let us consider the economic and pathological significance of this group. Poultry raising is of very widespread general interest all over the world and game birds are being imported and exported in increasing numbers, with their commensals. Some of these nematode parasites have been shown to have a marked pathological effect on their hosts as well as their abnormal human hosts.

The Thelaziidae inhabit various sites of the eye and must undoubtedly cause some irritation to the host. This irritation need not be of such a degree as to cause the death of the host, because parasites in their normal hosts never cause extinction of their staff of life. But

economically, their presence, as in the case of Oxyspirura in domestic chickens leads to heavy economic losses.

Finally, a word must be said about the evolution of the Thelaziidae. The genus is obviously a very old one originating many millions of years ago on the isolated island of South America. There is a tendency among these parasites to migrate along with their hosts to different geographical regions, where they have to undergo certain embryological changes and undergo modification with the geological changes, and as a result, all these factors give rise to numerous species. However, it must not be forgotten that many families of birds in South America are indigenous to the jungle and do not migrate. Therefore, how can we explain the occurrence of Thelazia in Europe and South America ? This can be explained by Wegener's hypothesis on the scattered distribution of animals, when the continents drifted apart, the organisms were separated from their kindred forms and have now come to exist in isolated pockets in distant regions.

In conclusion, the following Parasite-Host List sums up the study, and shows the new parasite-host and area records and the families of birds native to South America.

## PARASITE - HOST LIST.

| Parasite | Host | Family of Host. |
|---|---|---|
| T. pittae ♂ ♀ | Spizastur melanoleucus | Accipitridae (Hawks) |
| T. spizaëti sp.nov. | Spizaëtus ornatus | |
| O. octopapillata ** | - | |
| T. anadorhynchi sp.nov. | Anadorhynchus hyacinthinus | Psittacidae (Parrots and Macaws) |
| O. anacanthura ** | Guira guira | Cucilidae (Cuckoos) |
| T. cholodkowskii ♂ ♀ | Otus choliba | Strigidae (Owls) |
| T. sicki sp.nov. | Otus sp. | |
| O. brevisubulata ♂ | Nyctidromus albicollis | Caprimulgidae (Nightjars) |
| O. petrowi ♂ ♀ | Setopagis parvula | |
| T. dacelonis ♂ ♀ | Trogon melanurus | Trogonidae (Trogons) |
| O. anacanthura ♂ | Ramphastos culminatus | Ramphastidae * (Toucans) |
| O. sygmoidea ♂ ♀ | Ramphastos cuvieri | |
| C. thriponaxis ♂ ♀ | Ramphastos culminatus | |
| A. nyctidromi ♂ ♀ | - | Picidae (Woodpeckers) |

| Parasite | Host | Family of Host. | |
|---|---|---|---|
| T. tonkinensis ø o | Cephalopterus ornatus | Cotingidae (Chatterers) | * |
| O. cameroni sp.nov. | Tityra cayana | | |
| T. buteonis ø o | Pipele cumanensis | Cracidae (Curassows) | * |
| T. chungkingensis o | Mitu mitu | | |
| T. campanulata ** | Crypturellus strigulosus | Tinamidae (Tinamous) | * |
| T. lutzi ** | Tinamus tao | | |
| Thelazia sp. | Daptrius americanus | Falconidae (Falcons) | |
| Aprocta sp. | - | | |

* Families of birds found only in South America, according to Finn.(15)

ø New parasite-host record.

o New area record.

** Previously recorded South American parasites.

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