TREASURY DEPARTMENT
Public Health and Marine-Hospital Service of the United States

HYGIENIC LABORATORY.—BULLETIN No. 60

April, 1910

A STUDY OF THE ANATOMY OF WATSONIUS (n. g.) WATSONI OF MAN

AND OF

NINETEEN ALLIED SPECIES OF MAMMALIAN TREMATODE WORMS OF THE SUPERFAMILY PARAMPHISTOMOIDEA

By

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and

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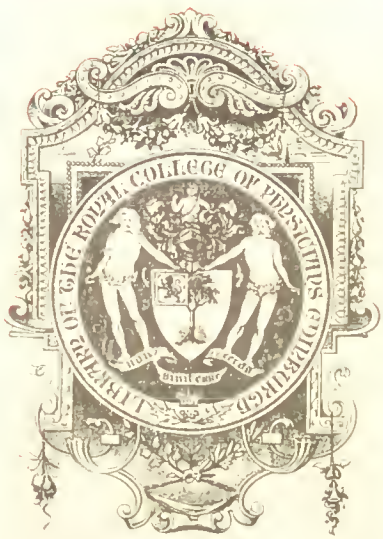

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AND OF NINETEEN ALLIED SPECIES OF MAMMALIAN TREMATODE WORMS OF THE SUPERFAMILY PARAMPHISTOMOIDEA.[a]

By Ch. Wardell Stiles,
Professor of Zoology,
and Joseph Goldberger,
Passed Assistant Surgeon, United States Public Health and Marine-Hospital Service.

SUMMARY.

The present paper contains the results of an anatomical study of one parasite of man (*Watsonius watsoni*) and comparison with 19 other closely related trematodes, part of which were sent to us for determination.

Watsonius watsoni, originally classified as *Amphistoma*, later as *Cladorchis*, represents the type of a new genus. Its testes are one caudad of the other, instead of side by side, as heretofore interpreted.

The families *Paramphistomidæ* and *Fasciolidæ* should be raised to superfamilies as *Paramphistomoidea* and *Fascioloidea*. *Paramphistomoidea* contains three families, *Gastrothylacidæ*, *Paramphistomidæ*, and *Gastrodiscidæ*.

These families may be divided into various subfamilies, genera, and subgenera, as shown in the table of contents (pp. 5–6) and in the various keys (pp. 15, 16, 50, 61, 62, 63, 74, 131, 173, 247, 249.

Anatomically, the group in question is very interesting, but a careful study of any given species is exceedingly tedious because of the thickness of the specimens. The projection method was found to be the most satisfactory in preparing drawings to illustrate the topography.

Of rather special interest is the perisuctorial cavity, which may be very large in some species. Dorsal and ventral mesenterium-like bands traverse this cavity, binding the oral sucker to the body parenchyma. The structure in question is strongly suggestive of a rudimentary body cavity, the absence of which is characteristic for the group of Flat Worms, to which these parasites belong.

We have been fortunate in having for study some of Cobbold's original material of *Amphistoma stanleyii* and *A. collinsii*, with the result that we accept *Pseudodiscus* as a valid genus. Anatomically, the fact is important that these species show a very complicated structure of the oral sucker and its pouches, the latter being separated from the former by intermediate bulbs.

Summaries of the separate groups may be found in the respective diagnoses and keys.

[a] Submitted for publication September 23, 1909.

INTRODUCTION.

Among the parasites recently sent to this laboratory for determination have been several species of amphistomes, which prove to be new to science. In studying them it has been found necessary to compare certain known forms especially the so-called *Cladorchis watsoni* of man. Fortunately for this work, we have had at our disposal some of Cobbold's original material of species of the little-known genus *Pseudodiscus* and one series of sections of the original material of *Cladorchis watsoni*.

The study has resulted in certain changes in classification and the proposition of several new genera and subgenera.

TAUTONYMY IN GENOTYPES.

One of us (Stiles) has upon several former occasions expressed the view that in the case of genotypes absolute or virtual tautonymy is exceedingly desirable. In accordance with this view we have, whenever the occasion presented itself, purposely formed the names so that either virtual or absolute tautonymy results. A consistent application of this principle would do much to reduce confusion in classification.

BIBLIOGRAPHIC REFERENCES.

Bibliographic references and systematic names of parasites refer to the citations given in Stiles & Hassall's Index Catalogue of Medical and Veterinary Zoology (Authors, Bull. 39, United States Bureau of Animal Industry; Trematoda, Bull. 37, Hygienic Laboratory, United States Public Health and Marine-Hospital Service).

TERMINOLOGY.

As some of the technical terms used in this paper are not in common use in helminthology, it may be well to give a few words of explanation in regard to them.

Oral sucker and pharynx.—The initial suctorial organ of the digestive tract of trematodes is usually named the "oral sucker," while the term "pharynx" is reserved for an organ of less constant nature which develops in the esophagus. In recent amphistome literature the term "pharynx" has been substituted by authors for the

"oral sucker" of the amphistomes. We agree with Looss that this substitution does not appear to be well founded and we therefore revert to the term "oral sucker."

Acetabulum.—The term "acetabulum" is reserved exclusively for the "caudal sucker," homologous with the "ventral sucker (acetabulum)" of the distomes.

Evaginations of oral sucker.—This is a general term used to designate any kind of an evagination from the lumen of the oral sucker; the evagination may be paired or circular.

Bulbs and pouches.—As these terms are used in this bulletin, a "pouch" is a cecal evagination, regardless of its histological structure or position relative to the sucker. In some species (as in *Pseudodiscus*) the pouch is separated from the sucker by a "bulb" namely, not a cecal structure.

The pouches vary somewhat in histological structure in different species. The walls usually present a loose mesh or parenchyma-like texture with few if any muscular elements; in some cases the meshwork appears more or less condensed, approaching the structure of the oral sucker as the latter occurs in *Homalogaster philippinensis* and *Watsonius watsoni.*

The bulbs agree with the oral sucker histologically, whether the latter be dense or loose in structure.

Testes and testicles.—We favor the use of the term "testis" and "testes" for the two male glands of the trematodes; if these glands are divided, as in *Pleorchis* or as in the cestodes, the subdivisions may well be called "testicles."

Genital pore.—The genital pore is the opening which leads from the external (ventro-median) surface of the worm into the genital atrium.

Genital atrium.—This is the cavity or depression into which the genital papilla projects. Its dimensions vary greatly in the different forms in which it occurs. In some it is partly divided into a ventral and a dorsal chamber by a more or less sharply developed projecting ring.

Porus hermaphroditicus.—The external opening of the ductus hermaphroditicus is the hermaphroditic pore and usually discharges into a genital atrium.

Topographic terms.—In a paper now in course of preparation, one of us (Stiles) is proposing a departure in the topographic terminology of the trematodes, and some of the terms are used in this bulletin. In brief, longitudinal and transverse straight lines are drawn at the periphery of the various organs; the longitudinal lines bound fields, the transverse lines bound zones. Portions of the body bounded by other than straight lines (as that portion bounded by the intestinal ceca) are termed "areas." Organs are then located with reference to these fields, zones, and areas. Thus, the testicular zones may

coincide, overlap, abut, or be separate; the testicular fields may coincide, overlap, abut, or be separate. An ovary may be described as in the pretesticular, testicular, or posttesticular zone, or in the extratesticular, testicular, or intertesticular field; a given organ may be in the prebifurcal zone, preacetabular zone, postacetabular, postovarial, postuterine zone, etc. The body is also divided into five transverse zones, each representing 20 per cent of the body length; these zones, beginning at the oral pole, are called the first, second, third, fourth, and fifth. It is believed that by aid of this system, descriptions may be made more exact than they frequently are at present, and that, especially in the case of tabular keys, the system will be found useful. A key to the figured species of distomes is now being formed on this principle; a preliminary study, based upon about 150 illustrations, has thus far been found to be very satisfactory.

SUPERGENERIC SYSTEMATIC UNITS.

During recent years, especially since 1898, the tendency in helminthology has been to raise species to generic rank, and genera to subfamily or even to family rank. In this tendency, helminthology has simply followed in the wake of other specialties in zoology. If in continuing this tendency we fail to recognize certain other systematic units, such as the superfamily (ending in *oidea*), and tribes and subtibes (ending in *idi* and *ini*), the danger is present that natural groups will be separated, units coordinate in rank will not be coordinate in actual value, and the classification will become confused.

It is true that the superfamily and the tribes and subtribes have not yet been recognized in the International Code, but they have been used by so many authors that they can be looked upon as recognized units. We here recognize the superfamily as standing between the suborder and the family, and we adopt for it the ending (*oidea*) proposed by Gill. The tribe (ending *idi*) and the subtribe (ending *ini*) we recognize as standing between the subfamily and the genus.

It would seem to us wise to raise the former trematode families *Fasciolidæ* and *Paramphistomidæ* to superfamily rank *Fascioloidea* and *Paramphistomoidea*, in order to leave room for expansion of systematic units made advisable because of recent changes in taxonomic conceptions in these groups. The present paper deals entirely with the *Paramphistomoidea*.

TECHNIQUE.

The material which forms the basis of this paper consisted, in the main, either of specimens sent to us for determination or of preserved specimens forming a part of the helminthological collection of the United States National Museum. Some of this latter material was

quite old, dating back as far as 1875 (*Ps. stanleyii*), but was remarkably well preserved. In the beginning of this work, after studying the external characters of the individuals of a species, we made "toto" mounts of stained and cleared specimens and a series of transverse and, if sufficient material was available, of sagittal and frontal sections. The general topography of the internal characters could more or less clearly be made out from the "toto" mounts and this would be corrected or amplified by a study of the serial sections. This method of procedure is obviously only applicable where several individuals, at least two, of one form are available for the study of the internal anatomy. Inasmuch as some of our most valuable material consisted of forms comprising not more than two individuals and only one of these was available for such study, the following method of procedure was devised by one of us (Goldberger) and applied with exceedingly satisfactory results. The external characters of the specimen selected were first carefully noted and then such drawings made as seemed desirable. These always included one of the ventral and another of the profile aspect, the outlines being made with the aid of the camera lucida. The specimen was next stained. We have used both carmine (para-carmine, carmalum, acetic acid alum-carmine) with and without counterstain (picric acid) and Mayer's hæmalum, but on the whole the carmine stains without counter stain gave us the most satisfactory pictures. After staining we dehydrated with alcohol and cleared in xylol. The cleared specimen was now examined under the microscope and drawings and notes made of such points in the internal topography as could be made out. After this the specimen was infiltrated and embedded in paraffin of a melting point of 54° C., careful note being taken of the orientation; this was always such as to give transverse sections at right angles to the median sagittal plane of the worm. Depending on the size of the worm the sections were cut at either 10μ or 20μ. In this connection it may perhaps be mentioned that, as has been repeatedly observed by one of us (Goldberger), the most favorable temperature for obtaining good ribbons of sections of this thickness is between 27° and 29° C.

The next step is the reconstruction of the worm from measurements of the sections with the ocular micrometer. The reconstruction is by projection on paper of a series of significant points at selected levels in either a ventral or a sagittal view. The base line in the former case may be one of the lateral margins, or, more simply and equally satisfactorily, the median sagittal plane (represented as the median longitudinal axis); in the case of the sagittal projection the profile line of the dorsum is used as the base line. The projected points belonging to the various organs are connected by lines which give, in effect, the outline, on a suitable scale, of the projected shadow of the body of the worm and of the organs or systems of organs. A

convenient scale is 50 for sections of 20μ and 100 for those of 10μ in thickness. On this scale each section is represented in projection as 1 mm. thick, and consequently the frontal apparent length of the worm would be represented as equal to the total number of the sections in millimeters. Given a satisfactory series of sections, this method enables one to work out the topography of the organs or systems of organs with a high degree of precision. It must be said, however, that it is also very tedious and time consuming. Our figures 1, 2, 23, 24, 45, 46, 61, 62, 72, 73, 83, 84, 94, 95, 105, 106, 139, 140, 192, and 193 were constructed in this way.

PARAMPHISTOMOIDEA, new superfamily.

SUPERFAMILY DIAGNOSIS.—*Trematoda*, *Malacocotylea*, *Digenea:* Acetabulum caudoterminal, subterminal, or ventral close to caudal end. Oral sucker and esophagus present, ceca 2. Hermaphroditic. Genital pore ventro-median, preequatorial, pretesticular, preovarial.

Male organs: Testes 1 or 2, usually preovarial.

Female organs: Vitellaria paired.

TYPE FAMILY.—*Paramphistomidæ*.

This superfamily is practically *Paramphistomidæ* Fischœder. It should, we believe, be divided into three families, as follows:

KEY TO FAMILIES OF PARAMPHISTOMOIDEA.

A^1. Body discoidal; divided into an anterior (cephalic) and a posterior (caudal) portion; venter with many, large papillæ; acetabulum ventral, at caudal end; ventral pouch absent ..... *Gastrodiscidæ*, p. 249.

A^2. Body not discoidal, not divided, venter not provided with many large papillæ:

B^1. Ventral pouch present ..... *Gastrothylacidæ*, p. 15.

B^2. Ventral pouch absent ..... *Paramphistomidæ*, p. 60.

GASTROTHYLACIDÆ, new family.

FAMILY DIAGNOSIS.—*Paramphistomoidea* (p. 15): Ventral pouch present.

TYPE GENUS.—*Gastrothylax* Poirier, 1883.

This group has heretofore been considered a genus in the family *Paramphistomidæ*, subfamily *Paramphistominæ*, but the presence of a ventral pouch separates it so radically from the other forms that distinct family rank seems justified. The typical, and thus far the only, subfamily *Gastrothylacinæ*, contains 13 species, which may be divided at present into 4 more or less natural groups. At least one of these groups (type *gregarius*) will doubtless soon require further subdivision. The question as to whether these groups should at present be given generic or subgeneric rank is one upon which there may be a very legitimate difference of opinion, but we believe that the entire tendency of the present day, wise or unwise as it may eventually prove to be, is to consider the differences in question as generic, and in the present paper we shall so regard them.

GASTROTHYLACINÆ, new subfamily.

SUBFAMILY DIAGNOSIS.—*Gastrothylacidæ* (p. 15): Body elongate, venter straight to concave, dorsum convex, cephalic end attenuate, rather pointed, straight, may curve slightly dorsad, caudal end slightly attenuate to rounded, usually slightly constricted immediately preacetabular, in transverse section more or less circular but form influenced by pouch. Ventral pouch opens slightly postoral, extending nearly or quite to acetabulum. Acetabulum relatively small, terminal to ventro-subterminal, slightly sunken, margin not raised. Genital pore without sucker. Excretory pore postvesicular or nearly so, in acetabular zone, caudad of pore of Laurer's canal. Oral sucker without evagination; esophagus without muscular thickening; ceca narrow, wavy or not wavy, long or short, end postequatorial.

Male organs: Testes 2, considerably smaller than acetabulum, coarsely lobate, rarely postovarial, chiefly preovarial, postequatorial, not widely separated from acetabulum; musculosa never enormous; cirrus-pouch absent.

Female organs: Ovary and shell-gland in testicular or posttesticular zone, never pretesticular; vitellaria extend from oral sucker to acetabulum, nearer ventral pouch than body wall, more ventral than dorsal, follicles in small groups; Laurer's canal anatomically prevesicular, but because of curve may lie partly in vesicular zone; uterus of 2 types (see genera).

Eggs: Operculated (at least in some forms).

TYPE GENUS.—*Gastrothylax* Poirier, 1883.

The four genera here recognized for the subfamily *Gastrothylacinæ* may be distinguished by the following key:

KEY TO GENERA OF GASTROTHYLACIDÆ, GASTROTHYLACINÆ.

A^1. Vas deferens and cephalic half of uterus in separate, right and left, largely extrasuctorial fields; uterus crosses to other side near equator of body; testicular fields separate, zones coincide; type *crumenifer*..... *Gastrothylax*, p. 16.

A^2. Vas deferens and cephalic half of uterus chiefly or entirely in suctorial field:

B^1. Testicular fields separate (lateral), zones coincide:

C^1. Vesicula seminalis with a straight and a coiled portion; testes in inter, extra, and cecal areas; type *wellmani*..... *Wellmanius*,[a] p. 51.

C^2. Vesicula seminalis without straight portion; testes inter or postcecal; type *gregarius*..... *Carmyerius*, p. 50.

B^2. Testicular fields coincide or overlap (median), zones coincide or overlap; type *elongatus*..... *Fischœderius*, p. 17.

GASTROTHYLAX Poirier, 1883.

GENERIC DIAGNOSIS.—*Gastrothylacinæ* (p. 16): Vas deferens and cephalic half of uterus in separate right and left, largely extrasuctorial fields, uterus crosses to other side near equator of body. Testicular fields separate, zones coincide and, chiefly, post cecal; ovary in intertesticular field. Cross section of ventral pouch triangular, with apex dorsad, base ventrad. Ceca end preovarian, preacetabular, in fourth zone, not wavy.

TYPE.—*G. crumenifer* (Creplin, 1847).

This genus is apparently Asiatic, and at present contains two species, which can be easily distinguished by the following key:

Ceca end pretesticular; body 9 to 11 mm. long; type host *Bos indicus*. [Probably from Asia]..... *G. compressus* Brandes, 1898.

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[a] In general we prefer masculine endings in zoological generic names.

Ceca end in testicular zone; body 9 to 18 mm. long; type host *Bos indicus*, Asia; also in *Bos kerabau*, Ceylon.....*G. crumenifer* (Creplin, 1847).

FISCHŒDERIUS, new genus.

GENERIC DIAGNOSIS.—*Gastrothylacinæ* (p. 16); Vas deferens and cephalic half of uterus chiefly or entirely in suctorial field. Testicular fields median, coincide or overlap, zones coincide or overlap, one testis more dorsal than the other, inter or postcecal; vesicula without straight portion. Ventral pouch divides body into 3 longitudinal body segments, a dorsal segment containing uterus, and 2 ventro-lateral segments.

TYPE SPECIES.—*F. fischœderi*. Asiatic.

This genus, which we dedicate to Fischœder (the well-known author who has done so much to advance our knowledge of the mammalian amphistomes), contains four very closely allied species, which may be distinguished by the following key:

a^1 Ceca end posttesticular, postovarian, in acetabular and fourth zone; testicular fields overlap, zones nearly coincide; body 8 to 10 mm. long; type host *Palonia frontalis*, Java.....*F. cobboldii* (Poirier, 1883).

a^2 Ceca end pretesticular, preovarian, preacetabular:

b^1 Genital pore on vertex of prominent hemispherical bulging; testicular fields and zones overlap:

c^1 Ceca end in third zone; ovary and shell gland not intertesticular; body 10 to 20 mm. long; type host "*Palonia*" *frontalis*, Java; also in *Bos kerabau* in China, and *Anoa depressicornis*.....*F. elongatus* (Poirier, 1883).

c^2 Ceca end in fourth zone; ovary and shell gland intertesticular; body 6.4 mm. long; type host *Bos kerabau*, Ceylon.....*F. fischœderi*, p. 17.

b^2 Genital pore not on vertex of prominent hemispherical bulging; ceca end in third zone:

c^3 Testicular zones overlap; ventral pouch not continued posttesticular; body 6.6 to 15.5 mm. long; type host *Bos* sp., Siam.....*F. siamensis*, p. 28.

c^4 Testicular zones coincide; ventral pouch continued posttesticular; body 6 to 7 mm. long; type host *Bos kerabau*, probably from Asiatic region.

F. ceylonensis, p. 39.

FISCHŒDERIUS FISCHŒDERI, new species.

[Figs. 1 to 10.]

SPECIFIC DIAGNOSIS.—*Fischœderius* (p. 17): Body 6.4 mm. long, 2 mm. broad, 2 mm. thick; buff color (alcohol specimen); rather conical, greatest transverse diameter near equator, greatest dorso-ventral diameter in caudal third; attenuated cephalad, and very slightly caudad; longitudinal axis somewhat curved, concavity ventrad; cephalic extremity bluntly pointed; caudal extremity blunt; dorsum convex longitudinally; venter slightly concave longitudinally; transverse sections nearly circular, but tending toward a bluntly rounded triangle, with apex ventrad, especially in equatorial region. Surface smooth except for a few blunt papillæ in cephalic region and on lip of aperture of ventral pouch. Opening of ventral pouch 0.5 millimeter from cephalic margin; pouch begins with a narrow neck, which at the genital pore widens into a large cavity, extending dorsally to near genital glands, ventrally slightly farther; transverse section of aperture and neck crescentic, of the cavity rather triangular with apex ventrad. Genital pore seemingly very slightly postbifurcal on a prominent bulging. Acetabulum 1.04 mm. in diameter, terminal, slightly sunken below surface of body, with 0.5 mm. aperture directed caudad but very slightly ventrad. Mouth terminal; oral sucker 0.6 mm. long, slightly larger than esophagus; perisuctorial cavity roomy;

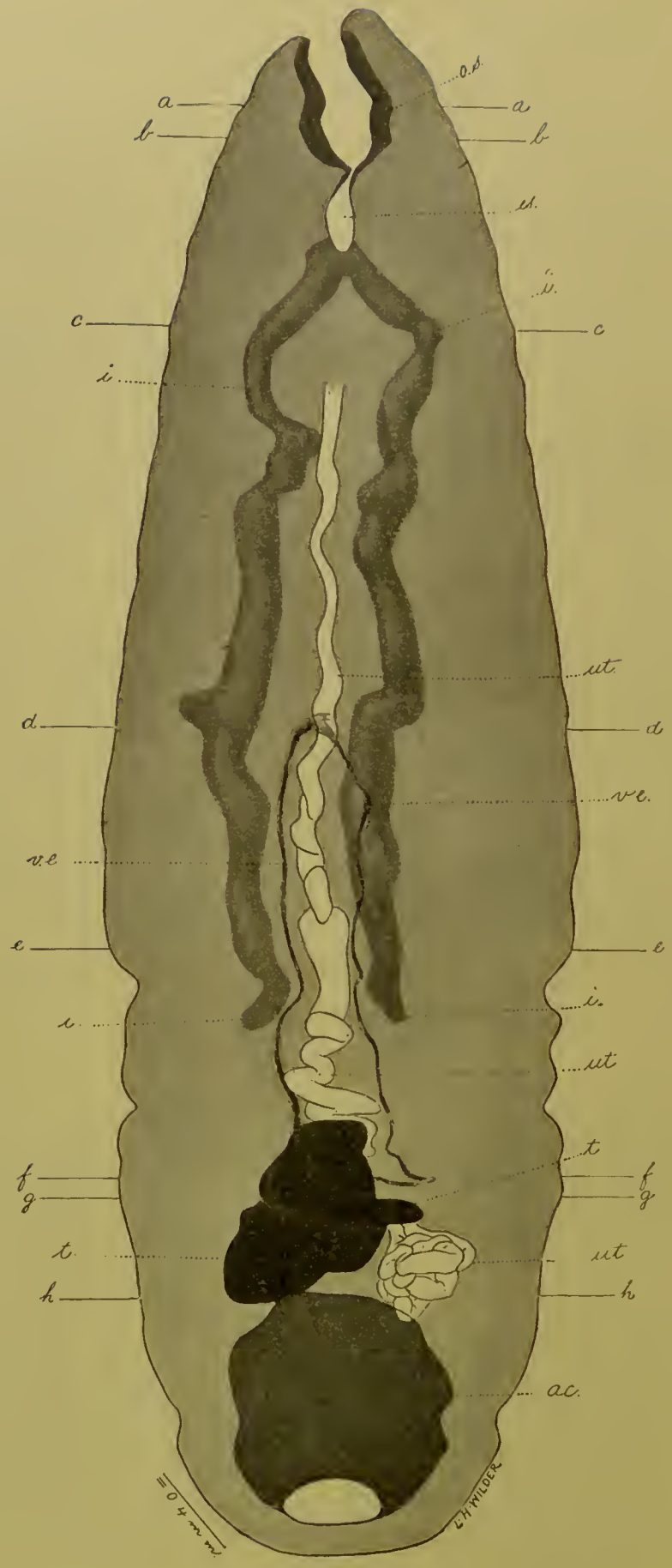

FIG. 1.

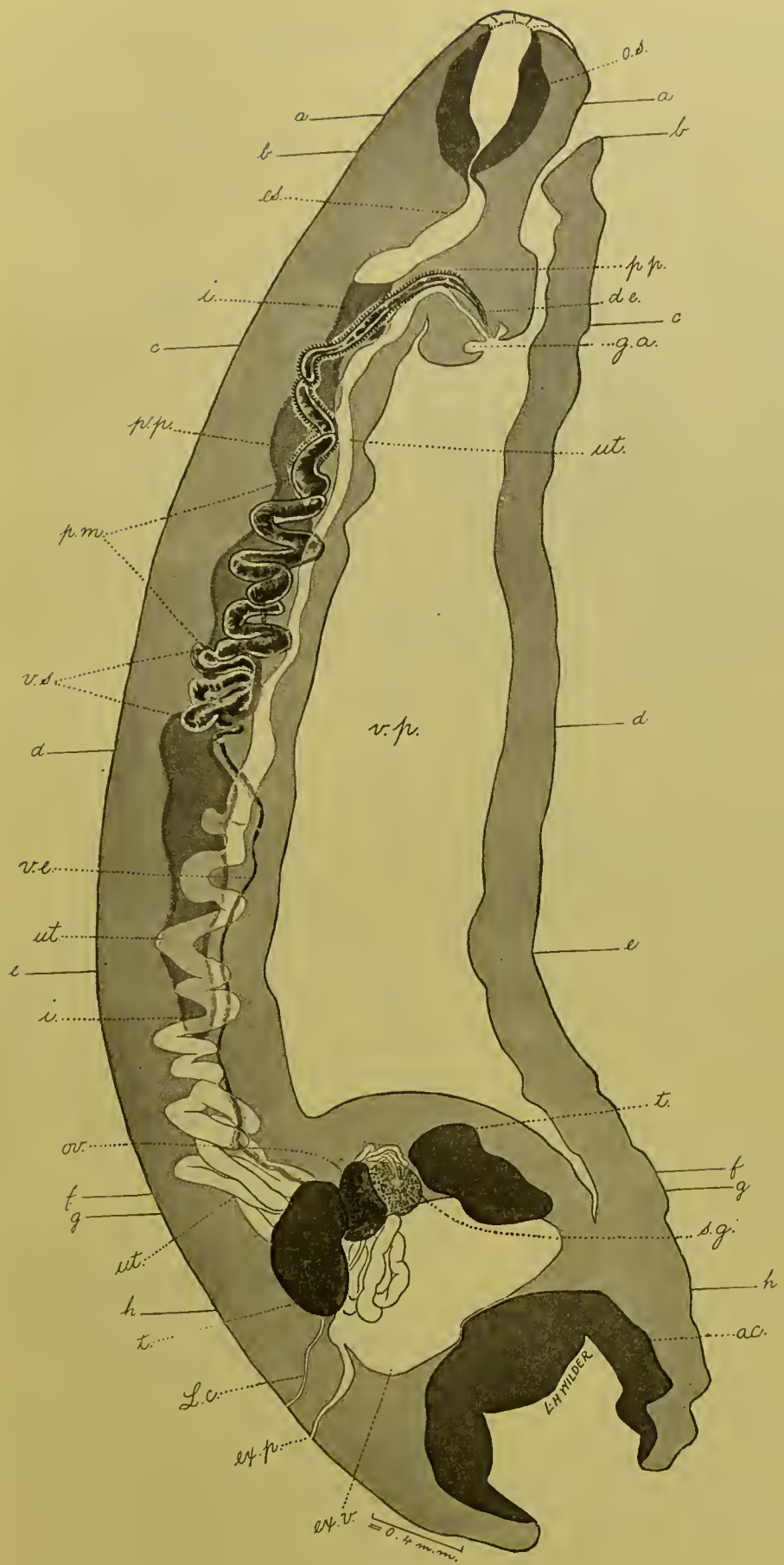
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FIG. 2.

intestinal bifurcation about one-sixth of body length from oral margin; intestinal ceca extend to caudal end of equatorial third of body. Excretory pore 0.16 mm. caudad of pore of Laurer's canal; excretory canal runs ventro-cephalad to dilated vesicle cephalad of acetabulum.

FIG. 3.

Male organs: Testes somewhat lobate, one ventral of the other, separated by ovary, one extending to right the other to left of median line, thus zones and fields overlap; the testes lie between acetabulum and fundus of ventral pouch; vasa efferentia arise on dorsal aspect, unite slightly cephalad of equator of body; vas deferens much coiled; pars prostatica less coiled; ductus ejaculatorius probably discharges independently of metraterm.

Female organs: Ovary and shell gland between testes; vitellogene glands consist of sparsely scattered follicles in ventrolateral body segments extending from slightly caudad of apparent genital pore to acetabulum; uterus extends from shell gland caudad, dorsally, turns cephalad, and runs between vasa efferentia, dips ventrally, extending cephalad, ventrally of vas deferens, to genital pore; Laurer's canal runs from oviduct dorso-caudad, opens on plane of cephalic margin of acetabulum, about 0.16 mm. cephalad of excretory pore.

Eggs: Few in number, 135 by 75μ in sections.

TYPE.—U.S.B.A.I. 15328.

HABITAT.—In (? organ of) *Bos kerabau*, from Ceylon.

FIG. 4.

SOURCE OF MATERIAL.—The single specimen studied was taken from bottle numbered 3377, containing a label with the following legend:

Name, *Gastrothylax elongatus* Poir. Host, *Bos kerabau*. Locality, Königsberg, Tiergarten (from Ceylon). Determined by Fischœder. Collected by Fischœder. Presented by Luehe, June, 1902.

The specimen was sectioned with a view to serving for purposes of comparison, but was found to differ from *G. elongatus* in several respects. Its new number is 15328.

EXTERNAL CHARACTERS.

Size.—The measurements taken from the sectioned specimen give a length of 6.4 mm. and greatest transverse and dorso-ventral diameters of about 2 mm. each.

Color.—The specimen was of a buff color.

Form.—In form it closely resembled *F. elongatus*, being somewhat spindle or cone shaped. While the greatest transverse diameter was in the equatorial region, the greatest dorso-ventral diameter was in the caudal third of the body. This appears to have been brought about by slight compression or shrinking from side to side of the caudal portion. The longitudinal axis is curved with the concavity ventrad. The cephalic extremity is bluntly pointed; the caudal is broad though somewhat attenuated as compared with the equatorial region. In the cephalic portion the transverse section is nearly circular but with some flattening ventrally in the region above the aperture of the ventral pouch (fig. 3); in the equatorial region the form in transverse section tends to assume a rounded-triangular outline (figs. 6 and 7) with the apex of the triangle ventrad.

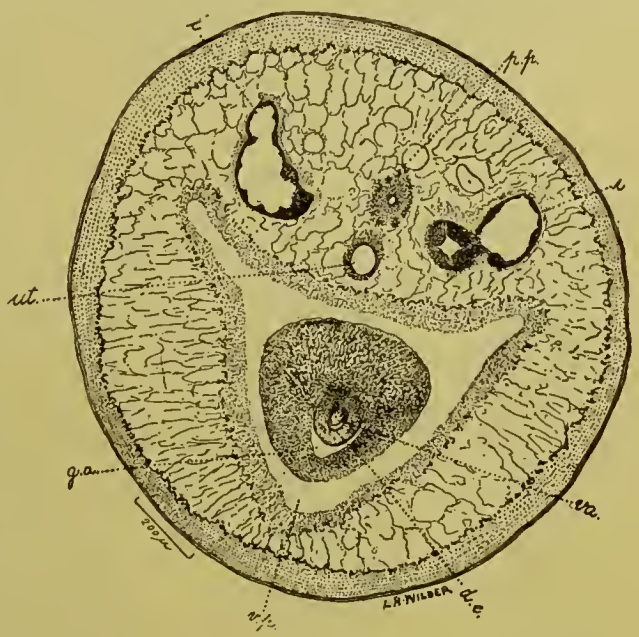

Fig. 5.

Surface.—The surface cuticle is unarmed; but a few blunt papillæ were observed on the cephalic portion and on the lip of the aperture of the ventral pouch (fig. 4).

Ventral pouch.—About 0.5 mm. caudad of the cephalic margin there is a transverse slit which marks the ventral aspect of the animal and serves as the aperture of the ventral pouch (see fig. 4). The lip of the aperture curves latero-cephalad from the median line forming two lateral ridges (see fig. 3), which rapidly fade out. Included between these ridges is a portion of the ventral aspect of the cephalic

extremity which is flattened and continuous with the dorsal wall of the neck of the pouch. The aperture gives entrance to a ventro-dorsally narrow passage which extends caudad to the level of the genital pore, beyond which this neck dilates rather rapidly to form the body of the pouch (fig. 2). The pouch extends caudad to a point slightly cephalad of the genital organs. The fundus of the pouch bulges somewhat cephalo-ventrad into the lumen in such a manner that the dorsal wall of the pouch is the shortest, the ventral the longest, and the lateral walls intermediate between the two. A dorso-ventrally very narrow, crescentic, slit-like prolongation of the pouch extends caudad in front of the ventral testis to the plane of the caudal aspect of the latter (figs. 2, 8, 9). In transverse section the aperture of the ventral pouch is a crescentic slit, measuring 0.45 mm. from horn to horn and about 0.1 mm. ventro-dorsally; the canal above (cephalad of) the genital pore retains the crescentic outline of the aperture, but below this level it tends to a triangular form, which becomes well defined in the body of the pouch. The apex of this triangle, like that of transverse sections of the body of the animal, is directed ventrad. Corresponding to the position of the angles of this triangle the inclosing body is constricted, marking off three segments, a dorsal and a right and left ventro-lateral, of which the dorsal is somewhat the largest (see figs. 6 and 7). In the equatorial region the longitudinal axis of the pouch and that of the body are substantially identical.

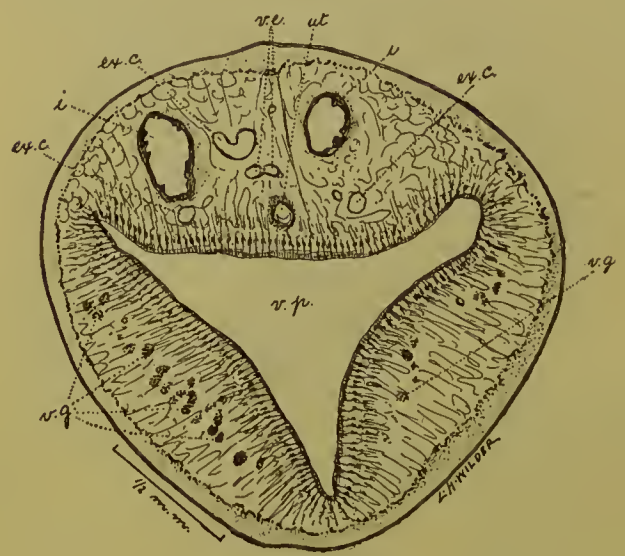

FIG. 6.

Genital pore.—On the dorsal wall of the neck of the ventral pouch at the vertex of a large muscular somewhat hemispherical bulging is the genital pore (figs. 2, 5). The pore leads into an atrium, the dorsal wall of which is in the form of a papilla, at the vertex of which is the opening of the ductus ejaculatorius and beneath and adjacent to this that of the metraterm. In the only specimen available for study the genital pore seemed to be in a plane slightly post-bifurcal. This appears to be due, however, to an artificial crowding or bending caudad of the hemispherical bulging which bears it. It is easily conceivable that a crowding or bending in the opposite direction would bring the pore to, or close to, the aperture of the ventral pouch.

Acetabulum.—This muscular organ, measuring about 1.04 mm. in diameter, occupies the caudal terminal portion of the body. It is, like that of *F. elongatus*, dome shaped, having an aperture measuring 0.05 mm., which is directed caudad and, because of the bending of the body axis, very slightly ventrad.

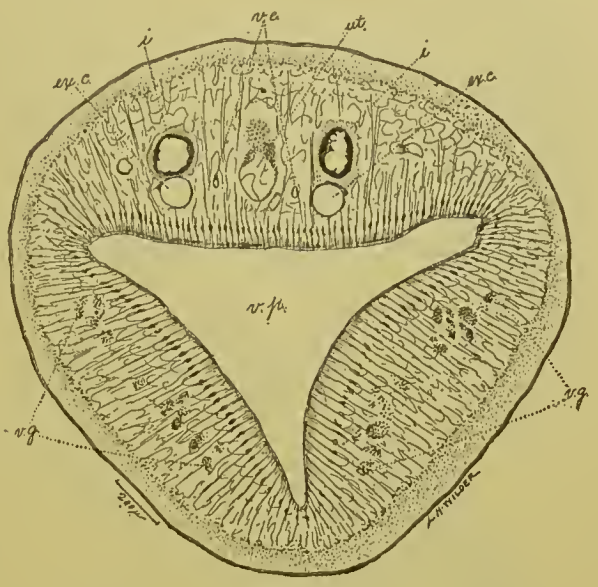

Fig. 7.

INTERNAL ANATOMY.

Digestive tract.—The bluntly pointed cephalic extremity is pierced by the mouth, which leads directly into a muscular oral sucker about 0.6 mm. long. This sucker lies in a large cavity (*p. s. sp.* figs. 3, 4), strongly suggestive of a rudimentary body cavity, which is traversed dorsally and ventrally by mesenterium-like bands (*m. b.* figs. 3, 4). The lumen of the sucker, in transverse section, is roughly circular near the mouth, but spindle shaped at its equator (fig. 3),with the long axis of the spindle in the transverse diameter of the animal; farther caudad this spindle becomes flattened dorso-ventrally so that the lumen becomes a transverse slit, which eventually becomes reduced to a small circular aperture as it gives entrance to the esophagus. It is provided with a number of not very prominent papillæ. The esophagus, as it leaves the base of the sucker, describes a fairly abrupt curve having its convexity ventrad and then passes caudo-dorsad to divide into two intestinal ceca; the esophagus measures about two-thirds the length of the oral sucker; dorsally of its cephalic portion is found a well-developed nerve complex.

Fig. 8.

The simple intestinal ceca pass for a short distance latero-caudad, then in irregular sinuous course caudad in the dorsal body segment. They terminate at the junction of the middle with the caudal third of the body.

The lumen of the oral sucker and that of the esophagus are lined by a cuticular layer in anatomical continuation with that of the body surface. It is thin in the sucker, thicker in the esophagus, and ceases abruptly at the fork. The intestinal lumen is lined by a layer of epithelial cells.

Genital system.—The two testes, the ovary, and the shell gland are in the caudal portion of the body between the fundus of the ventral pouch and the dome of the acetabulum, one testis lying dorsally, the other ventrally of the female glands.

Male organs.—The testes lie in about the same dorso-ventral plane, the left in front (ventral) of the right and separated from the latter by the interposition of the ovary, shell gland, and the dome of the distended excretory vesicle. The ventral testis extends more to the left of the median line, while the greater portion of the dorsal testis lies immediately to the right of this line, their fields consequently overlap; the latter testis lies also in a plane that is slightly lower (more caudad) than that of the former, their zones overlapping (figs. 1, 2, 8, 10). Both glands appear much shrunken, and each is made up of several lobes; the right is slightly larger than the left and the caudo-dorsal aspect of the latter appears excavated and molded to the contour of the ventro-cephalic aspect of the distended excretory vesicle (fig. 9). From the dorsal aspect of each testis there arises a vas efferens. These ducts pass dorso-cephalad, that from the left or ventral testis describing a somewhat sinuous course as it curves around to the left of the shell gland and ovary. Near the dorsum of the animal and in a plane just above (cephalad of) the testes, these ducts, one on each side of and slightly removed from the median line, turn directly cephalad and pursue a slightly sinuous course to the equator of the animal; at this level they begin to arch

Fig. 9.

inward toward the median line and soon unite to form the vas deferens (fig. 6). In the greater part of their course cephalad they lie more or less close to the ventro-median aspect of the corresponding cecum with the uterus between them (fig. 7).

The vas deferens, almost immediately after it begins, develops a complex coil and its lumen becomes more or less dilated and filled with spermatozoa; this portion represents the vesicula seminalis. Soon its walls, which appear as delicate as those of the vasa efferentia, become abruptly thickened by an enormous increase in the muscular layers and its lumen becomes much reduced in caliber. This portion of the vas deferens (pars musculosa) continues the coil begun by the vesicula, but after pursuing a course cephalad for about twice as long a distance as that of the vesicula, the muscular wall of the duct becomes enclosed in a moderately thick layer of cells. From this point, which is about at the junction of the first with the middle third of the body, the complexity of its loops becomes very greatly reduced, its course cephalad becomes less and less winding and the thickness of its muscular wall slowly diminishes; this portion represents the pars prostatica. The coils of the vesicula, musculosa, and the windings of the first portion of the prostatica lie in the space between the corresponding portions of the intestinal ceca. As the prostatica nears the esophageal fork it tends ventrad and eventually reaches the ventral aspect of the fork at which level it describes a curve in the sagittal plane of the body with the convexity of the curve cephalad (fig. 2). At the vertex of this curve the prostatic cells abruptly cease and the duct, which at this point has become somewhat reduced in size though still with walls of considerable thickness, turns ventro-caudad, approaches and then penetrates the base of the genital papilla, at the vertex of which,

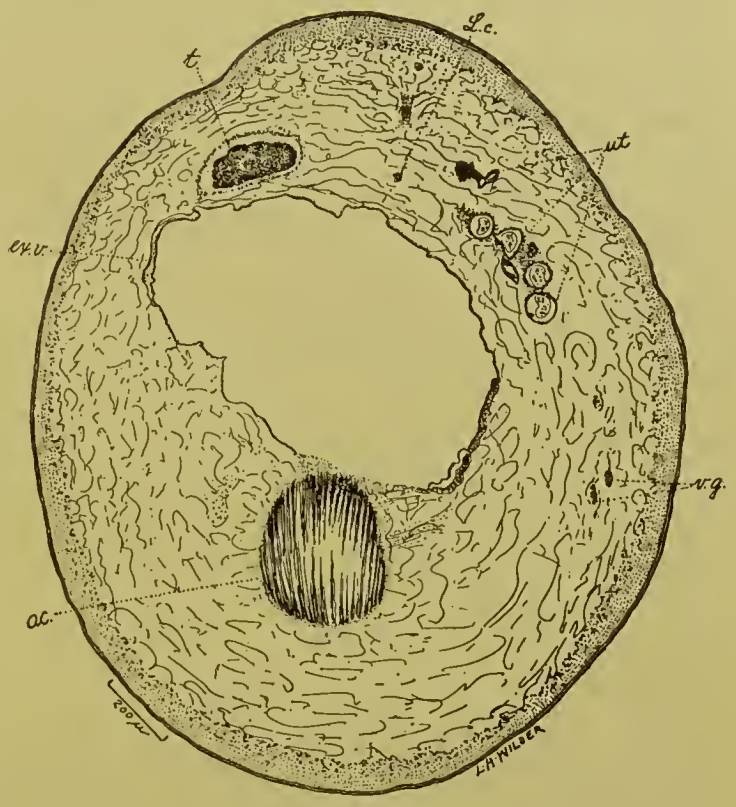

FIG. 10.

having become rapidly reduced in size, it opens by a minute pore just above the aperture of the metraterm (or possibly by a pore that is common to both ducts). The single specimen available for study does not show this with sufficient clearness for definite interpretation. To the portion of the male spermatic canal beyond the prostatica the name ductus ejaculatorius may be applied.

Female organs.—Lying in the axial region of the body between the upper (cephalic) portions of the two testes are the ovary and the shell gland, the latter being close to the left ventro-lateral aspect of the former (figs. 8, 9). The superior aspect of the ovary lies in a transverse plane that is slightly below (caudad of) the superior margin of the ventral and slightly above (cephalad of) that of the dorsal testis. The oviduct springs from the ventro-caudal aspect of the left pole of the ovary at the level of the caudal aspect of the shell gland to which the duct runs and which it penetrates, bending cephalad as it does so. In the shell gland it is joined by the vitello-duct. The shell gland is an egg-shaped body, considerably smaller than the ovary, close to the left ventro-lateral aspect of which it lies, with its long axis in the transverse diameter of the body of the parasite and with the broader, more bluntly rounded pole to the left. It is penetrated by the oviduct and the vitello-duct; the former at the caudal and the latter at the left ventro-lateral aspect. The two unite and the joint duct thus formed passes transversely to the right and slightly cephalad, forming the ootype in the center of the gland. Beyond this dilatation the duct is continued as the uterus, which emerges from the right pole of the gland (fig. 8). From this point the uterus curves over to the left of the shell gland. As it skirts close to the left of the shell gland, ovary, and dorsal testis in its course to the middle line of the dorsal segment some coils dip caudad to the left of the excretory vesicle. Having reached the median line it winds its way cephalad first between the vasa efferentia then under their arch and close to the ventral aspect of the vas deferens, retaining this relation to the male genital duct in the remainder of its course and forming a curve similar to that of the pars prostatica at the level of the esophageal fork before it, as the metraterm, penetrates the genital papilla at the vertex of which it opens either just below and separate from the aperture of the male genital duct or in common with it.

The uterine canal contains relatively few eggs; these were most numerous in the portion nearest the ovary. Measurement of one of these in section gave a length of 135μ and a width of 75μ. Laurer's canal leaves the oviduct from a point close to the shell gland and then passes dorso-caudad to open by a minute pore in the dorso-median line a little below the superior margin of the acetabulum and about 0.16 mm. above the excretory pore.

The vitellaria consist of sparsely scattered follicles confined to the ventro-lateral body segments. In a vertical direction they extend from a little below the level of the genital pore to the level of the superior margin of the acetabulum. The transverse vitello-ducts pass transversely inward with a tilt cephalad to unite in the median line dorsally and slightly caudally of the superior margin of the ventral testis and just cephalad of the plane of the superior margin of the shell gland. Their point of union is not dilated into a reservoir, but a slender duct is given off which passes at first caudad for a very short distance, then to the left, skirting the ventral aspect of the shell gland which it penetrates near the left extremity and, describing a sharp curve as it does so, becomes directed to the right and unites with the oviduct.

Excretory system.—The excretory vesicle is large and distended and fills the space between the male and female sexual glands above (cephalad) and the acetabulum below (caudad) (figs, 2, 9, 10). From its dorsal aspect there springs a short excretory duct which passes caudo-dorsad to open in the dorso-median line about 0.16 mm. caudad of the pore of Laurer's canal. The duct is lined by a fairly thick cuticular layer in anatomical continuation with that of the general body surface. Two large longitudinal excretory canals are found at about the level of the esophageal fork, where they lie near the dorso-lateral aspect of the corresponding ceca. As the intestines shift latero-dorsad, the canals come to lie first close to the median side and later close to the ventro-median and ventral aspect of the ceca (figs. 6, 7). The canals pass caudad to a point in the transverse plane of the superior margin of the ventral testis, when they bend somewhat ventrad to empty into the excretory vesicle.

RELATION TO OTHER SPECIES.

This worm seems most closely related to *F. elongatus*, from which it differs chiefly in the greater proportionate length of its intestine; in the position of the ovary and shell gland, which lie between the upper portion of the testes in this form, whereas in *F. elongatus* they are caudad of the dorsal testis.

ILLUSTRATIONS.

Fig. 1.—Frontal projection showing oral sucker (*o. s.*), esophagus (*es.*), intestinal ceca (*i.*), portion of the uterus (*ut.*), the testes (*t.*), vasa efferentia (*v. e.*), and acetabulum (*ac.*). *a–a, b–b, c–c, d–d, e–e, f–f, g–g, h–h,* planes of section. Enlarged. Original.

Fig. 2.—Profile projection showing oral sucker (*o. s.*), esophagus (*es.*), left intestine (*i.*), the ventral pouch (*v. p.*), the genital bulging with the genital pore leading into the genital atrium (*g. a.*), the uterus

(*ut.*), shell gland (*s. g.*), ovary (*ov.*), the testes (*t.*), left vas efferens (*v. e.*), vesicula seminalis (*v. s.*), pars musculosa (*p. m.*), pars prostatica (*p. p.*), ductus ejaculatorius (*d. e.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), and acetabulum (*ac.*). *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, *h–h* planes of section. Enlarged. Original.

FIG. 3.—Transverse section at *a–a* figs. 1 and 2. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and a dorsal dorso-ventral mesenterium-like strand (*m. b.*). Enlarged. Original.

FIG. 4.—Transverse section at *b–b* figs. 1 and 2. Shows aperture of ventral pouch (*a. v. p.*), papillæ on lip of aperture (*s. pap.*), oral sucker (*o. s.*), dorsal and ventral mesenterium-like strands (*m. b.*), perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 5.—Transverse section at *c–c* figs. 1 and 2. Shows form of body, ventral pouch (*v. p.*), ductus ejaculatorius (*d. e.*), metraterm (*va.*), uterus (*ut.*), pars prostatica (*p. p.*), and intestines (*i.*). Enlarged. Original.

FIG. 6.—Transverse section at *d–d* figs. 1 and 2. Shows form of body, form of ventral pouch (*v. p.*), intestines (*i.*), excretory canals (*ex. c.*), the vasa efferentia about to unite (*v. e.*), uterus (*ut.*), and vitellogene glands (*v. g.*). Enlarged. Original.

FIG. 7.—Transverse section at *e–e* figs. 1 and 2. Shows form of body, form of ventral pouch (*v. p.*), position and relations of intestines (*i.*), excretory canal (*ex. c.*), vasa efferentia (*v. e.*), uterus (*ut.*), and vitellogene glands (*v. g.*). Enlarged. Original.

FIG. 8.—Transverse section at *f–f* figs. 1 and 2. Shows form of body, form of ventral pouch (*v. p.*), position and relation of the testes (*t*), ovary (*ov.*), shell gland (*s. g.*), transverse vitello-ducts (*t. vd.*), the vasa efferentia (*v. e.*), uterus (*ut.*), vitellogene glands (*v. g.*), and excretory canals (*ex. c.*). Enlarged. Original.

FIG. 9.—Transverse section at *g–g* figs. 1 and 2. Shows form of ventral pouch (*v. p.*), position and relations of the testes (*t.*), dome of excretory vesicle (*ex. v.*), ovary (*ov.*), caudal extremity of shell gland (*s. g.*), oviduct penetrating shell gland (*ov. d.*), right transverse vitello-duct (*t. vd.*), uterus (*ut.*), and vitellogene glands (*v. g.*). Enlarged. Original.

FIG. 10.—Transverse section at *h–h* figs. 1 and 2. Shows position and relations of the superior margin of the acetabulum (*ac.*), excretory vesicle (*ex. v.*), dorsal or right testis (*t.*), Laurer's canal (*L. c.*), and uterine loops (*ut.*). Enlarged. Original.

FISCHŒDERIUS SIAMENSIS, new species.

[Figs. 11 to 22.]

SPECIFIC DIAGNOSIS.—*Fischœderius* (p. 17): Body 6.6 to 15.5 mm. long; buff color (alcohol specimens); rather spindle shaped, with truncated caudal end, but most specimens distorted; greatest diameter somewhat precquatorial; oral end very

bluntly pointed; longitudinal axis straight or slightly curved with concavity ventrad; transverse sections near both poles circular, but at equator nearly circular or oval to triangular with apex ventrad. Surface with coarse transverse sulci or striations, best defined near poles; otherwise smooth, except for papillæ at oral pole. Crescentic opening of pouch varies in position from oral plane to equatorial plane of oral sucker; neck of pouch with triangular to semicircular outline in transverse section, extends caudad of genital pore, body of pouch is triangular to circular in outline and extends nearly to ventral testis, but a ventral prolongation may enter testicular zone; in equatorial region, longitudinal axis of pouch coincides with axis of body. Genital pore about 0.7 mm. from aperture of pouch, either bifurcal, or slightly pre or post bifurcal; a larger external (ventral) and a smaller internal (dorsal) atrium present, the latter nearly filled by the genital papilla. Acetabulum 1.5 mm. in diameter, aperture circular, 0.6 to 1.0 mm., directed slightly ventrad. Mouth in a crateriform depression; oral sucker pyriform, 0.2 mm. long, 0.2 mm. in dorso-ventral diameter; perisuctorial space distinct; esophagus about as long as oral sucker; bifurcation about on plane of genital pore; ceca short, extend to equator or slightly beyond, tortuous, in longitudinal dorsal body segment. Excretory pore dorso-median or right or left, about on plane of cephalic margin of acetabulum, caudad of pore of Laurer's canal.

Fig. 11.

Male organs: Testes median, one dorsal of the other, markedly indented, fields and zones overlap, immediately preacetabular; vasa efferentia unite in preequatorial body zone about at junction of cephalic and equatorial thirds; vesicula and musculosa coiled, prostatica sinuous; ductus ejaculatorius opens separately from metraterm.

Female organs: Ovary in testicular zone and field, dorso-caudad or caudad of dorsal testis, median, right, or left of median line; vitellaria chiefly in ventrolateral longitudinal body segments, but to some extent in dorsal segment lateral of ceca, extending about from plane of genital pore to or near the first testis; uterus extends from shell gland dorso-lateral, may dip caudad, turns cephalad, runs dorsally of testes, under union of vasa efferentia, in suctorial field to genital papilla, discharging separately from ductus ejaculatorius; Laurer's canal extends from oviduct in sinuous course cephalo-dorsad to dorsum, and discharges median or right or left, in plane slightly cephalad or caudad of cephalic margin of ovary.

Fig. 12.

Eggs: Not measured.

Habitat.—In (? organ of) "Cow" (*Bos* sp.), Phrapatoom Siam.

Type.—U.S.P.H.& M.H.S. 9956.

Source of material.—These worms form part of a sending by Dr. P. G. Woolley from Phrapatoom, Siam. The host was given as *Bos* ("cow").

EXTERNAL CHARACTERS.

Size.—Measurements of 28 specimens show considerable variation in size. The length varies from 6.66 mm. to 15.5 mm.; in only 7 of 28 specimens does the length exceed 10 mm.

Color.—The worms (fixed, and preserved in glycerine alcohol) are of a buff color.

Form.—Most of the specimens appear more or less distorted; only a few appear to have preserved what is presumed to be their natural shape. These show considerable variation (figs. 11–14) in form; in general, however, this is not unlike a spindle with a truncated caudal extremity. The greatest diameter of this spindle form is not in the equatorial region of the worm but somewhat preequatorial. The cephalic extremity is very bluntly pointed. The longitudinal axis is straight or very slightly curved with concavity of the curve ventrad. The caudal extremity is truncate; it presents the aperture of the acetabulum, the plane of which, being directed with a certain obliquity from the venter to the dorsum and downward, appears to be tilted more or less ventrad.

Fig. 13.

The outline of the worm in transverse section is approximately circular both at the caudal and the cephalic extremities. In the equatorial region, however, some specimens show a triangular, some a triquadrant, and others a more or less circular or oval form. When triangular, the apex of the triangle is directed ventrad. This ventrally directed angle is replaced by a vertical groove in those specimens presenting a triquadrant form.

Surface.—The general cuticular surface is marked by coarse transverse striations or sulci, that are best defined about the cephalic and the caudal extremities; it is smooth otherwise except at the cephalic pole where it is beset by short, more or less conical papillæ which are most numerous and most prominent immediately around the oral aperture. The papillæ measure up to 0.03 mm. in length and up to 0.045 mm. in width at the base.

Fig. 14.

Ventral pouch.—The position of the aperture of the pouch varies; in some it is in the same transverse plane as the mouth (fig. 16); in others it is somewhat caudad of this plane, namely, about in the equatorial plane of the oral sucker (fig. 15).

The aperture is followed by a passage the dimensions of which increase but slowly up to the level of the genital pore; beyond this its dimensions increase rapidly and soon this passage, which may be regarded as the neck, expands into the body of the pouch. The pouch extends caudad to a point in a transverse plane slightly cephalad of the ventral testis, though in some a more or less crescentic slit-like prolongation is tucked in, as it were, ventrally of this gland.

The fundus of the pouch is in a plane directed more or less obliquely from the dorsum ventrad and caudad so that the dorsal wall of the pouch is shorter than the ventral.

The dorsal wall of the neck of the pouch is arched ventrad, relatively slightly in the vertical, but considerably in the transverse direction. It differs markedly, however, from the semipedunculated globular bulging in *F. fischœderi* (fig. 2).

The form of the pouch in transverse sections depends somewhat on the level. The aperture is a simple transverse crescentic slit (fig. 15). At the level of the genital pore the form of the neck of the pouch is or tends to a triangular outline with the apex ventrad (fig. 17). In one of the specimens, however, the outline approached more nearly that of a semicircle, with the arch ventrad.

In the equatorial region of the animal the outline of the pouch varies in different individuals. In some it is triangular; in others it is almost circular, though in some of the latter specimens the pouch may present a triangular outline in a plane farther cephalad.

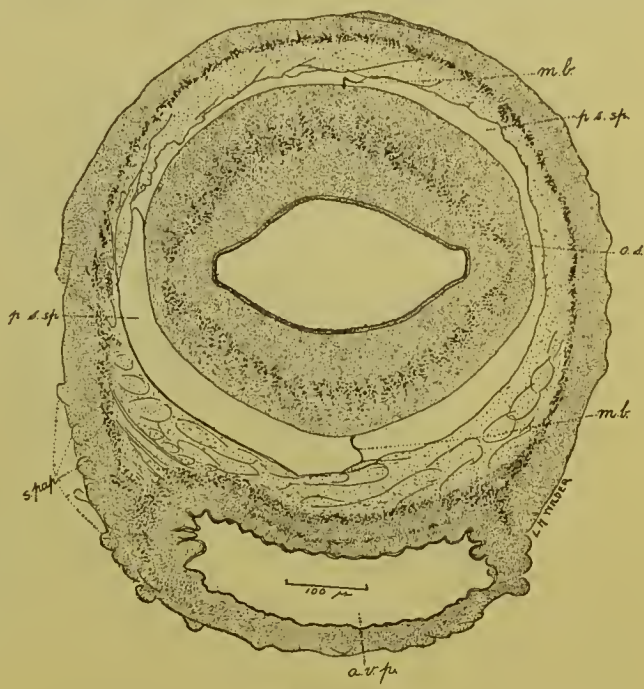

Fig. 15.

At the level of the cephalic aspect of the dorsal testis the outline of the pouch in transverse section also varies considerably in different specimens; in some it is a crescentic slit; in others, a caret-like slit, and in still others more or less irregularly circular.

In the equatorial region of the animal the longitudinal axis of the pouch coincides substantially with the longitudinal axis of the body. Whatever the form of the pouch in transverse section, the encircling body is divided into three approximately equal longitudinal segments by constrictions; one of the latter occupies the median ventral line and the others the right and left dorso-lateral regions, respectively (fig. 21). These constrictions correspond in position to the angles of the triangle when the pouch has this form.

Genital pore.—On the dorsal wall of the pouch, about 0.70 mm. from the aperture, is the genital pore. It is at about the level of the esophageal fork in 3 of 7 specimens; in 2 it is above and in 2 slightly below this level. The pore gives entrance to an atrium which appears to be divided into 2 chambers by a ring-like projection of the atrium wall. Of the 2 chambers thus formed, the outer, or ventral, is

much the larger. The inner, or dorsal, is almost completely filled by the genital papilla, leaving only a narrow slit-like space around the latter. The genital papilla projects into the chamber from what would be its dorsal wall. At the vertex of the papilla is the crater-like orifice of the metraterm and immediately above the latter is the minute aperture of the ductus ejaculatorius (figs. 17, 18, 19).

The projecting ring on the atrium wall varies considerably in prominence. In some specimens it is very well marked; in others it is but ill defined and apparently due only to a slight fold or narrow groove in the atrium wall.

Acetabulum.—This excavated somewhat hemispherical muscular organ occupies the caudal portion of the body. The terminal aperture is circular, tilted slightly ventrad, and in two sectioned specimens measured 0.6 mm. and 1.00 mm. in diameter, respectively.

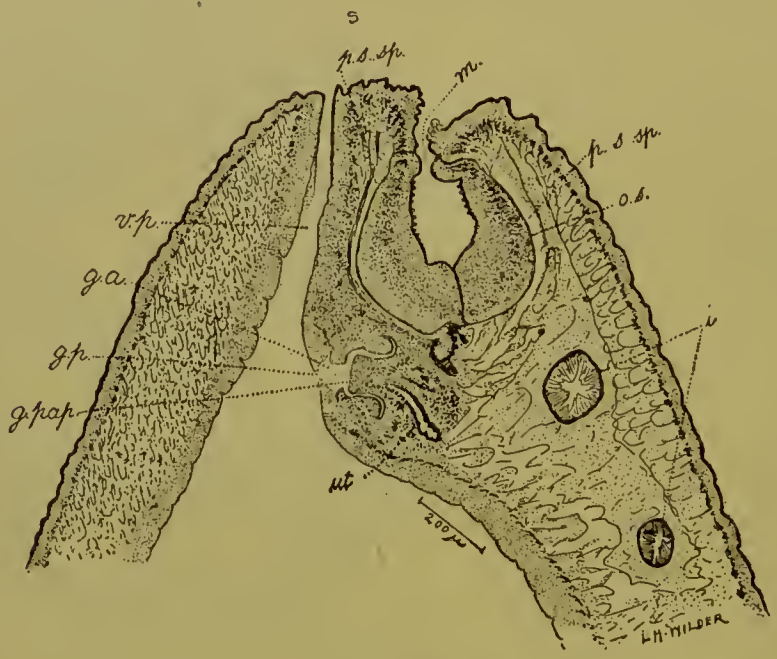

Fig. 16.

The muscular dome measured 0.45 mm. and 0.34 mm., respectively, in thickness in these two sectioned specimens.

The greatest diameter of the acetabulum measured in sectioned specimens was 1.5 mm. in one and 1.17 mm. in another.

INTERNAL ANATOMY.

Digestive tract.—The vertex of the bluntly pointed cephalic extremity is more or less depressed in the form of a more or less shallow irregularly circular crater, at the bottom of which is the mouth of the animal. This leads directly into a muscular pyriform oral sucker. The latter lies in a distinct cavity (figs. 15, 16), which is crossed dorsally and ventrally by dorso-ventral strands. Besides these strands,

the sucker is attached at both its poles to the body parenchyma. The lumen of the sucker varies somewhat in form in different individuals. In a general way it is a transversely broad, but dorso-ventrally a rather narrow space. In transverse sections the outline of the lumen varies at different levels. In the region of the mouth it is more or less circular or elliptical; farther caudad, about in the plane of the equator of the sucker, the outlines become spindle shaped with the major axis of the spindle in a transverse direction. This spindle-shaped outline is rapidly reduced to a transverse slit, and the slit in its turn, as the result of a contraction of its transverse diameter, becomes reduced to a small circular aperture which leads into the

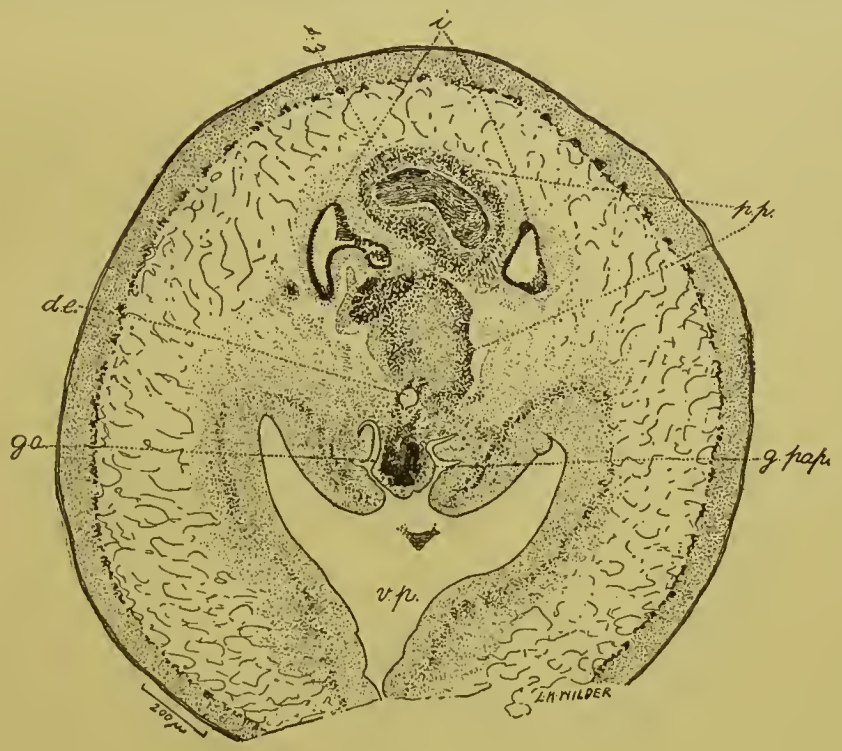

FIG. 17.

esophagus. The lumen is lined by a thin cuticle which, over about the cephalic half, is beset by very minute conical papillæ. The esophagus springs from the base of the oral sucker, and for a very short distance passes caudad in the axis of the latter; then rather abruptly it turns dorsad with but a slight inclination caudad. Its length is about equal to but does not exceed that of the sucker and it divides, laterally, into two intestinal cecal tubes. The angle formed by the fork appears to be somewhat in excess of 90°. The lumen is lined by a thick, cuticular layer.

The intestinal ceca, from their point of origin, pass, at first, latero-caudad, then directly caudad to terminate about midway between the cephalic and the caudal extremities. The ceca may extend

slightly beyond this point, or they may fall distinctly short of it. They pursue a somewhat tortuous course in the dorsal body segment from one-fourth to one-third of the width of the segment mediad of the constriction marking off this segment from the others. The lumen of the esophagus is lined with a cuticle-like layer, which ceases abruptly at the fork. Here it is replaced by a nucleated cell layer which extends throughout the intestine.

Genital system.—*Male organs:* The testes lie in the caudal portion of the axial region of the body immediately preacetabular (fig. 22). One is more or less directly dorsad of the other, but in slightly different though overlapping zones. The dorsal of the two testes is, as a rule, the one found in the higher (cephalad) of the testicular zones.

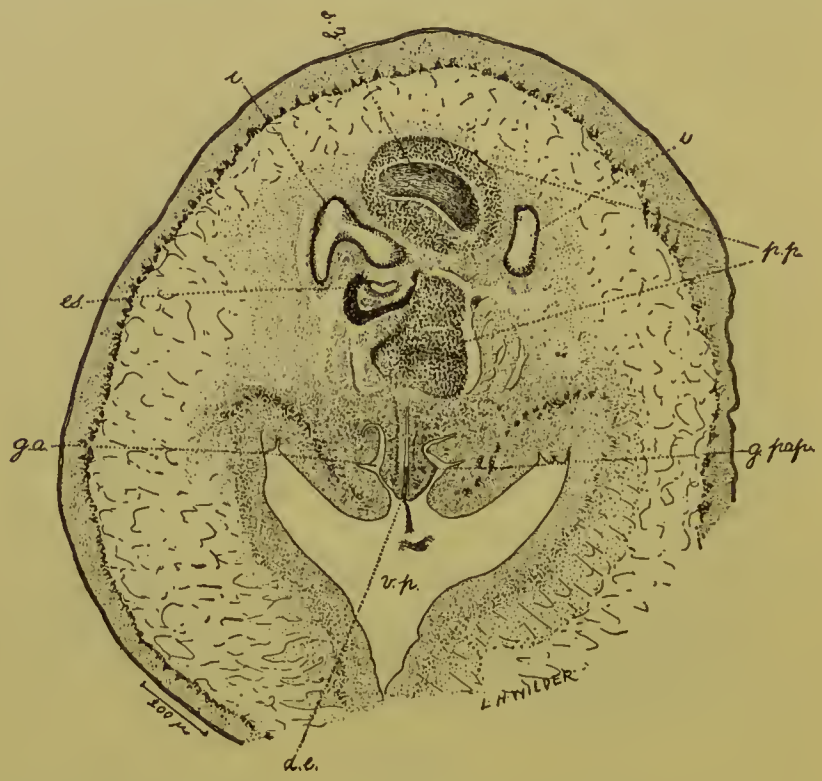

Fig. 18.

As a rule the testis from which the right vas efferens springs (the [?] right testis) is also the dorsal (and cephalic) one. In two of eight specimens studied this arrangement was reversed, the left testis (namely, the testis from which the left vas efferens springs) being dorsad and slightly cephalad of the right.

The margins of the testes are markedly indented, the indentations marking off lobes of different dimensions. From the dorsal or dorsocephalic aspect of each testis there springs a vas efferens which passes dorsad and slightly cephalad. The vas from the ventrally placed of the two testes, usually the left, describes a curve outward in its course as it skirts the margin of the dorsally placed gland. At about the level of the superior aspect of the superior testis the vasa effer-

entia change their course and proceed directly cephalad in the dorsal longitudinal body segment more or less close to and one on each side of the uterus. At about the level of the equatorial plane of the body of the animal the vasa efferentia come into relation with the intestinal ceca close to the ventro-median aspect of each of which they then continue on their way cephalad. They maintain this relation for some distance, then they bend rather abruptly inward toward the median line to unite and form the vas deferens. This union takes place at about the junction of the anterior with the middle third of the body.

The vas deferens, immediately after it begins, develops coils as it winds its way cephalad. These coils show a lumen which is more or less dilated in different specimens with walls no thicker than those of

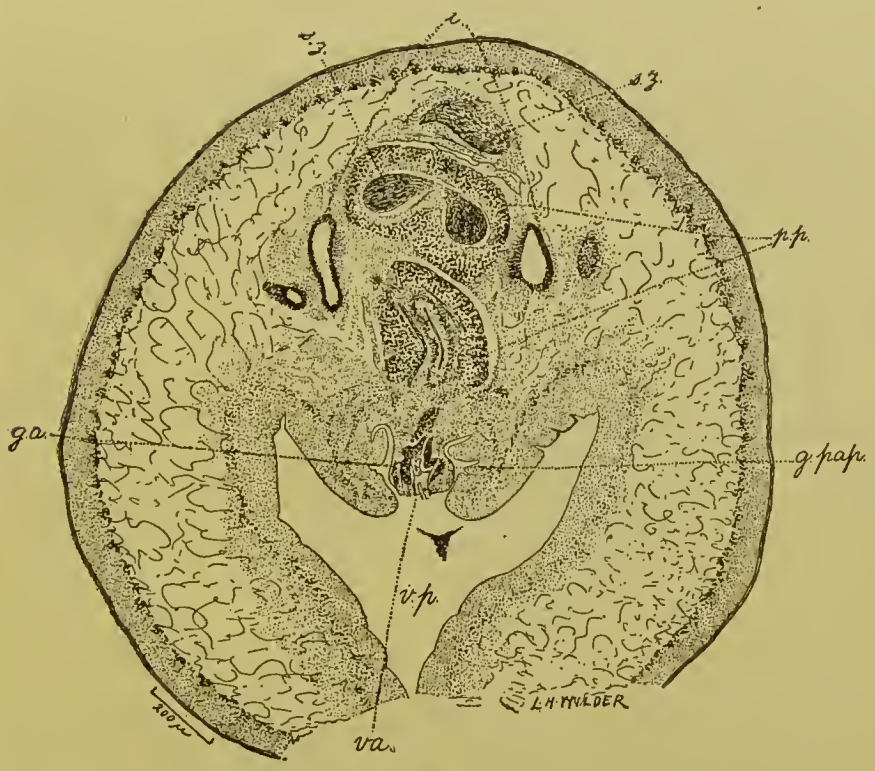

FIG. 19.

the vasa efferentia. This is the vesicula and, after proceeding a short distance, its walls become abruptly thickened by a marked increase in the muscular layer. This portion is the pars musculosa which also forms coils as it proceeds cephalad. These coils have a lumen that in some specimens is little if any smaller than that of the vesicula. This pars musculosa proceeds cephalad to within a short distance of the esophageal arch, where its direction is changed to cephalo-ventrad. At about this point, too, it ceases to form coils and is continued as the pars prostatica of the vas deferens. The pars prostatica pursues a more or less sinuous course and is inclosed in a thick layer of cells with well-defined nuclei. On reaching the base of the genital papilla this cell layer abruptly ceases. Before this point is reached there is ob-

servable also a gradual reduction in the thickness of the muscular coat. After penetrating the genital papilla, the wall of this duct, which now corresponds to the ductus ejaculatorius of other forms, becomes progressively thinner and its caliber becomes rapidly reduced in diameter so that at the vertex its opening is but a minute slit above the large female aperture.

Female organs.—The ovary lies in the testicular zone, dorso-caudad or directly caudad of the dorsally placed testis whether the latter be the left or the right. In other respects, however, its position is subject to considerable variation. In four of seven specimens the ovary was to the right, though close to the median dorso-ventral line; in two it was found in the median line, while in one it was to the left of this line.

The shell gland lies close to the ovary, but in other respects its relation to the latter varies considerably. In five of eight specimens the shell gland was found close to the left ventro-caudal aspect of the ovary, in two it was close to the right ventro-caudal aspect, and in one instance it was directly ventrad of the ovary.

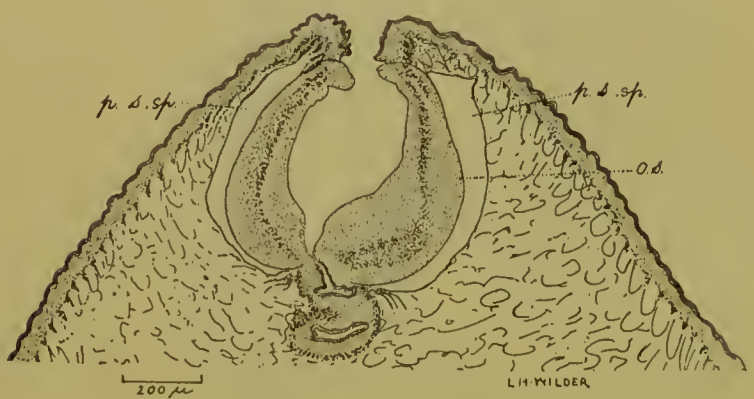

Fig. 20.

The oviduct springs from the ovary and passes to the shell gland, which it penetrates. Variations were observed both as regards the aspect of the ovary from which the duct sprang and the path which it pursued in its course to the shell gland. In six of eight specimens the oviduct sprang from the left lateral aspect of the ovary, in one from the right, and in one from the caudal aspect.

The path which the oviduct describes is more or less curved and is either in a transverse (horizontal) or in a more or less vertical plane.

The uterus emerges from the ventral, right or left lateral, or cephalic aspect of the shell gland. In none of the specimens studied did it emerge from either the dorsal or the caudal aspect. From this the uterus passed to the left dorso-lateral area of the body in seven of the eight specimens studied by us; in one instance the uterus passed to the right dorso-lateral region. In these areas the uterus at first may dip somewhat caudad, then it turns dorso-cephalad and toward the median line, passing dorsally of the dorsal testis and of the right or the left vas efferens, according as the uterus occupied the right or the left dorso-lateral areas. Having reached the median dorsal line it pursues a zigzag winding course cephalad with a vas efferens on each

side and passes beneath the arch formed by their union to gain the ventral aspect of the coiled vas deferens. It maintains this relation in the remainder of its course cephalad and ventro-cephalad to the genital papilla, which it penetrates. In this latter portion of its course the zigzag windings have become markedly reduced. Its terminal portion, the metraterm, pierces the genital papilla and opens by a large crateriform pore at the vertex of the latter.

The uterus contains a few eggs and the first portion also some spermatozoa; in one case it contained large cells resembling germ cells. Laurer's canal leaves the oviduct a little before the latter penetrates the shell gland. It then passes to the dorsum of the animal, describing a more or less sinuous course cephalo-dorsad to the right or left over or beneath the ovary to its pore on the dorsal surface; the pore lies in the median line or more or less to the right or left of it and in a transverse plane, which may be slightly above or below the superior margin of the ovary. In seven of eight specimens this point was more or less above the superior margin of the acetabulum, while in the eighth the pore of Laurer's canal was in a plane slightly below the superior margin of the acetabulum.

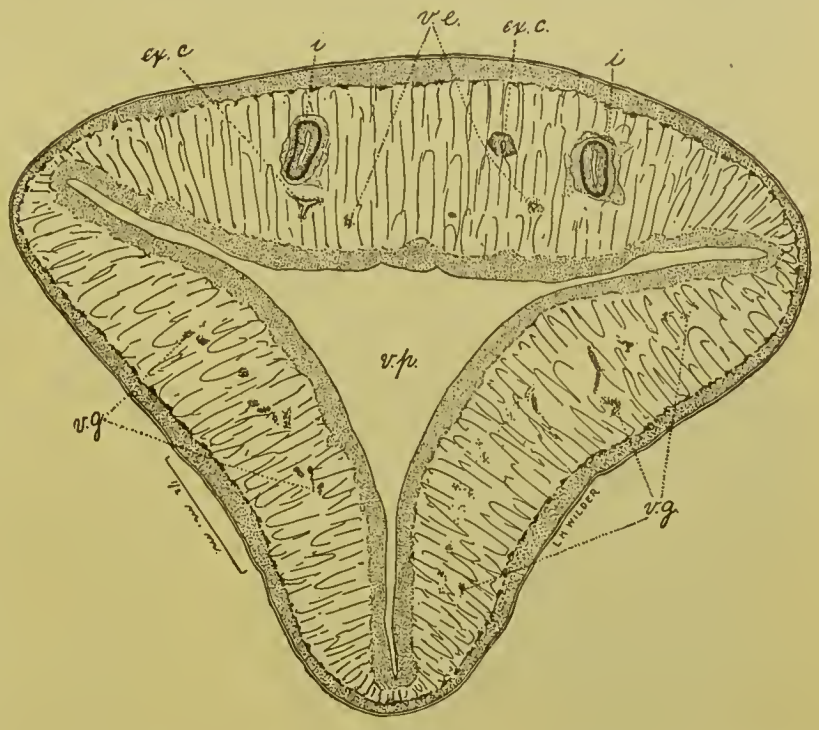

FIG. 21.

The vitellaria consist of sparsely scattered somewhat globular follicles, for the most part confined to the ventro-lateral body segments, but encroaching to some extent on those portions of the dorsal body segment external to the line of the intestinal ceca. They extend from about the level of the genital pore to a little short of or occasionally partly overlapping the zone of the superior testis. The transverse vitello-ducts pass mediad and slightly caudad from the lateral regions of the body about at the level of the ovary and ventrad of the latter to unite at the right or the left of and close to the shell gland, at which point a somewhat triangular dilatation is formed. From the

dorsal aspect of this dilatation (? vitelline reservoir) a relatively slender vitello-duct passes toward the shell gland and skirts one of the caudo-lateral aspects of the latter; on reaching the dorso-lateral aspect of this gland it curves cephalo-ventrad to penetrate the gland and then unites with the oviduct in the formation of the ootype.

Excretory system.—In the specimens studied the excretory vesicle was collapsed or only slightly distended and was placed dorso-cephalad of and at about the level of the dome of the acetabulum. The excretory duct leaves the dorsal aspect of the vesicle and passes to the dorsum in a more or less sinuous course, in most cases with a slight tendency caudad, but in some horizontally, and in others with a slight tilt cephalad. The excretory pore is caudad of the opening of Laurer's canal and is about at the level of the superior margin of the acetabulum, though in none of the specimens was it exactly so; in three of eight specimens it was slightly above and in five slightly below this point. Usually, also, it is in about the median dorsal line, but we found it somewhat to the right in one instance and considerably to the left in another. In each of two specimens it measured about 30μ in diameter.

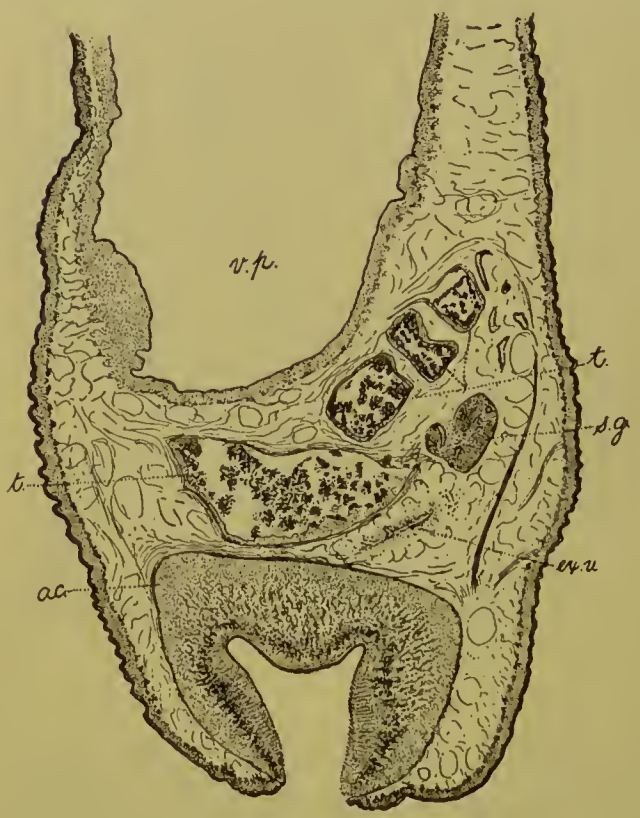

Fig. 22.

There are two main longitudinal canals which pass caudad in the dorsal longitudinal body segment lying near and ventral of the intestinal ceca in the cephalic half of the body, and they maintain this relative position beyond the termination of the ceca to the excretory vesicle.

ILLUSTRATIONS.

Fig. 11.—Ventral view. Enlarged. Original.

Fig. 12.—Profile view of specimen shown in Fig. 1. Enlarged. Original.

Figs. 13 and 14.—Profile views to show variation in form. Enlarged. Original.

Fig. 15.—Transverse section at level of aperture of ventral pouch. Shows form of body, surface papillæ (*s. pap.*), form of aperture of

ventral pouch (*a. v. p.*), form of oral sucker and its lumen (*o. s.*), perisuctorial space (*p. s. sp.*), and dorsal and ventral mesenterium-like strands (*m. b.*). Enlarged. Original.

FIG. 16.—Sagittal section through oral extremity. Shows mouth (*m.*), oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), aperture and neck of ventral pouch (*v. p.*), genital pore (*g. p.*), genital atrium (*g. a.*), genital papilla (*g. pap.*), intestine (*i.*), and uterus (*ut.*). Enlarged. Original.

FIGS. 17, 18, and 19.—Series of three transverse sections. Show form of body, form of neck of ventral pouch (*v. p.*), knuckle of esophagus (*es.*), intestinal ceca (*i.*), pars prostatica (*p. p.*) containing mass of spermatozoa (*sz.*), separate openings of ductus ejaculatorius (*d. e.*) and metraterm (*va.*), genital papilla (*g. pap.*) and genital atrium (*g. a.*). Enlarged. Original.

FIG. 20.—Frontal section through oral extremity to show sucker (*o. s.*) and perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 21.—Transverse section to show form of body and of ventral pouch (*v. p.*) in equatorial region. Shows also excretory canal (*ex. c.*), intestines (*i.*), vasa efferentia (*v. e.*) and vitellaria (*vg.*). Enlarged. Original.

FIG. 22.—Sagittal section of caudal extremity showing relations of acetabulum (*ac.*), excretory vesicle (*ex. v.*), testes (*t.*), shell gland (*s. g.*), and fundus of ventral pouch (*v. p.*). Enlarged. Original.

FISHŒDERIUS CEYLONENSIS, new species.

[Figs. 23 to 32.]

SPECIFIC DIAGNOSIS.—*Fischœderius* (p. 17): Body 6 to 7 mm. long by 2.56 mm. broad by 2.52 mm. thick; buff color (alcohol specimen); rather conical, but greatest diameter about at junction of equatorial and caudal thirds; rather prominently attenuated cephalad, slightly attenuated caudad; longitudinal axis slightly curved, concavity ventrad; cephalic end bluntly pointed; caudal extremity rather truncate; dorsum somewhat convex, venter slightly concave; lateral margins convex longitudinally; transverse sections near both poles nearly circular, but in equatorial region triangular with rounded angles, apex ventrad. Surface smooth, with exception of a few papillæ around mouth and aperture of ventral pouch. Opening of ventral pouch 0.62 mm. from oral margin; pouch begins with a narrow neck which extends to caudal margin of genital atrium (ventral chamber), then dilates into cavity which extends along dorsal wall to cephalic margin of testes and along ventral wall to equator of acetabulum; transverse sections of aperture and neck crescentic, and of cavity rather triangular with apex ventrad. Genital pore 1.18 mm. from cephalic margin, somewhat prebifurcal, in esophageal zone; a large external (ventral) and a small internal (dorsal) atrium present. Acetabulum 1.6 mm. in transverse and about 1 mm. in dorso-ventral diameter, terminal, slightly sunken in body, its 0.46 mm. aperture directed caudad and because of curvature of body axis very slightly ventrad. Mouth terminal, leads directly into oral sucker which is rather elongate pyriform, 0.62 mm. long, 0.33 mm. broad, 0.3 mm. thick, and lies in a well-developed cavity which is traversed dorsally and ventrally by mesenterium-like bands; esophagus relatively long, 0.72 mm., hence longer than oral sucker; bifurcation at junction of first and second

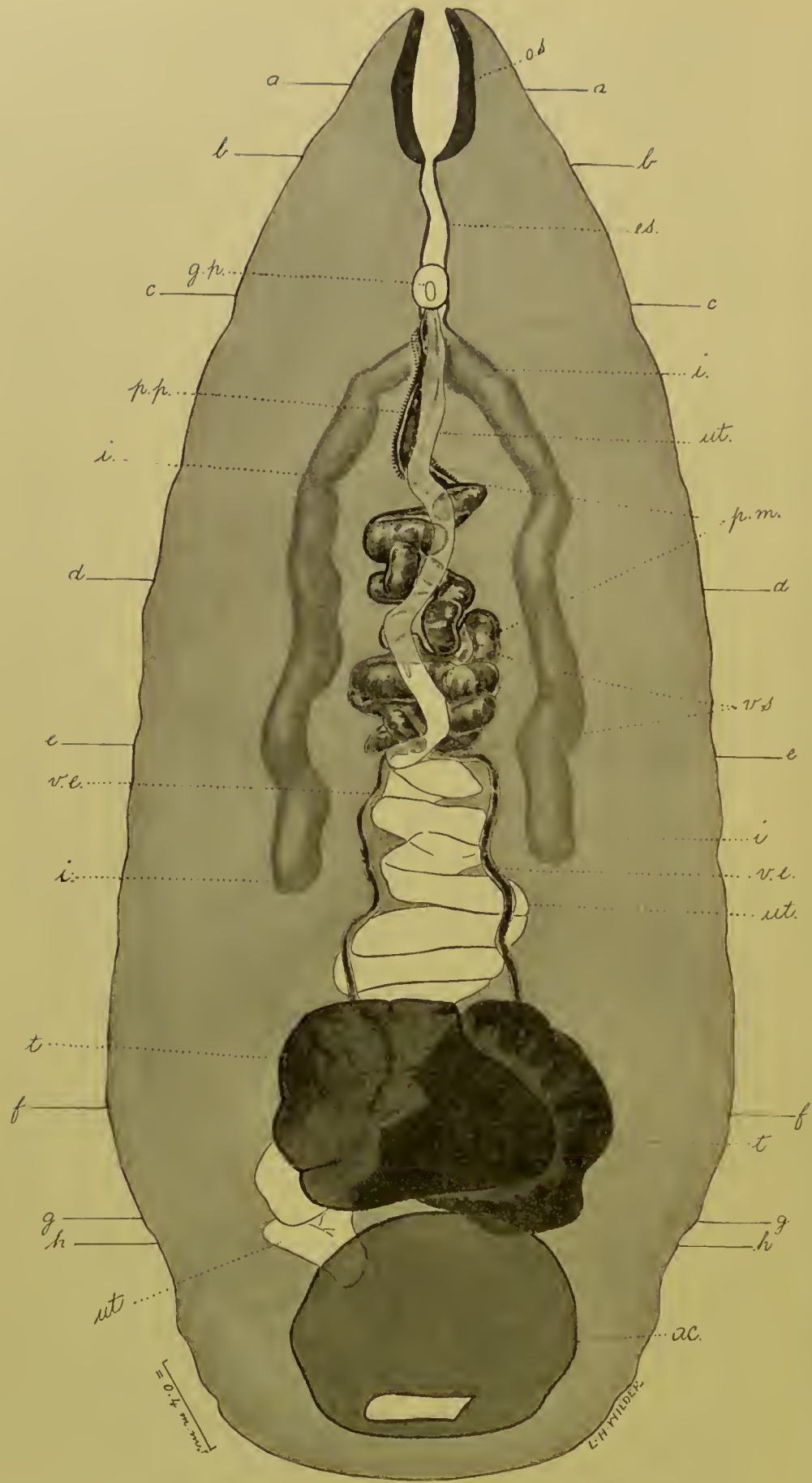
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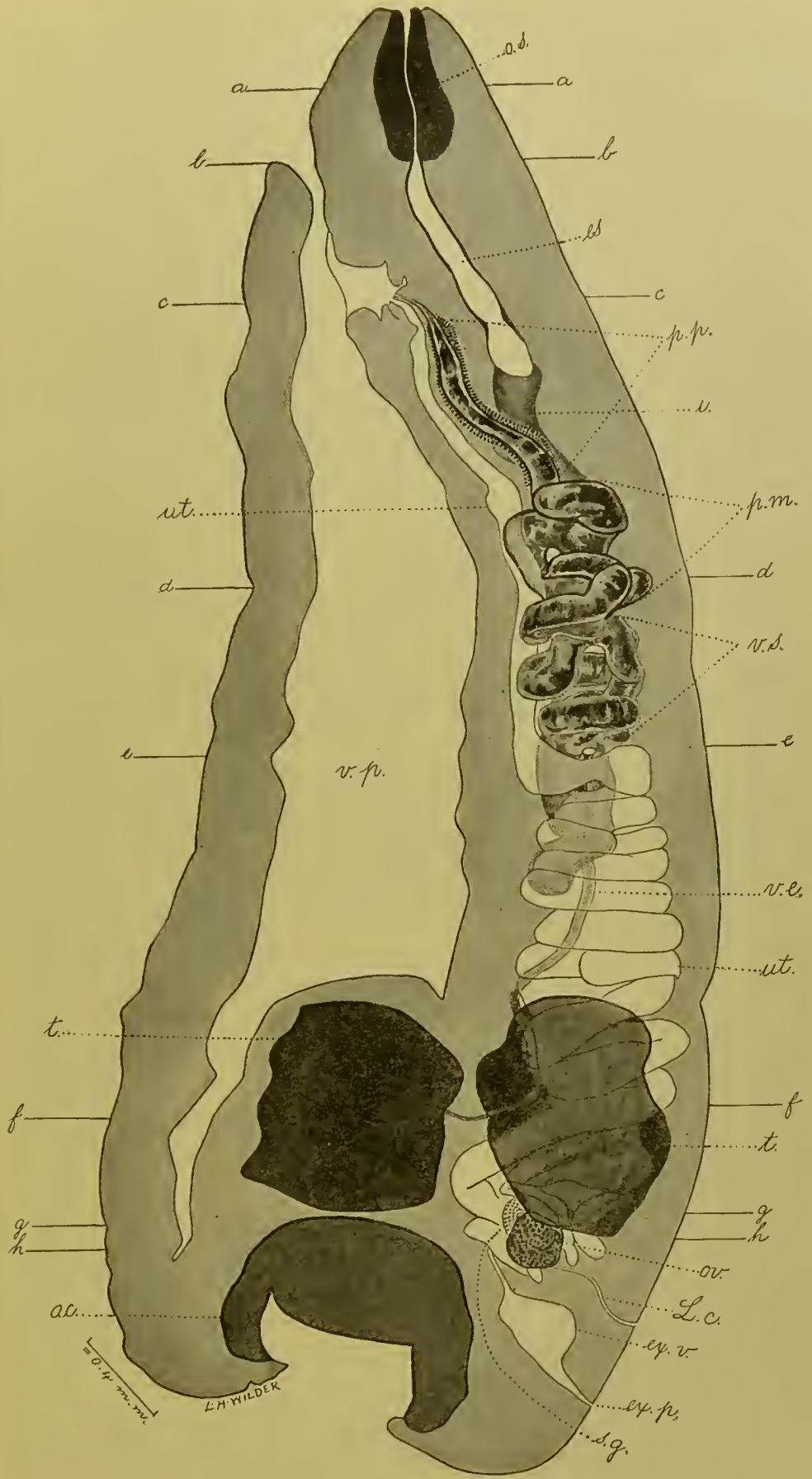
FIG. 23.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L.H. WILDER

FIG. 24.

fourths of body, ceca short, extend about to junction between third and fourth fifths of body. Excretory pore dorso-median about at equator of acetabulum and slightly (0.36 mm.) caudad of pore of Laurer's canal; duct short, vesicle not much distended in type specimen.

Male organs.—Testes large, indented, one dorsal of the other, immediately preacetabular, median, zones coincide, fields overlap, one testis extending more to the right, the other more to the left, of median line; vasa efferentia unite at equator of body; vesicula and pars musculosa well defined and coiled; pars prostatica long, nearly straight; ductus ejaculatorius relatively short, but distinct, discharges separately from metraterm.

Female organs.—Ovary and shell gland ventro-caudal of and very much smaller than dorsal testis; vitellaria in ventro-lateral and dorsal body segments, lateral of ceca, extending from level of caudal end of pars prostatica into but not beyond equatorial third; uterus extends from shell gland dextrad, dips slightly caudad, turns cephalad, forming loops dorsally of ventral and to right of dorsal testis, expands, passes under arch of vasa efferentia, then in slightly irregular line, but without loops, it extends cephalad in suctorial field ventrally of vas deferens, the metraterm discharges just below ductus ejaculatorius into atrium; Laurer's canal extends from oviduct dorso-caudad to dorso-median line 0.36 mm. cephalad of excretory pore and about on plane of cephalic margin of acetabulum.

Eggs: Not observed.

Host.—*Bos kerabau*, apparently from Ceylon, died in zoological garden in Germany.

Type.—U.S.B.A.I. 15358.

Source of material.—The single specimen studied was taken from a bottle numbered 3376, containing a label with the following legend:

Name, *Gastrothylax synethes* Fischœder. Cotype. Host. *Bos kerabau*. Locality, Kœnigsberg, Tiergarten [Leipzig]. Collected by Fischœder. Determined by Fischœder. Presented by Luehe; date, June, 1902.

The specimen, after staining with carmine, dehydration, and clearing, was found to differ from *Gastrothylax synethes* in several respects. It was then numbered 15358, sectioned, and studied in detail.

EXTERNAL CHARACTERS.

Size.—The alcohol specimen measured 7 mm. in length and 3 mm. in greatest width. Measurements from sections give 5.98 mm. length, 2.56 mm. greatest width, and 2.52 mm. greatest dorsoventral diameter.

Color.—The worm was of a buff color.

Form.—In a general way this specimen resembles both *G. synethes* and *G. elongatus*. Its greatest transverse and dorso-lateral diameters are at about the junction of the equatorial with the caudal third of the body. From this region toward the poles these diameters become progressively reduced, markedly toward the oral, slightly toward the aboral pole.

The longitudinal axis is slightly curved with the concavity ventrad.

In transverse section the outline of the body near the oral and aboral extremities is substantially circular (figs. 25–27, 30–31),

though just above the aperture of the ventral pouch the venter is flattened. In the equatorial region (figs. 28, 29) it is triangular in form with rounded angles, one of which occupies the median ventral longitudinal line.

Surface.—The surface cuticle is unarmed, but there are a few minute papillæ at the oral pole immediately around the mouth and on the lip of the aperture of the ventral pouch (fig. 26).

Ventral pouch.—On the ventral aspect of the animal, 0.62 mm. (measured from sections) caudad of the oral margin, there is a transverse depression which is the aperture of the ventral pouch (figs. 24, 26). This aperture leads into a ventro-dorsally narrow, slit-like passage which may be regarded as the neck of the pouch. This extends caudad to the lower (caudal) margin of the ventral chamber of the genital atrium, caudally of which it rapidly dilates into the body of the pouch. The body of the pouch extends caudad to just above the plane of the superior margin of the ventral testis. The fundus of the pouch (as in *F. fischæderi*) bulges somewhat cephalo-ventrad into the lumen in such a manner as to make the dorsal wall of the pouch much shorter than the ventral, and the lateral walls intermediate gradations between the two. As a result of this there is (in transverse sections) a crescentic slit-like prolongation of the pouch caudad between the ventral testis and acetabulum, on the one hand, and the ventral wall of the worm on the other (figs. 24, 30, 31). It extends caudad to a little below the superior margin of the acetabulum.

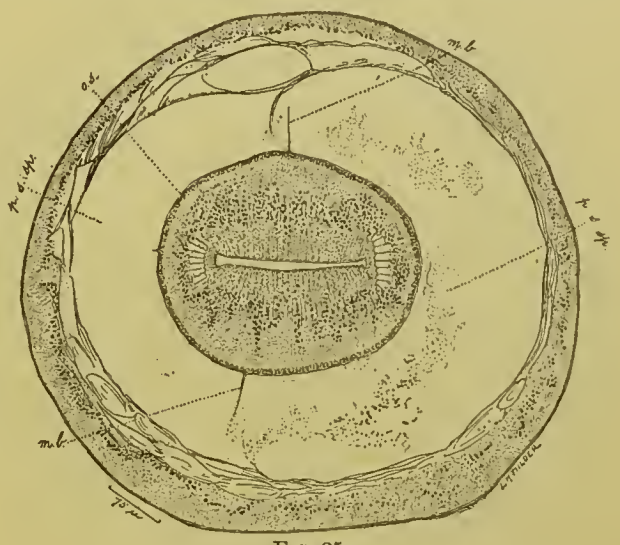

Fig. 25.

The outline of the pouch in transverse sections varies at different levels; the aperture is a narrow crescent measuring 0.135 mm. (in sections) in dorso-ventral diameter, with rounded horns, the distance between which is 0.525 mm. (in sections); the neck of the pouch retains the crescentic outline of the aperture; in the equatorial region of the worm the body of the pouch is somewhat triangular in outline with the apex directed ventrad. Corresponding to the position of the angles of this triangle the inclosing body shows constrictions which divide it into three segments, one dorsal and two ventro-lateral, of which the former is somewhat the largest (figs. 28, 29).

In the equatorial zone the pouch occupies substantially the axial region of the animal.

Genital pore.—On the dorsal wall of the neck of the ventral pouch there is a longitudinally elliptical opening, the genital pore, measuring 0.40 mm. in length by 0.30 mm. in width, leading into a large somewhat circular depression measuring 0.20 mm. in greatest depth (figs. 23, 24, 27). At the bottom of this depression (ventral chamber of genital atrium) is a small pore about 0.05 mm. in diameter leading into the slit-like dorsal chamber. The dorsal wall of this is formed by the genital papilla. At the vertex of the latter may be seen the minute aperture of the ductus ejaculatorius, and immediately beneath this, the considerably larger opening of the metraterm. This papilla is just above (cephalad of) the level of the esophageal fork.

FIG. 26.

Acetabulum.—This organ of adhesion, measuring about 1.16 mm. in transverse and about 1 mm. in dorso-ventral diameter, occupies the caudal terminal portion of the body, and its aperture, directed downward (caudad) and, because of the curvature of the body axis, slightly ventrad, measures about 0.46 mm. in diameter.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The bluntly pointed cephalic extremity is pierced by the transversely elongated spindle-shaped aperture of the oral sucker (the mouth). The sucker consists of a dorsal and a ventral muscular mass continuous laterally (figs. 23–25). The sucker measures 0.62 mm. in length, 0.30 mm. in greatest dorso-ventral, and 0.33 mm. in greatest transverse diameter. Its lumen is a narrow transverse slit, which becomes reduced to a minute aperture at the opening into the esophagus. The sucker rests in a roomy space (*p. s. sp.*, figs. 25, 26), in which it is held in position by its anchorage to the parenchyma and cuticle at its oral extremity, by the esophagus at its caudal extremity, and between these points by dorsal and ventral mesenterium-like strands.

The esophagus begins at the base of the sucker and passes caudad with but a slight tilt dorsad. It measures 0.72 mm. in length, and at the junction of the first with the second fourths of the body length it forks into the two intestinal ceca. The latter pass at first (for about one-fourth of their length) latero-caudad then in a direct though slightly sinuous course directly caudad in the dorsal body segment to terminate by cecal extremities at about the junction of the third with the fourth fifth of the body length. The cecal extremities lie, however, in slightly different transverse planes, the left being slightly above the right. As in *F. elongatus*, the lumen of the sucker and that of the esophagus are lined by a cuticle in anatomical continuation with that of the body surface; it is thin in the sucker, thicker in the esophagus, and ceases at the bifurcation. The intestinal ceca are lined throughout by a layer of epithelial cells.

FIG. 27.

GENITAL SYSTEM.—The testes, the ovary, and the shell gland are in the caudal portion of the body immediately cephalad of the acetabulum.

Male organs.—The two large testes lie in the same dorso-ventral line, the left dorsad of the right. The bulk, however, of the left testis lies to the left of the median line while that of the right or ventral testis lies to the right of the median line, so that their fields overlap. Both testes show marked indentations. A vas efferens springs from the dorsal aspect of each testis (fig. 30). From its point of origin the left vas efferens passes almost directly cephalad in the dorsal body segment a little to the left of the median line. The right vas efferens, on account of the difference in the position of the testes, is longer and at first runs almost horizontally dorsad but very soon turns and runs directly cephalad a little to the right of the median line. The two vasa efferentia unite in the median line in the equatorial plane of the body. Just before they unite each vas describes a curved course mediad so that by their union they form a transverse arch (figs. 29, 23). In their course the vasa are separated one from the other by coils of the uterus and their distal portions

run more or less close to the ventromesial aspect of the terminal portions of the corresponding intestinal ceca.

The vas deferens, formed by the union of the vasa efferentia, shows a well-marked, thin-walled vesicula seminalis, a well-defined pars musculosa, 127μ in diameter with walls 37μ in thickness (both portions very much coiled) and a long pars prostatica. The latter pursues an almost direct course cephalo-ventrad beneath, and then ventrally of the esophageal fork and caudal portion of the esophagus to the base of the genital papilla. At this point the prostatic cells enclosing the pars prostatica cease and the continuation of the duct pierces the genital papilla and opens by a minute aperture at the vertex of the latter. This terminal portion of the male canal becomes

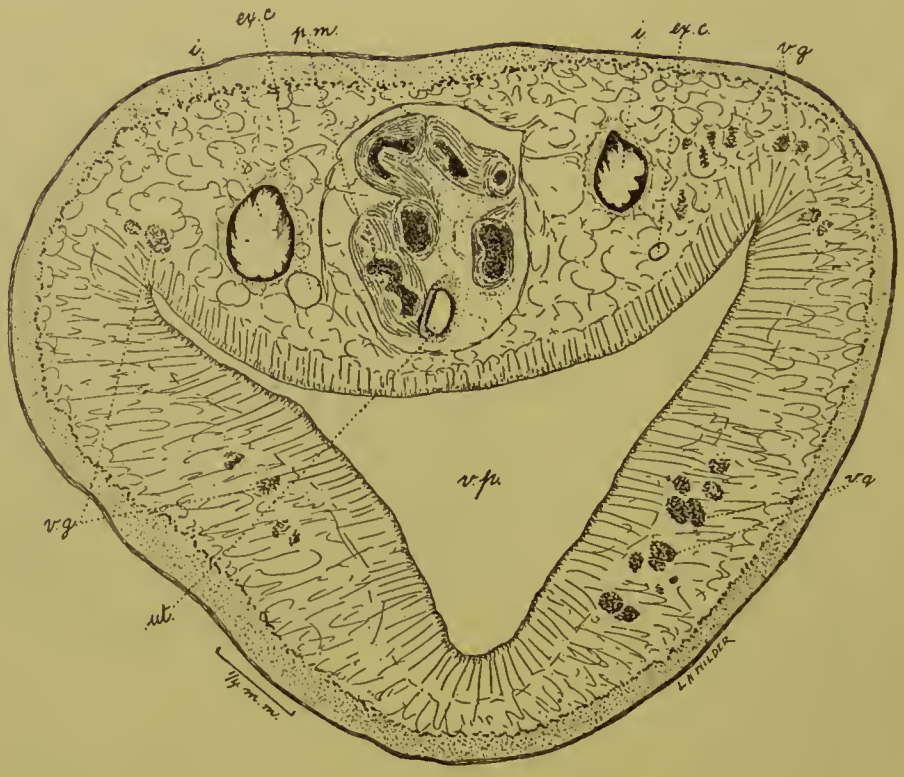

FIG. 28.

very rapidly thin walled and greatly reduced in caliber and corresponds to the ductus ejaculatorius.

Female organs.—The ovary and shell gland lie obliquely side by side, close to the ventro-caudal aspect of the dorsal (left) testis (figs. 31, 24). The ovary lies obliquely to the left of the shell gland and gives origin to the oviduct from its right lateral aspect. The oviduct at first passes slightly caudad from its point of origin, then turns abruptly to the right and cephalad to penetrate the dorso-caudal aspect of the shell gland, within the body of which it is joined by the vitelloduct and forms the ootype. The shell gland lies close to the right cephalo-mesial aspect of the ovary. It is penetrated, as already described, by the oviduct and a little to the right of the

latter by the vitelloduct; these unite to form the ootype which is continued as the uterus, emerging as such from the cephalic aspect of the shell gland. From its point of emergence the uterus passes to the right, dips slightly caudad, and then ascends cephalad forming coils dorsally of the ventral and to the right of the dorsal testis. Gradually the distended coils tend toward the median line of the body and soon come to occupy the space between the vasa efferentia. When the uterus reaches the arch formed by the union of the vasa efferentia it passes beneath and ventrally of the latter and ceases to form coils. It now takes an almost direct though slightly sinuous course cephalad close to the ventral aspect of the coils formed by the vesicula and pars prostatica and finally close to the ventral aspect of the pars prostatica and ductus ejaculatorius, to open by a pore of relatively considerable size at the vertex of the genital papilla below but very close to, though apparently quite distinct from, the male genital pore. Laurer's canal leaves the oviduct at about the point where the latter turns abruptly cephalad in order to penetrate the shell gland, passes dorso-caudad, and opens by a minute

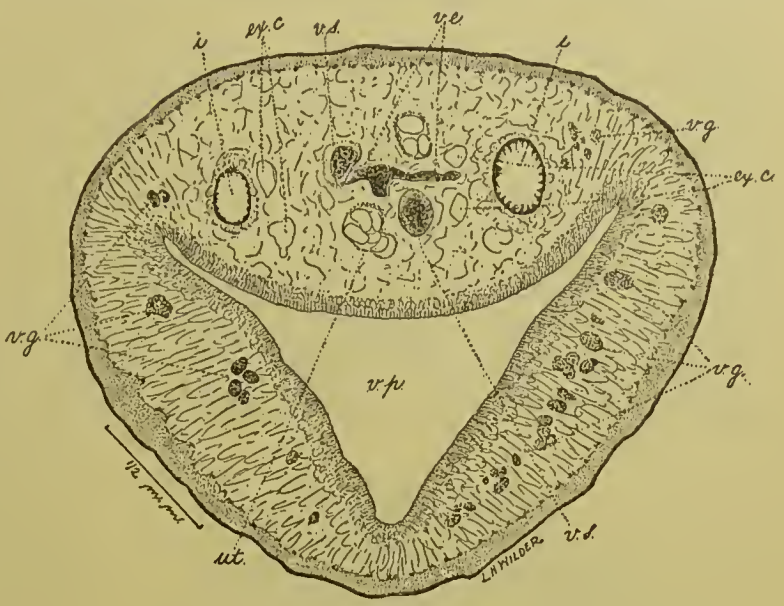

FIG. 29.

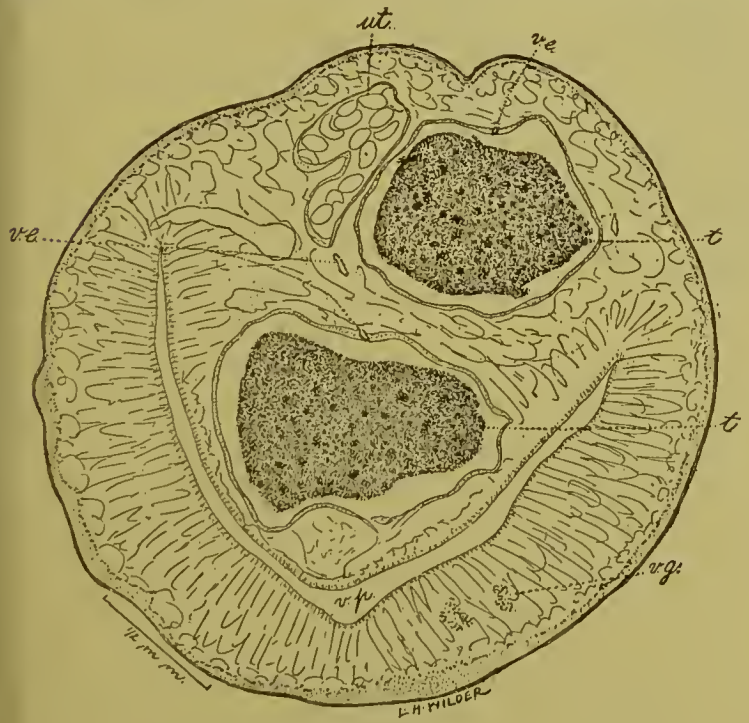

FIG. 30.

pore on the dorsum about 0.60 mm. cephalad of the caudal pole of the body and about 0.36 mm. cephalad of the excretory pore.

The follicles composing the vitellogene glands (figs. 28, 30) are scattered through the ventro-lateral body segments in a manner similar to that obtaining in *F. elongatus*, and in the dorsal body segment external to the intestinal ceca. Longitudinally the gland follicles extend from a plane corresponding to the caudal end of the pars prostatica caudad to the plane of the cephalic aspect of the testes. From about the caudal extremity of each vitelline gland a duct passes medio-caudad; the two transverse ducts unite close to the ventral aspect of the shell gland at about the level of the ootype. A well-defined vitelline reservoir is not present, unless the transverse ducts which are of considerable caliber and filled with vitelline cells may be so regarded. From the point of union of the transverse ducts a duct passes off in a direction caudad close to the ventral aspect of the shell gland, and follows its contour around to its dorso-caudal aspect. Here this duct penetrates the gland to unite in its substance with the oviduct.

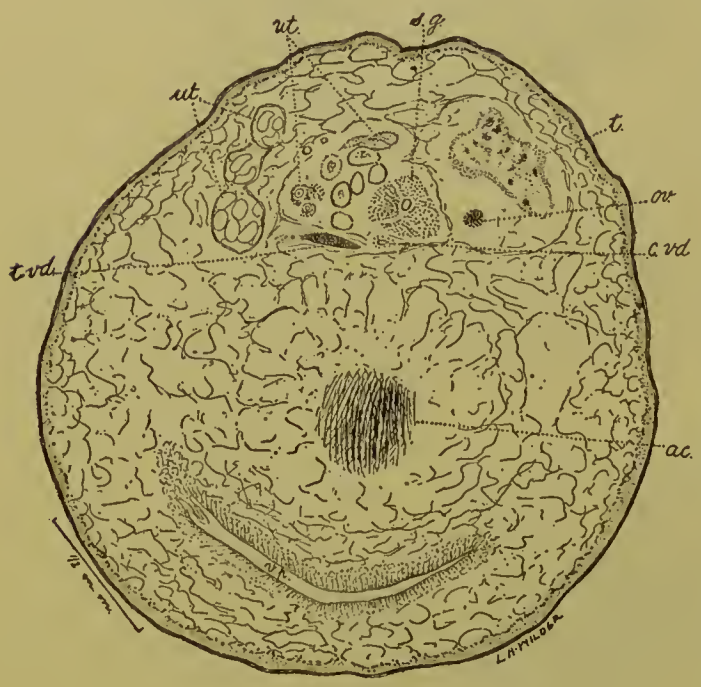

FIG. 31.

EXCRETORY SYSTEM. — The excretory vesicle lies caudo-ventrally of the ovary and shell gland and dorsally of the dome of the acetabulum. In the single specimen studied the vesicle appears for the most part as a transverse slit, distended slightly only in its caudal portion. From its caudal aspect a short duct is given off which passes dorso-caudad to open by a pore caudad of Laurer's canal. This duct is lined by a cuticle in anatomical continuation with that of the surface.

RELATION TO OTHER SPECIES.

The topography of the genital system and the termination of the intestinal ceca in the equatorial region bring this worm close to *F. elongatus* and *F. fischæderi*. The long esophagus and the roomy ventral chamber of the genital atrium, quite distinct from that in either *F. elongatus* or *F. fischæderi* appear to indicate that this is a distinct species and clearly differentiates it from both of them.

FIG. 23.—Frontal projection. Shows oral sucker (*o. s.*), esophagus (*es.*), position of genital pore (*g. p.*), intestinal ceca (*i.*), testes (*t.*), vasa efferentia (*v. e.*), vesicula seminalis (*v. s.*), pars musculosa (*p. m.*), pars prostatica (*p. p.*), uterus (*ut.*), and acetabulum (*ac.*). *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, *h–h* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 24.—Profile projection. Shows oral sucker (*o. s.*), esophagus (*es.*), right intestine (*i.*), testes (*t.*), right vas efferens (*v. e.*), vas deferens (*v. s.*; *p. m.*; *p. p.*), shell gland (*s. g.*), ovary (*ov.*), uterus (*ut.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), and acetabulum (*ac.*). *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, *h–h* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 25.—Transverse section at *a–a* figs. 23 and 24. Shows outline of body, form of oral sucker and of its lumen (*o. s.*), perisuctorial space (*p. s. sp.*), and mesenterium-like strands (*m. b.*). Enlarged. Original.

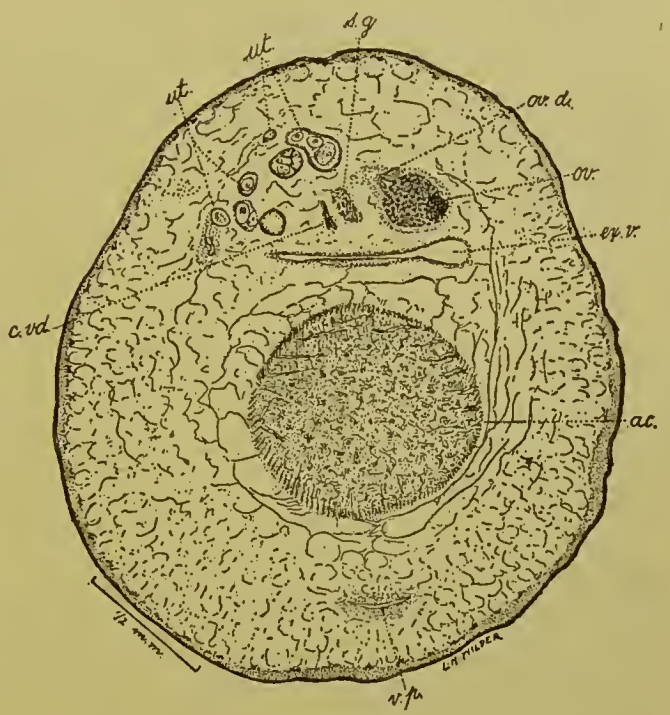

FIG. 32.

FIG. 26.—Transverse section at *b–b* figs. 23 and 24. Shows outline of body at level of aperture of ventral pouch (*a. v. p.*) and relation of latter to beginning of the esophagus (*es.*), the perisuctorial space (*p. s. sp.*) and surface papillæ (*s. pap.*) on margin of aperture of ventral pouch. Enlarged. Original.

FIG. 27.—Transverse section at *c–c* figs. 23 and 24. Shows outline of body, form of ventral pouch (*v. p.*), dorsal chamber (*g. a.*), ventral chamber of genital atrium (*g. a. c.*), ductus ejaculatorius (*d. e.*), metraterm (*va.*), esophagus (*es.*), and longitudinal excretory canals (*ex. c.*). Enlarged. Original.

FIG. 28.—Transverse section at *d–d* figs. 23 and 24. Shows triangular form of body, ventral pouch (*v. p.*), intestines (*i.*), excretory canals (*ex. c.*), pars musculosa (*p. m.*) of the vas deferens, uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 29.—Transverse (equatorial) section at *e–e* figs. 23 and 24. Shows form of body and of ventral pouch (*v. p.*), arch of union of vasa efferentia (*v. e.*), vesicula (*v. s.*), uterus (*ut.*), intestines (*i*), excretory canals (*ex. c.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 30.—Transverse section at *f–f* figs. 23 and 24. Shows form of body, caret-like form of ventral pouch (*v. p.*), testes (*t.*), uterus (*ut.*), origin of vasa efferentia (*v. e.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 31.—Transverse section at *g–g* figs. 23 and 24. Shows form of body, slit-like prolongation of ventral pouch (*v. p.*), superior margin of acetabulum (*ac.*), caudal aspect of dorsal testis (*t*), cephalic margin of ovary (*ov.*), shell gland (*s. g.*), transverse vitello-duct (*t. vd.*), common vitello-duct (*c. vd.*), and uterus (*ut.*). Enlarged. Original.

FIG. 32.—Transverse section at *h–h* figs. 23 and 24. Shows form of body, slit-like extremity of ventral pouch (*v. p.*), acetabulum (*ac.*), ovary (*ov.*) and origin of oviduct (*ov. d.*), caudal aspect of shell gland (*s. g.*), common vitello-duct (*c. vd.*), uterus (*ut.*), slit-like beginning of excretory vesicle (*ex. v.*). Enlarged. Original.

CARMYERIUS,[1] new genus.

GENERIC DIAGNOSIS.—*Gastrothylacinæ* (p. 16): Vas deferens and cephalic half of uterus chiefly or entirely in suctorial field. Testicular fields separate, zones nearly coincide, postcecal or intercecal; vesicula without straight portion. African and Asiatic.

TYPE SPECIES.—*C. gregarius* (Looss, 1896) [*Gastrothylax gregarius* Looss, 1896b, 5–13, 170–177, pl. 1, figs. 1–3].

This group, as at present constituted, contains 5 species which agree in certain characters, and yet are so different that they will certainly submit to further grouping as soon as additional forms become known. At present at least 4, probably 5, subgroups can be more or less clearly foreseen. For the sake of conservatism we will here recognize 5 monotypic subgenera, as follows:

A[1]. Genital atrium with very large ventral chamber; testes postcecal:

B[1]. Ceca corkscrew like, rather narrow, long, end in fourth zone; testes deeply indented; transverse section of pouch triangular, apex ventrad; vitellaria fine; type *Gastrothylax synethes* Fischœder, in *Bos kerabau*, from Ceylon. New subg. *Synethes*.

B[2]. Ceca straight, broad, short, end in third zone; testes lobate, very lateral; transverse section of pouch triangular, apex dorsad; vitellaria coarse; type *Gastrothylax gregarius* Looss, in *Bos bubalus*, Egypt, also in *Bos taurus*, East Africa. New subg. *Carmyerius*.

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[1] This genus is dedicated to Miss Caroline Myer, technical clerk in the United States Bureau of Animal Industry, in recognition of the obligation which we feel that helminthologists owe to Miss Myer for her years of faithful work on the Index Catalogue of Medical and Veterinary Zoology.

A^2. Genital atrium without ventral chamber; testes post or intercecal:

B^3. Ceca straight, narrow, rather long, end in fourth zone; testes lobate, postcecal; transverse section of pouch circular; type *Gastrothylax spatiosus* Brandes, in *Bos taurus*, Arabia.....New subg. *Gastrothylacias*.

B^4. Ceca rather sinuous, narrow, long, end in fourth and fifth zones; testes intercecal; transverse section of pouch triangular, apex ventrad; type *Gastrothylax mancupatus* Fischœder, in *Bos taurus*, East Africa....New subg. *Gastrothylacides*.

B^5. Ceca swollen in caudal half, rather long, end in fourth zone; testes inter and postcecal; transverse section of pouch rather triangular, apex ventrad; type *Gastrothylax minutus* Fischœder, in *Tragelaphus scryptus*, Kamerun, also in *Antilope* sp.....New subg. *Thylogaster*.

WELLMANIUS, new genus.

Generic diagnosis.—*Gastrothylacinæ* (p. 16): Vas deferens and cephalic half of uterus chiefly or entirely in suctorial field. Testicular fields separate, zones coincide, testes in inter, extra, and cecal areas, dorsal of ceca; vesicula seminalis consists of a caudal straight and a cephalic coiled portion.

Type species.—*Wellmanius wellmani* new species. Africa.

This new species, new genus, separates out very easily from the other forms of *Gastrothylacidæ*. Both the genus and the species are dedicated to the American student of African tropical medicine who sent us the material. The "virtual tautonomy" used here and elsewhere is intentional.

WELLMANIUS WELLMANI, new species.

[Figs. 33 to 42.]

Specific diagnosis.—*Wellmanius* (p. 51): 6.5 to 8.25 mm. long, by 3 to 4 mm. broad, more or less conical in form, straight or curved, circular in transverse section, greatest diameter near acetabulum. Surface unarmed, but bluntly pointed cephalic end bears small papillæ. Opening of ventral pouch 0.67 mm. from anterior end; pouch extends to acetabulum; its transverse section triangular (then pentagonal), with apex ventrad; shorter dorsally than ventrally, ventral end extending in acute angle, caudal wall thus not representing a transverse plane. Genital pore at about the equator of the esophagus; genital papilla may be prominent, nearly filling atrium. Acetabulum terminal, 1.7 to 2.5 mm. in diameter, its aperture tilted slightly ventrad. Oral sucker rather pyriform; esophagus, shorter than sucker, bifurcates one-fifth to one-fourth the body length into 2 tortuous wavy ceca which extend to the acetabulum. Excretory system well developed with large vesicle and with thick-walled efferent canal opening dorso-median, caudad of the opening of Laurer's canal.

Male organs: Testes lobate, lateral, in same transverse zone, but their fields are separated by dome of acetabulum and excretory vesicle; vas deferens median; vesicula seminalis, pars musculosa, pars prostatica, and ductus ejaculatorius well developed.

Female organs: Ovary usually left, shell gland right of median line, between cephalic end of testes; uterus coiled; metraterm straight; Laurer's canal opens median, cephalad of excretory pore; vitellaria extend from slightly caudad of intestinal fork to near termination of ventral pouch; at first (cephalad) the follicles are small, sparse, and scattered, then larger and more numerous, extending ventrad of intestinal ceca and ventral pouch.

Eggs: 112.5 by 60μ, oval, operculated.

Habitat.—Lesser Reed Bok (*Cervicapra bohor*), Benguella (type locality), Africa.

Type.—U.S.P.H.&M.H.S. 9831, alcoholic material and sections.

Source of material.—This material was sent to us by the American Society of Tropical Medicine. It was collected by Dr. F. C. Wellman in Benguella, West Africa, from the stomach of the Lesser Reed Bok (*Cervicapra bohor*). The sending contains a piece of stomach showing how these trematodes attach themselves to the mucosa.

Fig 33.

EXTERNAL CHARACTERS.

Size.—The specimens vary in size from 6.5 to 8.25 mm. in length by 3 to 4 mm. in breadth.

Color.—Alcohol specimens are of a buff color.

Form.—The specimens differ somewhat one from another, but all are more or less conical in form, with the longitudinal axis either straight or more or less curved with the convexity dorsad. The cephalic extremity is rather bluntly pointed and bears the terminal mouth which may be directed slightly dorsad or slightly ventrad. The body is more or less circular in cross section and its greatest diameter is more or less near the caudal extremity which bears a large terminal acetabulum, the terminal circular orifice of which, in some of the specimens, is also tilted slightly ventrad. In some of the specimens the body is somewhat constricted transversely at or slightly caudad of the equator (figs. 33, 34).

Surface.—The surface cuticle is devoid of spines or hooks, but is marked by fine transverse sulci and at the oral extremity it is sparsely beset by bluntly rounded papillæ. It is marked at one point, a little (0.675 mm. in one series of sections) below the oral margin, by a small transverse slit, which is the aperture of the ventral pouch and indicates the position of the venter of the animal. Immediately above this slit the surface over a circumscribed area is slightly depressed (see figs. 33, 34).

Fig. 34.

Ventral pouch.—The ventral pouch extends from its aperture, which is situated a little (0.675 mm. in a sagittal section) below the level of the oral margin to a little above the level of the upper margin of the acetabulum. In transverse sections the form and dimensions of its lumen vary greatly at different levels and to a considerable extent in different specimens. The aperture lies in a slight depression of the venter. It is crescentic and more or less slit like in form (fig. 37), measuring 0.39 mm. from horn to horn in one of the sectioned specimens. A little below the level of the genital pore, which is on

the dorsal wall of the pouch, the outline in transverse sections is found to have become changed from the crescentic slit to nearly a triangular form with the apex ventrad (fig. 38).

In its further course caudad the triangular lumen of the pouch gradually shifts toward the axial region of the body which it then comes to occupy. Coincident with this shifting of position there is a further change of outline, the triangular form becoming more or less pentagonal but with the apex still directed ventrad (fig. 39). At first the caliber of the lumen of the pouch increases, but as the fundus of the pouch is approached, its ventro-dorsal diameter becomes rapidly contracted because the fundus instead of occupying a horizontal (transverse) plane occupies a plane which is directed obliquely caudo-ventrad, the dorsal wall of the pouch being shorter than the ventral; in consequence of this, the outline of the pouch in sagittal section is somewhat that of a triangle with its apex at the entrance of the pouch (fig. 35). The lining of the pouch is a cuticle in anatomical continuation with that of the surface and appears to be in irregular longitudinal and transverse folds, producing an appearance somewhat suggestive of papillæ in sections. In the specimens sectioned, the pouch contained some granular matter and a few eggs.

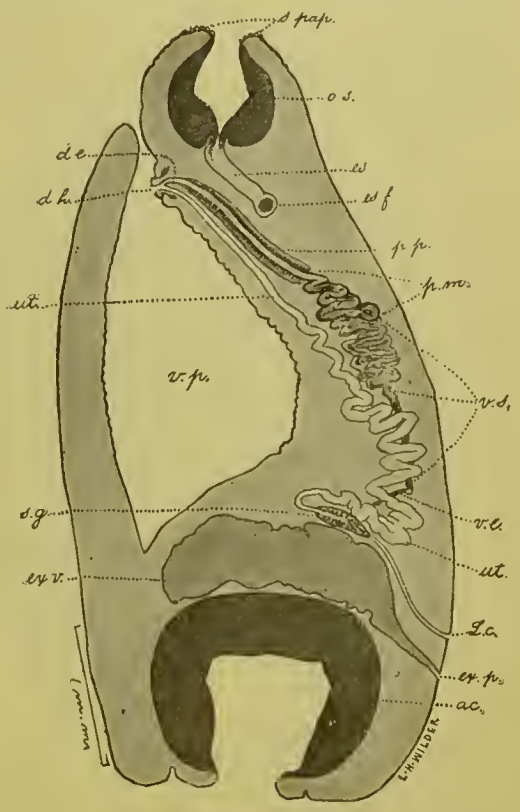

Fig. 35.

Genital pore.—On the dorsal wall of the pouch a little (0.375 mm. in one sagittal section) below its aperture and in about the equator of the esophagus is the genital pore. This pore is at the vertex of a somewhat flattened hemispherical bulging. In a sagittal section of one specimen this bulging measured 0.40 mm. in its longitudinal diameter. The genital pore leads into a chamber which is almost completely filled by a papilla (genital). In one sectioned specimen a part of this papilla protruded into the ventral pouch through the pore, its margin closely embracing and somewhat constricting it (fig. 35).

Acetabulum.—This muscular organ of adhesion occupies the caudal extremity and its aperture, which is more or less circular, is in the axial line with a slight tilt ventrad in some of the specimens. The diameter of the acetabulum varied from 1.7 to 2.5 mm. in the specimens in which it was measured. The ventro-dorsal diameter of the aperture in one specimen measured 0.40 mm.

DIGESTIVE TRACT.—The bluntly pointed cephalic extremity is pierced by the more or less circular mouth which leads directly into a very muscular, somewhat pyriform, oral sucker. In cross (transverse) section the outline of the sucker varies in different specimens from an ellipse to a circle. The oral pole of the sucker extends to the surface where it forms a ring around the oral aperture, being marked off from the general body surface by a narrow more or less deep encircling groove (fig. 40). Inclosing the sucker is a space which is traversed, dorsally and ventrally, by dorso-ventral strands. At the esophageal end the sucker is attached to the body parenchyma so that the organ is anchored at both its poles.

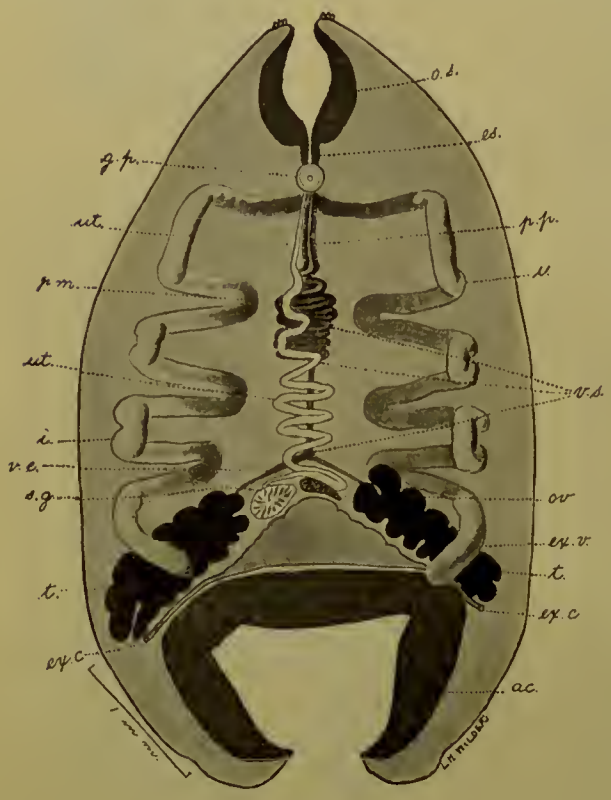

FIG. 36.

The lumen of the sucker, when studied in transverse sections, is circular in outline at its oral end, becoming somewhat spindle shaped in the equatorial region; beyond this region the lumen at first becomes dorso-ventrally contracted, forming a transverse slit; this eventually becomes reduced to a small circular orifice at the entrance into the esophagus. It is lined by a thin cuticle-like layer, anatomically continuous with that of the surface, and it is beset by small more or less conical papillæ; these papillæ are sparsely scattered in the region of the mouth but numerous and closely aggregated in the remaining portion (figs. 37, 40). From its origin at the base of the sucker the esophagus passes caudo-dorsad; at a point a little less than one-fifth to one-fourth the body length from the oral margin it forks into two intestinal ceca. The esophagus is somewhat shorter than the sucker.

From their point of origin the intestinal ceca, without giving off any branches, pass at first latero-caudad, then having reached the dorso-lateral region of the body they take a dorso-ventrally wavy course caudad to terminate ventrad of the corresponding testis at or a little above the level of the upper margin of the acetabulum (fig. 36, 41).

The lumen of the esophagus is lined by a thick layer of cuticle. At the point of origin of the intestinal ceca the cuticular lining is

replaced by a nucleated cell layer which extends throughout the remaining length of the intestine.

The intestinal ceca do not appear to be exactly of equal length, nor is the level at which they terminate absolutely fixed. They may terminate at the level indicated or somewhat above (cephalad of) that point.

GENITAL SYSTEM.—*Male organs:* The two testes are situated in the same transverse zone near the caudal extremity of the worm at or just cephalad of the level of the anterior (cephalic) portion of the acetabulum, and separated in the former case by the dome of the acetabulum, ventrally, and the excretory vesicle, dorsally, and in the latter case by the excretory vesicle alone (figs. 36, 41, 42). The testes are somewhat compressed laterally and their margins are deeply indented, the indentations marking off lobes of different dimensions. (Cephalo-ventrad each is in relation with the corresponding cecum. From the dorsal aspect of each gland arises a vas efferens; these two ducts take a course at first dorsad and slightly cephalad, then toward the median line, and unite at a point a little above the level of the upper margin of the testes, to form the vas deferens (fig. 36).

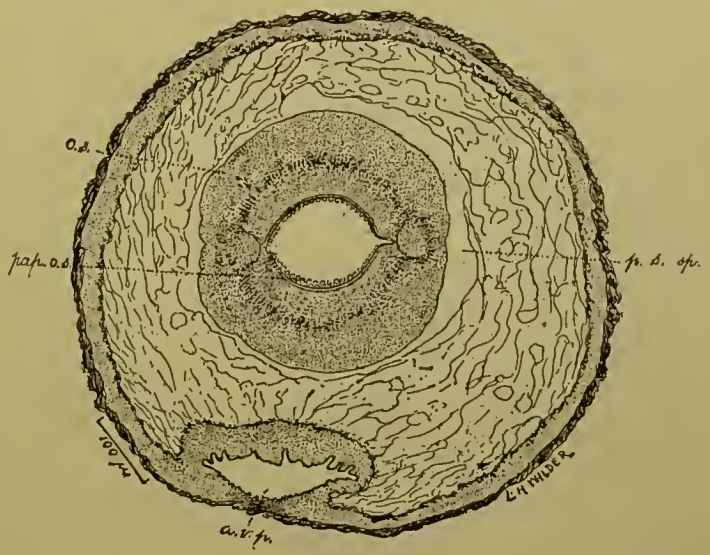

FIG. 37.

The vas deferens is clearly divisible into a vesicula, musculosa, prostatica, and ejaculatorius. The vesicula may be described as consisting of two portions; the first pursues quite a straight course cephalad, close under the dorsum, about in the median line, close to the dorsal aspect of the uterus, and with rather a thick wall proportionate to its empty contracted lumen. The second portion of the vesicula forms numerous compact coils, its walls are thinner, and the caliber of its lumen is increased. Farther cephalad the wall changes in structure, becoming quite muscular (pars musculosa), while the duct still forms compact coils; the cephalic end of the pars musculosa turns abruptly ventrad, the duct becomes surrounded by numerous cells and loses its muscular layer, turns sharply cephalad, and proceeds as the pars prostatica toward the genital pore. It passes ventro-cephalad of the intestinal arch, runs dorsally of the metraterm, ventrally of the esophagus, decreases gradually in diam-

eter, and loses its prostatic cells; it now continues as the ductus ejaculatorius. The latter enters the genital papilla, and unites with the metraterm to form the short ductus hermaphroditicus, which opens at the vertex of the papilla as the porus hermaphroditicus (fig. 35).

Female organs.—The ovary and the shell gland are in the caudal portion of the body, but further than this considerable variation was observed in their position and their relation to each other and to the excretory vesicle. This was thought to be dependent in part on the degree of distention of the excretory vesicle. The ovary lies immediately to the right or to the left of the median sagittal plane, cephalodorsad or dorsad of the excretory vesicle and somewhat above the level of the superior margin of the acetabulum. In 3 of 4 sectioned specimens it was to the left of the median plane; in the fourth it was to the right. In 3 of the 4 specimens the ovary was close to the dorsal portion of the cephalic aspect of the excretory vesicle (fig. 35), rather than dorsally of the body of the vesicle. With respect to its relation to the acetabulum, it was found that while in 3 of the 4 specimens the ovary was cephalad of the dome of the acetabulum, with the excretory vesicle interposed (fig. 36), in the fourth series of sections the ovary was distinctly below (caudad of) the transverse plane of the superior margin of the acetabulum. In all cases it was distinctly nearer the dorsum than the venter. The shell gland lies close to the right or to the left and more or less cephalad of the ovary, in one instance, cephalo-ventrad of the ovary. Both organs vary in form in the different specimens; for the most part they are somewhat flattened, oblong bodies, but may appear pyriform or subglobular. The ovary is somewhat the larger of the two. From the aspect of the ovary nearest the shell gland the oviduct arises and passes to the shell gland, which it penetrates. Just before entering the latter it gives off Laurer's canal. In the shell gland it is at once joined by the vitello-duct; the common duct so formed then dilates some-

FIG. 38.

what to form the ootype and beyond this point the canal is continued as the uterus, which emerges from the shell gland at the ventro-cephalic aspect. The uterus then winds its way dorsad over the shell gland; a coil of it forms a loop which is tucked in between the dorsum, on the one hand, and the shell gland and the ovary on the other, before beginning its course cephalad. In the first part of its course cephalad it is included between the two vasa efferentia, but passes ventrad beneath the arch formed by their union to gain the ventral aspect of the vas deferens. It maintains this ventral relation to the vas deferens and its terminal portion, pars prostatica, etc., in the remainder of its course to the genital papilla. As already mentioned, it opens near the vertex of the latter into a short duct (ductus hermaphroditicus) common to it and the ductus ejaculatorius.

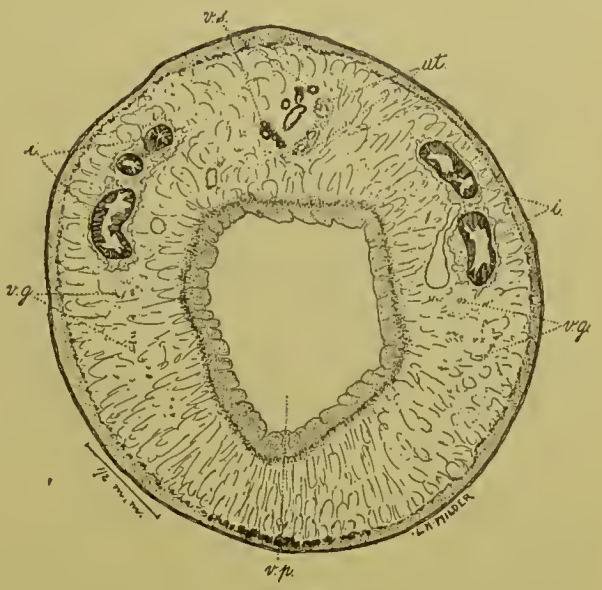

FIG. 39.

Numerous eggs were observed filling the loops here and there and, near the shell gland, some of the loops contained masses of spermatozoa.

Laurer's canal passes from its point of origin dorso-caudad to open in the median line slightly below the upper margin of the acetabulum and a little above the excretory pore. The canal is long and slender; it is lined by a thick cuticle in anatomical continuation with the cuticle of the surface, and its lumen may contain cells resembling those in the vitelloducts. Receptaculum seminis is wanting.

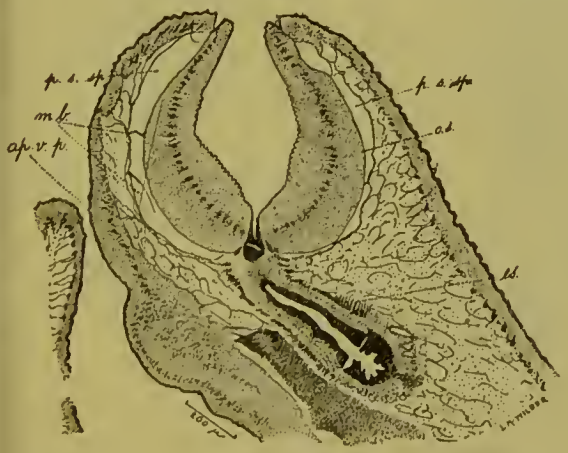

FIG. 40.

The vitellaria begin in a transverse plane somewhat caudad of the esophageal bifurcation. At first there are a few small scattered follicles ventrad of the intestinal ceca, but gradually follicles appear which are larger and somewhat more numerous and scattered close around and ventrally of the

intestinal ceca and ventral pouch. They extend caudad to a plane slightly above (cephalad of) the termination of the ventral pouch; at about this point and ventro-centrad of the intestinal ceca, the vitello-ducts arise, and each passes medio-dorso-caudad or caudad (between the testes); the two ducts unite about in the median line immediately cephalad of the origin of the excretory vesicle. The common duct thus formed passes dorsad toward the shell gland and pierces the caudal or the right (? or in some specimens left) lateral aspect of this gland to join the oviduct just before the latter dilates into the ootype.

FIG. 41.

Eggs.—The eggs are oval in outline and provided with a small operculum at one end. We found some difficulty in obtaining them in a condition satisfactory for measurement. One egg measured 112.5 by 60μ.

FIG. 42.

EXCRETORY SYSTEM.—The excretory vesicle, when distended, is of considerable size. It lies immediately above the acetabulum and between the two testes. Its ventro-dorsal diameter is about equal to the corresponding diameter of the acetabulum. It receives on either side, at about its ventro-lateral aspect, a large excretory canal, which may be observed to wind its way from the cephalic portion of the body caudad on the ventro-lateral aspect of the corresponding testis, then beneath the latter to its destination. From the dorso-caudal aspect of the vesicle a thick-walled canal arises, which after a

short course caudo-dorsad opens on the dorsal surface at the excretory pore a little below the opening of Laurer's canal (fig. 35).

ILLUSTRATIONS.

FIG. 33.—External appearance, ventral view. Enlarged. Original.

FIG. 34.—External appearance, ventral view. Enlarged. Original.

FIG. 35.—Diagrammatic sagittal section, showing internal anatomy: *ac.*, acetabulum; *d. e.*, ductus ejaculatorius; *d. h.*, ductus hermaphroditicus; *es.*, esophagus; *es. f.*, esophageal fork; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *i.*, intestinal ceca; *L. c.*, Laurer's canal; *o. s.*, oral sucker; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *s. pap.*, surface papillæ; *v. e.*, vasa efferentia; *v. p.*, ventral pouch; *v. s.*, vesicula seminalis; *ut.*, uterus. Enlarged. Original.

FIG. 36.—Diagrammatic frontal section shows internal anatomy: *g. p.*, position of genital pore; *ex. c.*, excretory canals; *ov.*, ovary; *t.*, testes. For other abbreviations see fig. 35. Enlarged. Original.

FIG. 37.—Transverse section at level of aperture of ventral pouch. Shows form of body, aperture of ventral pouch (*a. v. p.*), oral sucker (*o. s.*), papillæ of suctorial lumen (*pap. o. s.*), and the perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 38.—Transverse section slightly caudad of level of genital pore. Shows form of body, triangular outline of ventral pouch (*v. p.*) at this level the intestinal ceca (*i.*) and their relation to the ventral pouch, to pars prostatica (*p. p.*) and uterus (*ut.*), excretory canals (*ex. c.*) and vitellaria (*v. g.*). Enlarged. Original.

FIG. 39.—Transverse section at about the junction of the second with the equatorial fifth of the body length. Shows form of body, irregularly pentagonal form of ventral pouch (*v. p.*), intestinal ceca (*i*), vesicula seminalis (*v. s.*), uterus (*ut.*), and vitellaria (*v. g.*) Enlarged. Original.

FIG. 40.—Sagittal section showing oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), mesenterium-like strands (*m. b.*), esophagus (*es.*), and aperture of ventral pouch (*ap. v. p.*). Enlarged. Original.

FIG. 41.—Transverse section immediately cephalad of superior margin of acetabulum shows the laterally placed testes (*t.*) separated by the excretory vesicle (*ex. v.*) and the position and relation of the (caudal portion of the) ovary (*ov.*), uterus (*ut.*), vasa efferentia (*v. e.*), intestinal ceca (*i.*), transverse vitello-ducts (*t. vd.*) and caudal terminal portion of ventral pouch (*v. p.*). Enlarged. Original.

FIG. 42.—Transverse section immediately below superior margin of acetabulum. Shows the laterally placed testes (*t.*) separated by

the acetabulum (*ac.*) and excretory vesicle (*ex. v.*). Shows also the shell gland (*s. g.*), uterus (*ut.*), and common vitello-duct (*c. vd.*). Enlarged. Original.

Family PARAMPHISTOMIDÆ Fischœder, 1901, restricted.

FAMILY DIAGNOSIS.—*Paramphistomoidea* (p. 15): Ventral pouch absent.
TYPE GENUS.—*Paramphistomum* Fischœder, 1901.

The family *Paramphistomidæ* Fischœder, 1901, is here restricted to the forms without a ventral pouch. Our work is based primarily upon the amphistomes of mammals, but it seems not entirely excluded that further study of the amphistomes of other vertebrates may result in a further restriction of the family to forms in which the oral sucker is without an evagination.

Fischœder (1901a), in writing upon species found in mammals, recognized 2 subfamilies for *Paramphistomidæ*, namely, *Paramphistominæ* and *Cladorchinæ*. Cohn (1904), in dealing with species found in amphibians and reptiles, recognized the subfamily *Diplodiscinæ* for three genera, but he did not compare his forms with the forms discussed by Fischœder. Daday (1907) later described forms from fish, classifying some of them near some of the forms described by Fischœder, others in *Diplodiscus*, but he did not enter into a discussion of the classification of the subfamilies. Disregarding the new genera proposed in the present paper, the classification stands at present as follows:

Paramphistomidæ Fischœder, 1901.
- *Paramphistominæ* Fischœder, 1901.
  - *Paramphistomum* Fischœder, 1901.
  - *Stephanopharynx* Fischœder, 1901.
  - *Gastrothylax* Poirier, 1883.
- *Cladorchiinæ* Fischœder, 1901.
  - *Cladorchis* Fischœder, 1901.
    - Subg. *Cladorchis* Fischœder, 1901.
    - Subg. *Taxorchis* Fischœder, 1901.
    - Subg. *Stichorchis* Fischœder, 1901.
  - *Microrchis* Daday, 1907.
  - *Pseudocladorchis* Daday, 1907.
  - *Pseudodiscus* Sonsino, 1895.
  - *Gastrodiscus* Leuckart, 1877.
  - *Homalogaster* Poirier, 1883.
- *Diplodiscinæ* Cohn, 1904.
  - *Diplodiscus* Diesing, 1836.
  - *Catadiscus* Cohn, 1904.
  - *Opisthodiscus* Cohn, 1904.
- Subfamily not given.
  - *Balanorchis* Fischœder, 1901.

When we consider the status of this group prior to 1901, the great advance in our knowledge which we owe to Fischœder must be immediately recognized, and this advance has been further supported,

especially by Cohn and Daday. That the classification as it now stands is not final lies in the nature of things; and on account of the fact that definite data are lacking in the case of many species it must be expected that in the future rather radical changes may perhaps be necessary. In the immediate future, changes are more or less experimental, though they may appear justified.

Gastrothylax should, we believe, be placed in a separate family (see p. 16).

Stephanopharynx presents such a striking character in its circular evagination of the oral sucker that it seems wise to separate it entirely from *Paramphistominæ;* but if left in this subfamily, it should at least be placed in a tribe distinct from *Paramphistomum.*

Gastrodiscus and *Homalogaster* are so different from the other members of *Cladorchiinæ* that they should either be placed in a distinct subfamily or in a distinct family.

Diplodiscinæ will probably be justified as a distinct subfamily, or at least as a distinct tribe, but further data are desirable in regard to its genera.

Balanorchis is placed with difficulty. It probably represents a distinct subfamily; if classified in *Cladorchiinæ,* it should represent a distinct tribe.

It is exceedingly difficult at present to draft a key representing the natural relations of members of this family, but the following key, admittedly more or less artificial, will be found of use in tracing the genera. This key is based primarily upon the type species:

KEY TO THE KNOWN AND NEW GENERA OF PARAMPHISTOMIDAE S. STR.

A^1. Oral sucker without evagination [this probably represents a distinct subfamily *Paramphistominæ*, p. 62]; cirrus pouch absent; body not divided; ovary not pretesticular [eventually these may be tribal or subtribal characters]:

B^1. Genital sucker absent; type *cervi*..... *Paramphistomum*, p. 73. [For subgenera, see p. 74.]

B^2. Genital sucker present; type *cotylophorum*..... *Cotylophoron*, p. 63.

A^2. Oral sucker with evagination:

B^3. Evagination circular [this will probably prove to be of supergeneric value, indicating a subtribe or tribe, probably a subfamily, *Stephanopharynginæ*]; genital sucker and cirrus pouch absent, body not divided [these characters will probably prove to be supergeneric]; type *compactus.*

Stephanopharynx, p. 168.

B^4. Evagination paired [if of subfamily value, this unites *Cladorchiinæ* and *Diplodiscinæ* in one subfamily; later investigations may show that these groups can be separated on the excretory system, cf. *Diplodiscus*]:

C^1. Genital sucker present; testes clearly branched:

D^1. Vitellaria entirely posttesticular; testicular zones coincide, preequatorial, widely separated from acetabulum, fields separate; uterus of unusual course, first runs near dorsum cephalad to testes, then diagonally caudad near venter, then cephalad near venter to pore; type *schistocotyle.*

Taxorchis, p. 170.

D^2. Vitellaria not entirely posttesticular; testes in equatorial third; uterus not as in *Taxorchis;* type *pyriformis*..... *Cladorchis*, p. 169.

C^2. Genital sucker absent; testes lobate or lobulate:
D^3. Cirrus pouch absent:
E^1. Each oral evagination single (only pouch present), type *watsoni*. *Watsonius*, p. 212.
E^2. Each oral evagination double (pouch and bulb present), type *stanleyii*. *Pseudodiscus*, p. 170.
D^4. Cirrus pouch present [perhaps in part a special subfamily, see *Diplodiscinæ*, p. 247]:
E^3. Acetabulum divided into two parts by constriction; one testis present; esophagus with muscular swelling at bifurcation; type *dolichocotyle*. *Catadiscus*, p. 248.
E^4. Acetabulum with central projecting sucker; two testes present; esophagus without muscular swelling; type *diplodiscoides*. *Opisthodiscus*, p. 248.
E^5. Acetabulum cavity with prominent papillæ; excretory system does not enter acetabulum; testes preovarial, at least not postovarial; evaginations of sucker well developed, at least not confined to wall; esophagus without pronounced muscular thickening; testicular zones coincide; excretory pore vesicular, type *papillatus*.....*Pfenderius*, p. 232.
E^6. Acetabulum otherwise:
F^1. Excretory system branches radially in acetabulum [perhaps special subfamily *Diplodiscinæ*, with *Diplodiscus*, *Catadiscus*, *Opisthodiscus*]; testes coalesce in adult; esophagus with muscular swelling at bifurcation; type *subclaratus*.....*Diplodiscus*, p. 248.
F^2. Excretory system does not appear to enter acetabulum:
G^1. Testes postovarial, portuterine, postequatorial; type *anastrophus*. *Balanorchis*, p. 247.
G^2. Testes preovarial, at least not postovarial:
H^1. Evaginations of sucker not well developed, confined to wall of sucker; sucker with two phincters; type *cylindricus*. *Pseudocladorchis*, p. 232.
H^2. Evaginations of sucker well developed, at least not confined to wall; sucker with one sphincter; esophagus with muscular thickening; testicular zones separate; excretory pore prevesicular:
I^1. Testes not lobate; excretory pore equatorial; type *mcgacotyle*. *Microrchis*, p. 246.
I^2. Testes 4-lobate; excretory pore postequatorial, posttesticular, with powerful sphincter; type *fabaceus*....*Chiorchis*, p. 246.

Subfamily PARAMPHISTOMINÆ, restricted.

SUBFAMILY DIAGNOSIS.—*Paramphistomidæ* (p. 60): Oral sucker without evagination.
TYPE GENUS.—*Paramphistomum*.

There seems every indication that the group here defined will represent a subfamily.

Additional characters for the two known genera are: Cirrus pouch absent, ovary not pretesticular, excretory system does not enter acetabulum.

As additional genera become known, these characters may result in dividing the subfamily into tribes and subtribes.

The two known genera may easily be distinguished as follows:

Genital sucker absent; type *cervi*.....*Paramphistomum*, p. 73.
Genital sucker present; type *cotylophorum*.....*Cotylophoron*, p. 63.

COTYLOPHORON, new genus.

GENERIC DIAGNOSIS.—*Paramphistominæ* (p. 62): Esophagus with or without muscular thickening; ceca long, wavy, end in acetabular zone. Acetabulum of moderate size, terminal, tilts ventrad. Excretory vesicle and canal directed cephalad; excretory pore prevesicular. *Genital sucker present*, genital papilla present, ventral chamber of genital atrium absent.

Male organs: Testes smaller than acetabulum, lobate, immediately preacetabular, zones overlap slightly, fields nearly coincide, crossing median line.

Female organs: Ovary ventral of excretory vesicle; Laurer's canal crosses excretory vesicle; its pore opens caudad and laterad of excretory pore, in acetabular and vesicular zones.

TYPE SPECIES.—*Cotylophoron cotylophorum* (Fischœder, 1901).

Thus far, two easily separated species may be classified in this genus. They are distinguished as follows:

Esophageal muscular thickening present; genital pore bifurcal; body 5 to 8 mm. long; type hosts: *Bos taurus*, Togo; *Bos taurus indicus*, German East Africa. *C. cotylophorum*, p. 63.

Esophageal muscular thickening absent; genital pore postbifurcal; body, 4.3 to 5.5 mm. long; type host: *Ovis aries*, India..... *C. indicum*, p. 63.

Species COTYLOPHORON COTYLOPHORUM (Fischœder, 1901) Stiles & Goldberger, 1910.

1901: *Paramphistomum cotylophorum* Fischœder, 1901a, 370 (stomach of *Bos taurus*, Togo; *Bos zebu*, German East Africa).

1909: *Cotylophoron cotylophorum* (Fischœder, 1901) Stiles & Goldberger, 1910a, 63. For full bibliography, see Stiles & Hassall, 1908, Index Catalogue, etc., Trematoda.

COTYLOPHORON INDICUM, new species.

[Figs. 43 to 52.]

SPECIFIC DIAGNOSIS.—*Cotylophoron* (p. 63): Body 4.3 to 5. 5 mm. long by 1.5 to 2 mm. broad; color (in glycerine alcohol) faint brown tint; slender, conical in form, greatest breadth near caudal extremity; tapers to bluntly pointed oral extremity; longitudinal axis curved, concavity ventrad; dorsum convex longitudinally and transversely, venter concave longitudinally, convex transversely; lateral margins slightly excurvate longitudinally, convex dorso-ventrally; transverse section elliptical. Surface without spines or papillæ except possibly at oral aperture which may (?) bear minute papillæ. Genital pore distinctly postbifurcal, on vertex of slight but not sharply defined bulging about one-third of body length from oral pole, and surrounded by genital sucker. Acetabulum caudal, sunken so that apparent aperture is formed by body, margin not projecting, 1.14 mm. in dorso-ventral diameter, aperture tilted somewhat ventrad, 0.6 mm. in diameter, muscular dome 0.24 mm. thick. Mouth at blunt cephalic extremity; oral sucker pyriform in sagittal section, its lumen papillate, narrow dorso-ventrally, rather broad transversely; maximum measurements of sucker 0.52 mm. long, 0.42 mm. in dorso-ventral and 0.6 mm. in transverse diameter; perisuctorial space roomy; esophagus about two-thirds as long as sucker and curved slightly ventrad; ceca arise from dorso-lateral aspects of end of esophagus, slightly less than one-fourth the body length from oral extremity, at first forming with each other a very acute angle they approach the lateral margins of body, then extend caudad in well-marked dorso-ventrally wavy course to terminate about $\frac{5}{6}$ of body length from mouth, postovarial, in acetabular zone, the left cecum ending slightly caudad of the right; ceca of relatively considerable caliber. Excretory pore dorso-median about at junction of equatorial with caudal third of body, about 0.16 mm. cephalad of acetabulum,

cephalad of caudal margin of caudal testis and about 0.56 mm. cephalad of pore of Laurer's canal; excretory canal short, thick walled, runs caudo-ventrad to well-developed elongate, slightly bag-shaped vesicle, the fundus of which is close to dome of acetabulum, intercecal, at end of ceca.

Male organs: Testes large, but somewhat smaller than acetabulum, irregularly globular, lobate, in median line, cephalad of acetabulum, intercecal, fields nearly coincide, zones overlap; union of vasa efferentia slightly cephalad of cephalic testis; vas deferens coiled; its vesicula seminalis much coiled, dilated; pars musculosa not coiled, narrow; pars prostatica about as long as musculosa, directed ventrad; ductus ejaculatorius short, unites with metraterm to form ductus hermaphroditicus, which is 195μ long and opens at porus hermaphroditicus on vertex of cylindrical genital papilla, which is 105μ long, 75μ in diameter; the latter almost fills a chamber 105μ deep, 105μ in diameter; this in turn is surrounded by a hemispherical, sharply defined, muscular genital sucker.

Female organs: Ovary and shell gland in testicular to posttesticular zones, intercecal, sinistral, close to acetabulum in cephalic portion of acetabular zone, shell gland in ovarian and postovarian zones; vitellaria with sparse and scattered, but well-developed follicles, chiefly extra-cecal, extending throughout cecal zone and slightly postcecal; a few follicles enter also the cecal and intercecal areas; uterus extends from ventral pole of shell gland, runs cephalo-ventrad, forming coils, turns dorsad, skirting the left lateral aspect of the caudal testis, turns cephalad dorsally of this testis, passes dorsally of both testes, ventrad over cephalic margin of cephalic testis, under arch of vasa efferentia, cephalad again ventrally of vas deferens to penetrate genital sucker caudad of penetration of male duct, and unites with latter in wall of genital sucker to form the ductus hermaphroditicus; Laurer's canal passes from oviduct in a curve (convexity cephalad) dorsally, crossing on left aspect of excretory vesicle to left of dorso-median line and opens dorsally of excretory vesicle, about 0.56 mm. caudad of excretory pore.

Eggs: Not observed.

Type.—U.S.N.M. 5781.

Habitat.—In (? organ of) sheep, *Ovis aries*, India.

Source of material.—Six specimens, in bottle of the Hassall Collection bearing the Smithsonian number 5781, were labeled: "*Amphistoma conicum;*" host, *Ovies aries;* locality, India; presented May 19, 1886.

EXTERNAL CHARACTERS.

Size.—The specimens (in glycerine alcohol) varied in length from 4.3 to 5.5 mm. and in width from 1.5 to 2 mm.

Color.—The specimens in glycerine alcohol are of a faint brown tint.

Form.—The worms are of a slender conical form, broadest near the caudal extremity and tapering to a bluntly pointed attenuated oral extremity. The longitudinal axis is more or less curved, with the concavity directed ventrad. The dorsum is convex longitudinally and transversely; the venter is concave in the longitudinal direction, but convex transversely, its convexity being less marked, however, than the corresponding convexity of the dorsum. The lateral margins are slightly excurvate in the longitudinal direction and convex dorso-ventrally. In transverse section the body of the worm is

elliptical in outline, with a somewhat greater transverse than dorso-ventral diameter.

Surface.—The general cuticular surface is smooth; that is, unprovided with spines or papillæ. Around the oral aperture some minute papillæ may be present, but this could not be determined with certainty.

Fig. 43.

Genital pore.—In the median sagittal line of the venter, about one-third of the worm's length from the oral extremity, there is the genital pore. It is situated at the vertex of a slight but not sharply defined ventral bulging.

Acetabulum.—This is in the caudal extremity, with a terminal though a more or less ventrally tilted aperture. The rim is sunken or more or less retracted beneath the inclosing body surface (fig. 45), so that the (apparent) aperture is formed by the inclosing parenchyma. Measured from a projection of one sectioned specimen (which measured 3.9 mm. in length), the maximum dorso-ventral diameter of the acetabulum was 1.14 mm. and of its aperture 0.60 mm., with a thickness of dome of about 0.24 mm.

INTERNAL ANATOMY.

The following description of the internal anatomy is based on a series of transverse sections of one specimen (5781a) which measured 3.90 mm. in length, 1.66 mm. in greatest transverse and 1.42 mm. in greatest dorso-ventral diameter as measured from projections made from the sections.

Fig. 44.

Digestive tract.—The mouth, which pierces the blunted cephalic extremity, leads directly into the oral sucker. The latter is muscular and of a pyriform outline as viewed in median sagittal section. Its maximum dimensions as measured in projection of a series of transverse sections are: Length, 0.52 mm.; dorso-ventral diameter, 0.42 mm.; transverse diameter, 0.60 mm. Its attenuated pole presents the aperture of the mouth and is marked off from the oral surface by a narrow encircling groove (fig. 45). Its broad blunt base gives origin to the esophagus. A roomy space incloses the body of the sucker (fig. 47). The lumen of the sucker is a dorso-ventrally narrow but transversely a rather broad space; it is lined with a cuticle which is beset with short conical papillæ.

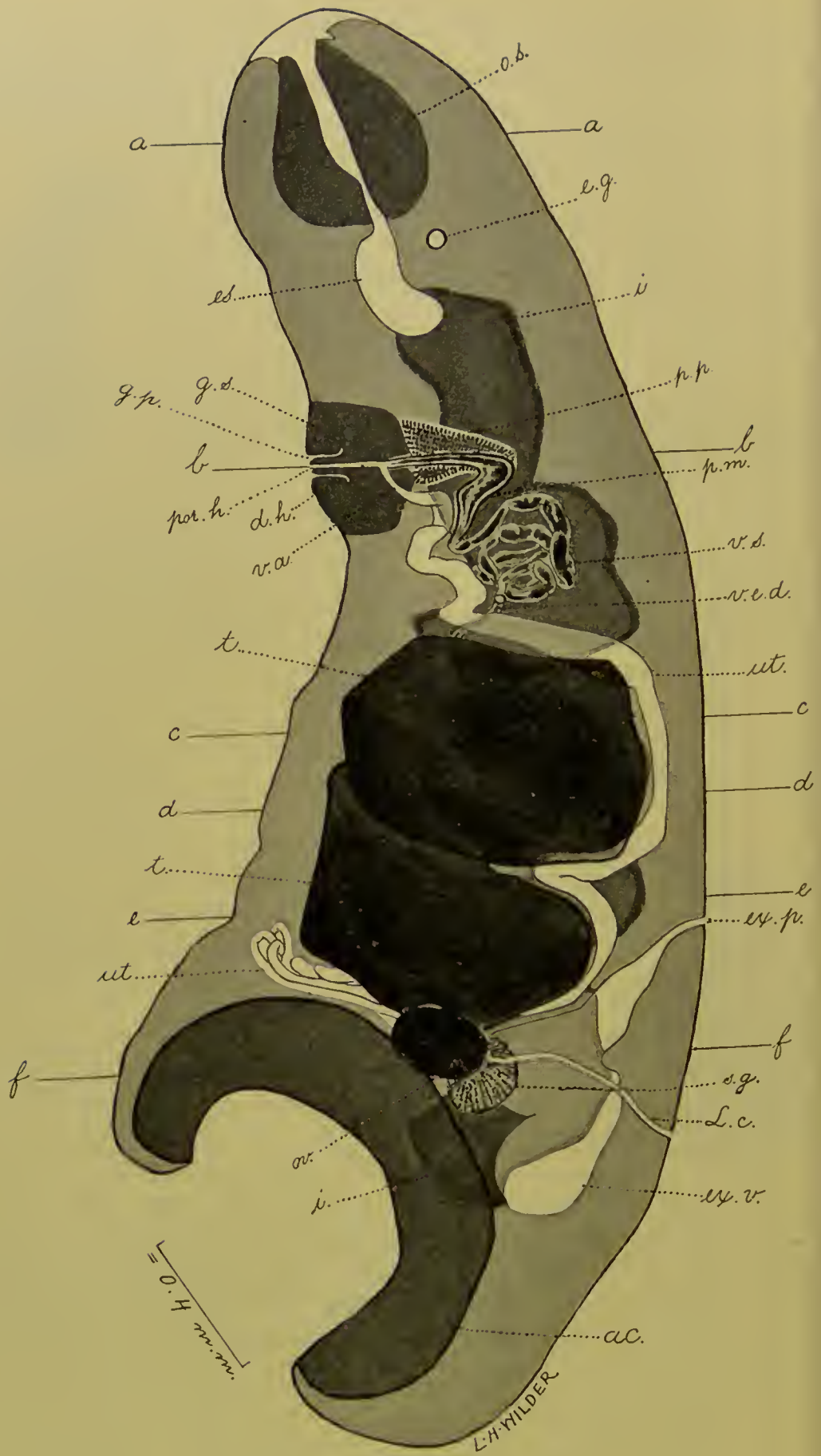
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FIG. 45.

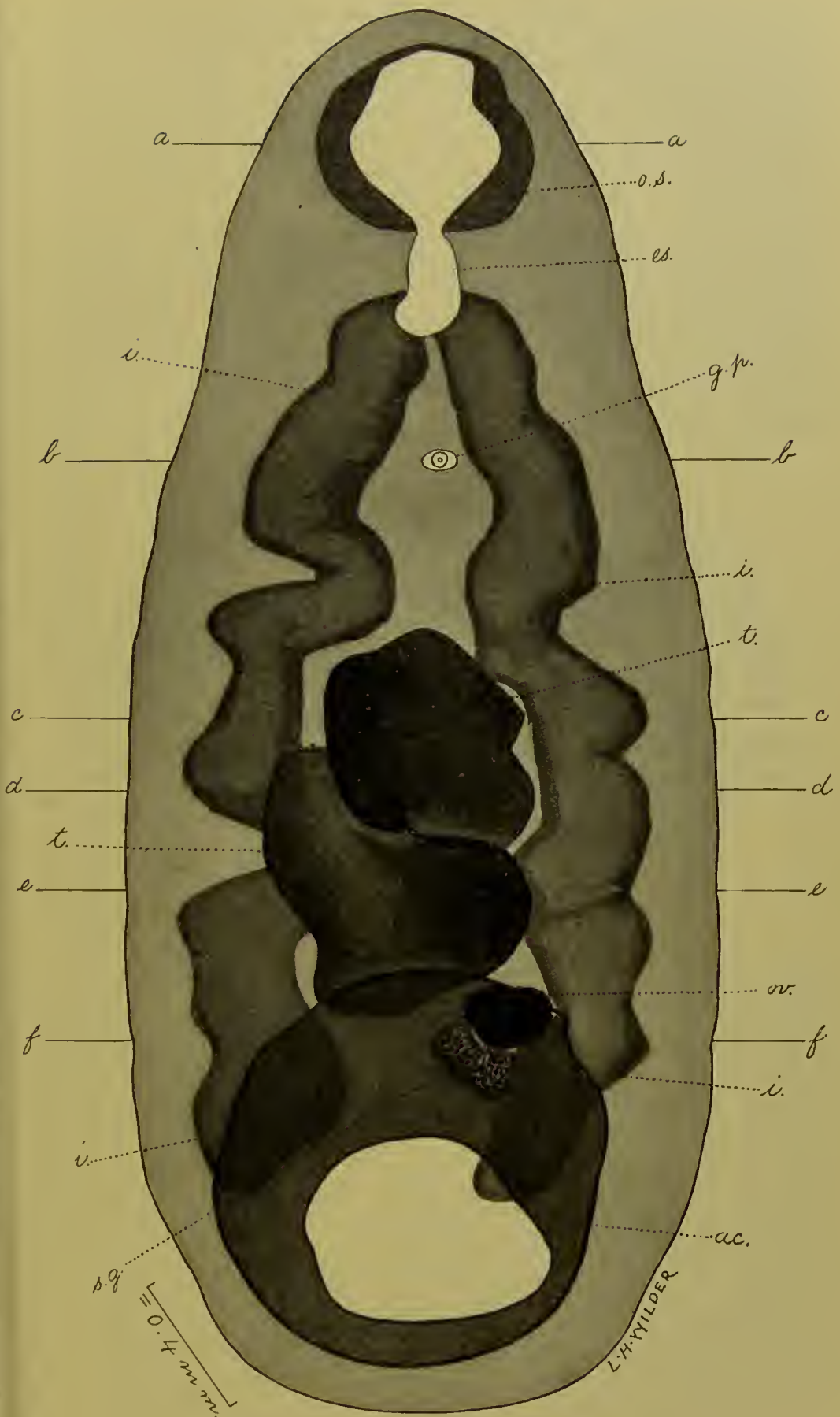

FIG. 46.

The esophagus, from its point of origin at the base of the sucker, passes caudad for a distance equal to about two-thirds the length of the sucker, where it gives off the intestinal ceca from both dorso-lateral aspects. The esophagus describes a slight curve ventrad. Its walls are thick and its lumen is lined with a thick cuticular layer. Dorsally of the first part of the esophagus there is a transverse nervous cord (fig. 45).

The intestinal ceca take their departure from the esophagus at a point slightly less than one-fourth the body length from the oral extremity. At their origin they form a very acute angle one with the other. The ceca at first approach the lateral margins of the body, then pass caudad in a well-marked dorso-ventrally wavy course, to terminate cecally at about the junction of the fifth with the caudal sixth of the body length; the right intestinal cecum terminates at a slightly higher (more cephalic) level than the left. The ceca are of relatively considerable caliber and are lined by a layer of epithelium.

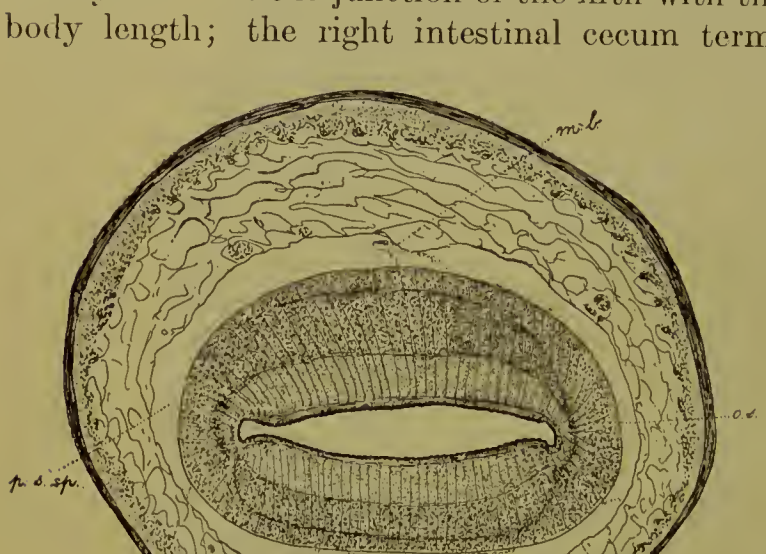

FIG. 47.

GENITAL SYSTEM.—*Male organs.*—The two testes are in the axial region of the body, one caudad of the other, but the caudally placed testis presents a cephalic lobe which overlaps the caudal portion of the right ventro-lateral aspect of the cephalic testis. The two testes occupy a zone immediately cephalad of that of the acetabulum and equal to one-fourth of the body length of the worm. The testes are irregularly globular in form and are indented by fissures marking off numerous lobes on their surface. Each testis gives origin to a vas efferens; that from the cephalic testis springs from its left dorsal aspect (fig. 49), while that of the caudal testis springs from its dorso-cephalic aspect (fig. 51). The vas from the cephalic testis at first passes cephalad close to the left lateral aspect of the testis from which it springs, later it passes cephalo-dorsad and toward the median line, arching over the testis and the uterus to unite with its fellow of the right side (from the caudal testis) to form the vas deferens. The right vas efferens, after its origin from the caudal testis, passes at first to the right and cephalad (dorsally of the cephalic lobe of the caudal

testis) to gain the right lateral aspect of the cephalic testis at some slight distance from which it ascends cephalad, eventually arching over the cephalic testis and the uterus to unite, as already described, in forming the vas deferens. The first part of the vas deferens is a much coiled, thin-walled, dilated duct (vesicula seminalis), distended with spermatozoa. This is abruptly succeeded by a narrow, thicker, and more muscular walled uncoiled part (pars musculosa), which ascends cephalad for a short distance, when it in turn is succeeded by a portion which is inclosed in a thick layer of cells. This portion (par prostatica) passes directly ventrad, and after a course about equal in length to the musculosa it penetrates the genital sucker. Here the prostatic cells cease and the continuation of the duct may be regarded as the ductus ejaculatorius. This joins near the base of the genital papilla

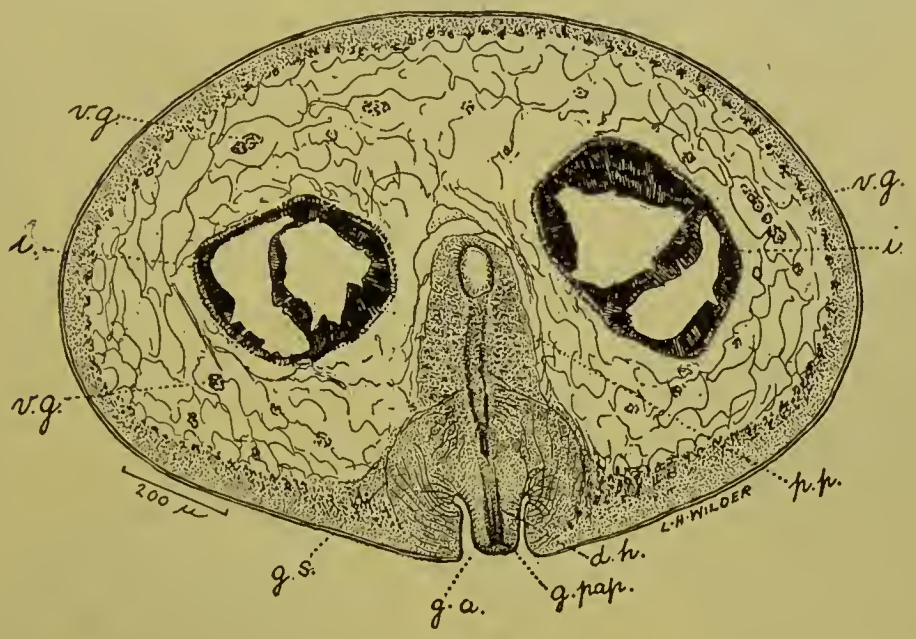

FIG. 48.

with the terminal portion of the uterus to form the ductus hermaphroditicus which is 195μ long and pierces the axial region of the genital papilla. The copulatory apparatus presents the genital pore in the median line of the venter at about the junction of the cephalic with the equatorial third of the body and considerably caudad of the esophageal fork (figs. 45, 48). This pore leads into a cylindrical chamber 105μ in depth and about 105μ in diameter, that is almost entirely filled by a cylindrical genital papilla, which, arising from the dorsal wall of the chamber, projects forward (ventrad) into it. The papilla, measured in transverse section, was 75μ in diameter and 105μ in length. Inclosing this genital atrium is a muscular mesh presenting somewhat the form of a hemisphere and in outline suggestive of a sucker. The genital atrium may be regarded as the cavity of the sucker and the genital pore as its aperture. It presents a sharply

defined limiting layer delimiting it from the body parenchyma (fig. 48).

Female organs.—The ovary is in the caudal portion of the body to the left of the median sagittal plane, close to the dome of the acetabulum and immediately caudad of the cephalic margin of the acetabulum. The oviduct takes origin from the dorsal aspect of the ovary and at first passes directly caudad. It then bends and passes to the right toward the shell gland, which it penetrates, but giving off Laurer's canal just before it does so. Immediately after entering the shell gland it unites with the common vitello-duct to form a fusiform ootype, which is directed obliquely from the left and dorsally to the right and ventrally to be continued as the uterus. Laurer's canal passes dorsad close to the left aspect of the excretory vesicle to reach the dorsum at a point to the left of the median line and about 0.56 mm. caudad of the excretory pore.

FIG. 49.

The shell gland lies in close apposition to the right side of the ovary; their zones are, however, not identical but overlap, that of the ovary being a little the more cephalad of the two. On account of this relation to the ovary, the shell gland lies just to the left of the median sagittal plane and of the excretory vesicle, which at this level is crowded over to the right. As already stated the shell gland is penetrated by the oviduct, the point of penetration corresponding to the dorsal pole of the gland. It is also penetrated by the common vitello-duct, the point of penetration being close to but a little caudad

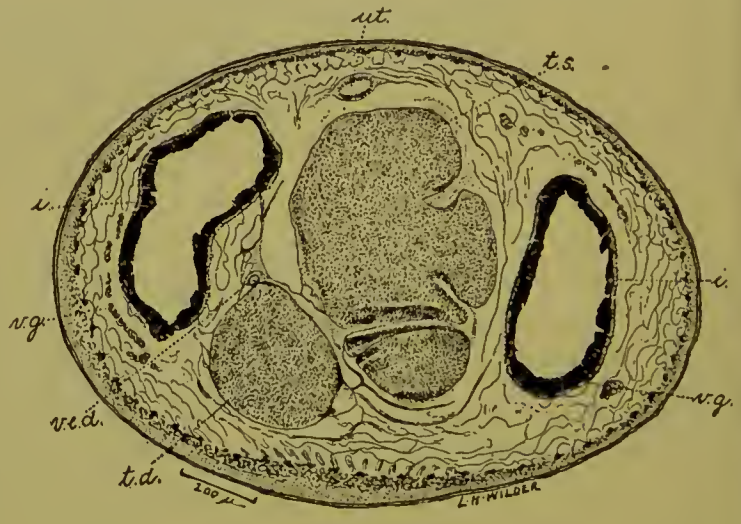

FIG. 50.

of the point of penetration of the oviduct. The uterus emerges from its ventral pole, being, as already described, a continuation of the fusiform ootype. Immediately after emerging, the uterus ascends cephalad, forming some coils close to the right ventro-lateral aspect of the ovary, and ascending further ventro-cephalad it forms some coils directly cephalad of the acetabulum and ventrad of the ventro-caudal aspect of the caudal testicle. It now turns dorsad, skirting the left lateral aspect of the caudal portion of the caudal testis to gain a position dorsally of this testis, where it turns cephalad. The uterus now ascends dorsally of the testes until it reaches the level of the cephalic aspect of the cephalic testis, when it passes ventro-cephalad over this testis and beneath the coiled vesicula and arch of union of the vasa efferentia to gain the ventral aspect of the former. Here it bends cephalad again, eventually penetrating the genital sucker at a point slightly caudad of that of the pars prostatica and, as already described, uniting with the ductus ejaculatorius to form the ductus hermaphroditicus.

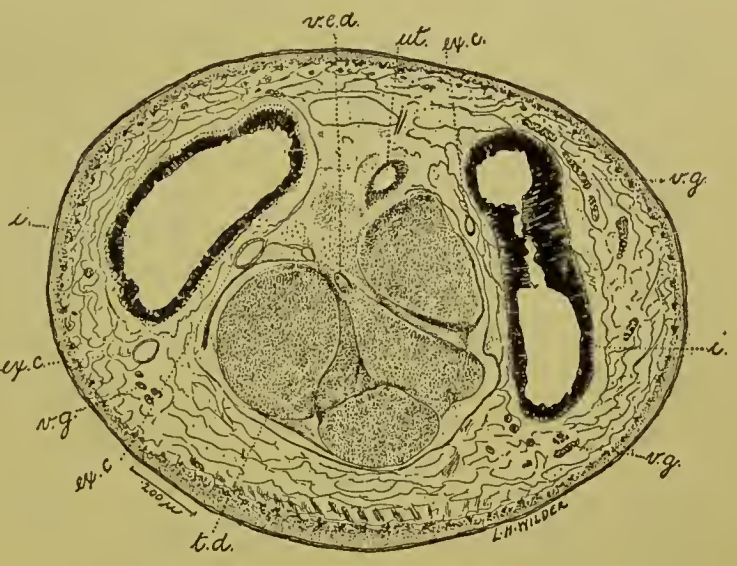

Fig. 51.

The vitellaria, consisting of sparsely scattered but well-developed follicles, are placed in the extracecal fields; longitudinally they are coextensive with the cecal zone, though a few follicles are found slightly caudad of this zone, and not only in the extracecal fields but also in the cecal and intercecal areas.

The transverse vitelloducts pass transversely toward the median line, ventrally of the corresponding testis, and unite close to the ventro-caudal aspect of the shell gland. From their point of union the common vitello-duct takes its departure, skirts closely the caudal aspect of the shell gland and, as already described, penetrates this gland close to its dorsal pole.

Eggs.—Eggs were not observed in the uterus.

Excretory system.—The excretory system is well developed. A well-developed excretory vesicle lies in the caudal portion of the body. It is in the form of an inverted elongate pouch, the fundus of the vesicle being close to the dome of the acetabulum in the intercecal field at the level of the cecal ends of the intestines. The body of the

vesicle extends cephalad and toward the dorsum, its diameters in transverse section becoming progressively smaller. Eventually it gives place to a short, thick walled duct, which opens in the median line of the dorsum at about the junction of the equatorial with the caudal third of the body length and about 0.16 mm. cephalad of the transverse plane of the cephalic margin of the acetabulum and slightly cephalad of the level of the caudal margin of the caudal testis.

RELATION TO OTHER SPECIES.

Cotylophoron indicum comes close to *C. cotylophorum*, from which it differs chiefly in the structure of the esophagus, which is provided with a bulbus thickening in the latter species but is without it in the

FIG. 52.

former. The two differ also in the details of structure of the copulatory apparatus and in the position of the genital pore. In *C. indicum* the genital sucker is less sharply delimited, projects less, has a much smaller genital atrium, and the genital pore is decidedly postbifurcal; on the other hand, in *C. cotylophorum* the genital sucker is sharply marked, with rim prominently bulging the venter, with a relatively roomy genital atrium and with the genital pore in the bifurcal zone.

ILLUSTRATIONS.

FIG. 43.—Profile view. Enlarged. Original.

FIG. 44.—Ventral view. Enlarged. Original.

FIG. 45.—Profile projection of same, showing oral sucker (*o. s.*), esophagus (*es.*), esophageal ganglion (*e. g.*), right intestine (*i.*), genital sucker (*g. s.*), testes (*t.*), right vas efferens (*v. e. d.*), vesicula seminalis (*v. s.*), pars musculosa (*p. m.*), pars prostatica (*p. p.*), ductus herma-

phroditieus (*d. h.*), porus hermaphroditicus (*por. h.*), genital pore (*g. p.*), metraterm (*va.*), uterus (*ut.*), shell gland (*s. g.*), ovary (*ov.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v*), excretory pore (*ex. p.*), and acetabulum (*ac.*). *a–a, b–b, c–c, d–d, e–e, f–f,* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 46.—Ventral projection of same. Lettering as in fig. 45. Slightly diagrammatic. Enlarged. Original.

FIG. 47.—Transverse sections at *a–a*, figs. 45 and 46. Shows oral sueker (*o. s.*) with the papillæ lining the lumen, perisuetorial space (*p. s. sp.*), and mesenterial band (*m. b.*). Enlarged. Original.

FIG. 48.—Transverse seetion at *b–b*, figs. 45 and 46. Shows genital atrium (*g. a.*), genital papilla (*g. pap.*), genital sucker (*g. s.*), ductus hermaphroditieus (*d. h.*), pars prostatiea (*p. p.*), intestinal ceca (*i*), vitellaria (*v. g.*). Enlarged. Original.

FIG. 49.—Transverse section at *c–c*, figs. 45 and 46. Shows form of body at equator, cephalic testis (*t. s.*), origin of left vas efferens (*v. e. s.*), position of the right vas efferens (*v. e d.*), uterus (*ut.*), intestinal ceea (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 50.—Transverse seetion at *d–d*, figs. 45 and 46. Shows caudal portion of cephalic testis (*t. s.*), and cephalic lobe of caudal testis (*t. d.*), right vas efferens (*v. e. d.*), uterus (*ut.*), intestinal eeea (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 51.—Transverse section at *e–e*, figs. 45 and 46. Shows caudal testis (*t. d.*), origin of right vas efferens (*v. e. d.*), uterus (*ut.*), intestinal eeea (*i.*), vitellaria (*v. g.*), and excretory canals (*ex. c.*). Enlarged. Original.

FIG. 52.—Transverse section at *e–e*, figs. 3 and 4. Shows ovary (*ov.*), shell gland (*s. g.*), first part of uterus (*ut.*), Laurer's eanal (*L. c.*), excretory vesiele (*ex. v.*), intestinal eeea (*i.*), vitellaria (*v. g.*), and acetabulum (*ac.*). Enlarged. Original.

Genus PARAMPHISTOMUM, Fischœder, 1901.

GENERIC DIAGNOSIS.—*Paramphistominæ* (p. 62): Body tends to a conical form, with convex dorsum and cancave venter, rather attenuate cephalad, rather blunt caudad; ventral pouch absent. Acetabulum terminal, tilts ventrad, small to very large, sunken, margin not raiscd, aperture small to large. *Genital sucker absent*, pore ventro-median, pretesticular. Excretory vesicle at least partly in acetabular zone. *Oral sucker without evagination;* esophagus with or without muscular thickening; ceca long, nearly straight to wavy, end postequatorial, posttesticular, usually in acetabular zone.

Male organs: Testes 2, usually intercecal, small to large, finely lobulate to coarsely lobate, exceptionally nearly smooth, fields coincide to separate, zones coincide to separate; *cirrus pouch absent.*

Female organs: Ovary and shell gland usually posttesticular, never pretesticular; Laurer's canal may cross vesicle; uterus runs dorsally of testes, under arch of vasa efferentia, then ventrally of vas deferens.

Eggs: With (or without ? ?) operculum.

TYPE SPECIES.—*P. cervi* (Schrank, 1790).

The species of this genus may be arranged in several groups, the individual members of which appear more closely related to each other than to individual members of other groups. Still it is somewhat difficult at present to separate the forms with entire satisfaction. That several of these groups will eventually be recognized as of generic rank seems certain, but in the interest of conservatism, we propose to recognize them temporarily only as subgenera, as follows:

Subgenus *Paramphistomum*, with *cervi* (type), *epiclitum*, *liorchis*, and *bathycotyle*.
Subgenus *Orthocœlium*, with *orthocœlium* (type), and *dicranocœlium*.
Subgenus *Bothriophoron*, with *bothriophoron* (type), and *papilligerum*.
Subgenus *Cauliorchis*, with *cauliorchis* (type), *crassum*, probably *papillosum*, and doubtfully *indicum* and *calicophorum*.
Subgenus uncertain: All the other known species.

The following key will aid in separating the species in question:

KEY TO SPECIES OF PARAMPHISTOMUM

A^2. Laurer's canal crosses excretory canal or vesicle.....p. 75.
A^1. Laurer's canal does not cross excretory canal or vesicle, its pore is always cephalad of excretory pore; ovary prevesicular; testes touch median line:
B^1. Ceca nearly or quite straight, end in pre- or acetabular zone; esophagus with slight muscular thickening; acetabulum small; excretory vesicle club-shaped; ventral chamber of genital atrium absent; testes lobate, distinctly and considerably preacetabular, fields coincide; vitelline follicles coarse, grouped; type *orthocœlium*.....Subgenus *Orthocœlium*, p. 77.
C^1. Excretory vesicle and canal directed dorso-cephalad, excretory pore slightly prevesicular; genital pore bifurcal; vitelline follicles usually in single row each side; testes about as large as acetabulum; oral sucker with sphincter; esophagus twice as long as oral sucker; ceca deep, end pre- to acetabular; body 5 to 11 mm. long; type host *Bos kerabau*, from Ceylon.
P. orthocœlium, p. 77.
C^2. Excretory vesicle and canal directed dorso-caudad, excretory pore postvesicular; genital pore postbifurcal; vitelline follicles usually in two rows each side; testes larger than acetabulum; oral sucker without sphincter; esophagus about one and one-half times as long as oral sucker; ceca rather narrow and in section nearly circular, end preacetabular; body 5 to 8 mm. long; type host *Bos indicus*.....*P. dicranocœlium*, p. 77.
B^2. Ceca sinuous to wavy, end in acetabular zone; [subgeneric position as yet uncertain, but not typical subgenus *Paramphistomum*]:
C^3. Esophageal muscular thickening absent; esophagus about as long as sucker; ceca wavy; excretory pore in vesicular zone; acetabulum terminal small to moderate; genital pore postbifurcal; ventral chamber of genital atrium small; testes (? about equal to and) removed from acetabulum, fields coincide, zones slightly separate; musculosa long, coiled; ovary slightly ventro-cephalic; vitellaria in esophageal, cecal, and cephalic part of postcecal zone; body 5 to 11 mm. long; type host *Bos kerabau*, Ceylon.
P. streptocœlium.
C^4. Esophageal muscular thickening present; testes lobate; acetabulum moderate:
D^1. Excretory pore prevesicular; ventral chamber of genital atrium present, genital atrium (dorsal chamber) papillated; ceca wavy; testicular zone overlaps acetabulum; body 3 to 3.9 mm. long, 1.8 to 2.3 mm. broad; type host *Bos indicus*, Siam.....*P. parvipapillatum*, p. 143.

D^2. Excretory pore in vesicular zone; ventral chamber of genital atrium small, complicated; musculosa quite large, coiled; ceca wavy; testicular zone slightly preacetabular, testes slightly larger than acetabulum, testicular fields nearly coincide; ovary acetabular; vesicle not club-shaped; body between 4.5 and 7 mm. long, 2.46 mm. broad, 2.26 mm. thick; type host *Cervus eldi*.....*P. shipleyi*, p. 150.

D^3. Excretory pore postvesicular; ventral chamber of genital atrium absent; ceca sinuous; testicular zones abut to separate, slightly preacetabular; testicular fields coincide; vitelline follicles coarse, grouped, extend esophageal, cecal, postcecal; vesicle not club-shaped; body 2 to 6 mm. long, 0.7 to 2.5 mm. broad; type host *Bos bubalus*, Cochin China, and *B. taurus*, Annam.....*P. scoliocœlium* Fischœder, 1904.

A^2. Laurer's canal crosses excretory canal or vesicle; Laurer's pore (except in *cauliorchis* and possibly *papilligerum*) caudad of excretory pore; ovary never entirely cephalic of vesicle, but always ventral; testes not distinctly larger, but usually smaller than or about equal to acetabulum; esophagus without muscular thickening; ceca sinuous to wavy, not straight:

B^3. Ventral chamber of genital atrium very large; testes lobate, about equal in size to acetabulum, testicular fields median, nearly coincide, zones slightly separate, nearly abut, preacetabular; acetabulum moderate; ceca long, end in acetabular zone, moderately broad; type *bothriophoron*.

Subgenus *Bothriophoron*, p. 77.

C^5. Ventral chamber not papillate; pore of Laurer's canal latero-caudad of excretory pore, which is prevesicular; testes a little removed from acetabulum; genital sphincter present; body 6 to 9 mm. long; type host *Bos indicus*, Madagascar.....*P. bothriophoron*, p. 77.

C^6. Ventral chamber papillate; pore of Laurer's canal slightly caudad of excretory pore; testes slightly preacetabular; body 8.5 mm. long, 4.3 mm. broad; type host *Cervus eldi*.....*P. papilligerum*, p. 78.

B^4. Ventral chamber of genital atrium absent or small:

C^7. Acetabulum large to very large:

D^4. Excretory pore prevesicular:

E^1. Testicular fields separate, not median, zones overlap, testes lobate, much smaller than acetabulum, acetabular to somewhat preacetabular but not far removed; musculosa long and thick; Laurer's pore postero-lateral of excretory pore; ventral chamber (?); genital pore postbifurcal, excretory vesicle not narrow, but swollen; acetabulum large; body 5 to 8 mm. long; type hosts *Bos taurus*, Togo, *Bos zebu*, German East Africa.....*P. calicophorum*, Fischœder, 1901.

E^2. Testicular fields median, coincide or overlap, zones lobate, testes much smaller than and near the acetabulum; ventral chamber absent; excretory vesicle long and narrow; acetabulum very large:

F^1. Genital pore in suctorial zone; musculosa straight, narrow, prostatica shorter than musculosa; acetabulum less than half as long as body; testes large; ceca wavy, broad; excretory vesicle long; body 9.75 mm. long, 4.5 mm. broad; type host *Buffelus indicus*.

P. fraternum, p. 131.

F^2. Genital pore in esophageal zone; musculosa coiled; testes large; acetabulum more than half as long as body; ceca wavy, moderately broad, end in acetabular zone; body 6 to 9 mm. long, 4 mm. broad; type host *Bos indicus*, Siam.....*P. siamense*, p. 161.

F^3. Genital pore in postbifurcal zone; musculosa (?); prostatica longer than musculosa; acetabulum less than half as long as body; ceca sinuous, moderately broad, end in acetabular zone; body 8 to 13 mm. long; type host *Bos indicus* at Berlin, Germany.

P. explanatum Creplin, 1847.

D^5. Excretory pore in vesicular zone; testes small, much smaller than acetabulum, cauliflower shaped, near acetabulum; vesicle bag-like; ceca wavy:

E^3. Testicular fields separate, not median, testes pre- and acetabular; musculosa enormous; vasa efferentia convex cephalad; ovary ventro-cephalic of vesicle; pore of Laurer's canal slightly latero-cephalic of excretory pore; genital pore postbifurcal; ceca moderately broad; body 6 to 7.5 mm. long, 3.6 to 4.25 mm. broad; type host *Bos indicus*, India.....*P. cauliorchis*, p. 86.

E^4. Testicular fields overlap, median; testes diagonal, pre- and acetabular, musculosa large; ovary ventral of vesicle; pore of Laurer's canal caudad of excretory pore; genital pore in suctorial zone; ceca broad; body 6 to 6.5 mm. long, 4 to 4.76 mm. broad; type host *Bos indicus*, India.....*P. crassum*, p. 101.

E^5. Testicular fields coincide, median, testes preacetabular; musculosa large; ovary ventro-cephalic of vesicle; pore of Laurer's canal caudad of excretory pore; ventral chamber small, papillate; genital pore in esophageal zone, ceca moderately broad; body 5 to 6 mm. long, 2.6 mm. broad; type host *Bos indicus*, India.....*P. papillosum*, p. 112.

C^8. Acetabulum small to moderate; ventral chamber absent; testicular fields median, coincide or overlap; ovary ventral of vesicle:

D^6. Testes distinctly removed from acetabulum; genital pore postbifurcal; vesicula club-shaped; excretory pore prevesicular:

E^6. Acetabulum small, about one-eighth as long as body; genital sphincter absent; pars prostatica large, oval; musculosa short, not coiled; body 11 to 15 mm. long; type host *Bos kcrabau*, also in *Portax tragocamelus*.....*P. gracile* Fischœder, 1901.

E^7. Acetabulum moderate; genital sphincter present; pars prostatica thin; musculosa long, coiled; body 8 to 11 mm. long; type host *Antilope dorcas*.....*P. microbothrium* Fischœder, 1901.

D^7. Testes near acetabulum:

E^8. Testes much smaller than acetabulum, cauliflower-like; excretory vesicle bag shaped, distended; excretory pore in pre- and vesicular zones; body 5.25 to 9.5 mm. long, 2 to 3 mm. broad; type host *Bos indicus*, India.....*P. indicum*, p. 121.

E^9. Testes about equal to (or slightly smaller or larger than) acetabulum; excretory pore distinctly prevesicular; type *cervi*.

Subgenus *Paramphistomum*, p. 77.

F^4. Testes nearly smooth; genital pore prebifurcal; pars musculosa very short; body 3 to 8 mm. long; type hosts *Cervus simplicicornis*, *C. campestris*, *C. mexicanus*, *C. rufus*, *C. dichotomus*, *C. namby*. Brazil.....*P. liorchis* Fischœder, 1901.

F^5. Testes lobate:

G^1. Testes distinctly smaller than acetabulum; acetabulum one-third as long as body; body 11 to 15 mm. long; type host *Bos kcrabau*, Ceylon.....*P. bathycotyle* Fischœder, 1901.

G^2. Testes not distinctly smaller than acetabulum:

H^1. Genital pore bifurcal or only slightly postbifurcal; body 5 to 12 mm. long; type host *Cervus claphas*, Europe..*P. cervi* (Schrank, 1790).

G^3. Genital pore markedly postbifurcal; body 5 to 9 mm. long, 2 to 3 mm. broad; type hosts *Bos bubalus*, Cochin-China, and *Bos indicus*, at Berlin, Germany.....*P. epiclitum* Fischœder, 1904.

Subgenus PARAMPHISTOMUM.

SUBGENERIC DIAGNOSIS.—*Paramphistomum* (p. 73): Ceca sinuous to wavy, not straight; long, end in or close to acetabular zone; esophagus without muscular thickening. Acetabulum moderate, terminal. Excretory vesicle elongate, more or less club shaped, its pore prevesicular. Ventral chamber of genital atrium absent.

Male organs: Testes lobate to smooth, near and about equal to acetabulum, at least neither very much larger nor very much smaller (except possibly *bathycotyle*), testicular zones slightly separate or abut or slightly overlap, fields median, nearly or quite coincide.

Female organs: Ovary ventral of vesicle; Laurer's canal crosses excretory canal or vesicle, its pore caudad of excretory pore; vitellaria in esophageal, cecal, and postcecal zones.

TYPE SPECIES.—*P. cervi* (Schrank, 1790).

This subgenus contains at least 4 species (*cervi, epiclitum, liorchis,* and *bathycotyle*), all of which have been studied by Fischœder.

ORTHOCŒLIUM, new subgenus.

SUBGENERIC DIAGNOSIS.—*Paramphistomum* (p. 73): Ceca nearly or quite straight, end preacetabular or in proximal portion of acetabular zone; esophagus with slight muscular thickening. Acetabulum small, terminal, tilts ventrad. Excretory vesicle club shaped. Ventral chamber of genital atrium absent.

Male organs: Testes about equal to or larger than acetabulum, lobate, zones abut and are considerably preacetabular, fields coincide, in median line.

Female organs: Ovary prevesicular; Laurer's canal does not cross excretory vesicle or duct, its pore cephalad of excretory pore; vitelline follicles coarse, grouped, extend from esophageal into postcecal and even into acetabular zone.

TYPE SPECIES.—*Paramphistomum orthocœlium* Fischœder, 1901.

This subgenus, which at present contains two species (*orthocœlium* and *dicranocœlium*, see key p. 74), will probably eventually be recognized as a distinct genus. Both of these species have been studied by Fischœder.

BOTHRIOPHORON, new subgenus.

SUBGENERIC DIAGNOSIS.—*Paramphistomum* (p. 73): Ceca sinuous to wavy, not straight; long, end in acetabular zone, and moderately broad; esophagus without muscular thickening. Acetabulum moderate, terminal. Excretory vesicle distended, not club shaped. *Ventral chamber of genital atrium very large.*

Male organs: Testes lobate, about equal in size to and not far away from acetabulum, testicular zones slightly separate, nearly abut, fields median, nearly coincide.

Female organs: Ovary ventral of vesicle; Laurer's canal crosses excretory canal or vesicle, its pore (in the type species at least) caudad of the excretory pore; vitellaria well developed, extend from bifurcation to slightly caudad of ceca.

TYPE SPECIES.—*Paramphistomum bothriophoron* (Braun, 1891).

Two species (namely, *bothriophoron* and *papilligerum*) may be classified here. They are easily separated by the papillate or nonpapillate condition of the ventral chamber of the genital atrium. *P. bothriophoron* has been recently studied by Fischœder.

PARAMPHISTOMUM PAPILLIGERUM, new species.

[Figs. 53 to 56.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 8.5 mm. long by 4.3 mm. broad; color (?); greatest breadth near caudal end; tapers gradually to bluntly pointed oral pole, very rapidly to very bluntly rounded caudal pole. Surface without papillæ. Genital pore at junction of cephalic with equatorial thirds of body, with elliptical bulging 1.08 mm. in transverse, 0.8 mm. in longitudinal diameter, with 2 transverse labia; genital pore about 0.61 mm. by 0.37 mm.; surface of bulging sparsely papillate; at this point a crateriform, papillate atrium. Acetabulum terminal, sunken in parenchyma, its margin not projecting, 1.88 mm. in transverse diameter, opening caudad (terminal) 0.46 mm. in transverse diameter. Mouth in depression at cephalic pole; oral sucker rather oval in frontal section, its lumen papillate; lies in a well developed perisuctorial cavity; esophagus bent, convexity ventrad, its wall rather uniform in thickness; ceca long, wavy dorso-ventrally, extend caudad about to equator of acetabulum. Excretory pore about dorso-median, slightly cephalad of pore of Laurer's canal; excretory canal runs to dorsal (or dorso-caudal?) aspect of well-developed vesicle lying dorsally and dorso-cephalad (?) of acetabulum.

Male organs: Testes large, lobate, in median line, intercecal, fields overlap, zones slightly overlap; union of vasa efferentia slightly cephalad of cephalic testis; vas deferens dilated, coiled; pars intermedia connects this with coiled musculosa; pars prostatica relatively short, passes directly ventrad; ductus ejaculatorius opens just above metraterm into transverse (in frontal plane) slit-like chamber, whence a duct passes ventrad apparently piercing a papilla; the latter projects into a chamber which is connected by a very short duct with the papillated genital atrium.

Female organs: Ovary and shell gland between caudal testis and acetabulum, ovary slightly to left of median line, shell gland about median; vitellaria with well-developed, sparsely scattered follicles, chiefly in extracecal area, extending from esophageal to slightly caudad of cecal zone; uterus extends from shell gland slightly caudo-sinistrad, then ventrally of ovary and shell gland dextrad, bends cephalad dorsally of testes, ventrad under arch of vasa efferentia, cephalad ventrally of vas deferens to open caudad of male opening into the slit-like chamber.

Eggs: Oval, 135μ by 67μ, operculated (?).

TYPE.—U.S.P.H. & M.H.S. 10706 (returned to Doctor Shipley).

HABITAT.—In (stomach (?) of) *Cervus eldi*, locality not known.

SOURCE OF MATERIAL.—The material, consisting of a series of frontal sections, was kindly loaned us by Dr. A. E. Shipley.

EXTERNAL CHARACTERS.

SIZE.—Measurements taken from the sections give about 8.5 mm. for the maximum vertical diameter and about 4.3 mm. for the maximum transverse diameter.

FORM.—The greatest width of the worm is near the caudal extremity, from which region it tapers in both directions. The caudal extremity is broad, rounded from side to side, and presents the aperture of the acetabulum; the cephalic extremity is bluntly pointed and presents at its vertex a well-marked depression, at the bottom of which is the oral aperture.

SURFACE.—The general surface of the worm appears unprovided with such structures as spines or hooks, and except for the genital bulging is without papillæ.

Genital pore.—In about the median sagittal line of the venter and about at the junction of the cephalic with the middle third of the body length there is a bulging, elliptical in outline and measuring at the base about 1.08 mm. in transverse and about 0.80 mm. in vertical diameter. At the vertex of this bulging there are two transverse lip-like structures, continuous laterally, which bound, as it were, a transversely elliptical aperture. This aperture may be regarded as the genital pore, and measures 0.61 mm. in transverse and about 0.37 mm. in median sagittal diameter. The surface of the bulging is beset by minute sparsely scattered papillæ.

The genital pore gives entrance to a crateriform depression or atrium, the surface of which is closely beset by nipple-like papillæ (fig. 53), which are considerably larger than those of the surface of the genital bulging.

Acetabulum.—The acetabulum is in the caudal extremity of the worm and measures 1.88 mm. in greatest transverse diameter. Its aperture is terminal and measures 0.46 mm. in maximum transverse diameter. The rim of the acetabulum does not project beyond the caudal body surface, but appears rather retracted and its aperture slightly encroached upon by folds of the encircling portions of the body.

INTERNAL ANATOMY.

Digestive tract.—The mouth is at the bottom of the depression at the cephalic pole of the worm, and leads directly into the lumen of a large muscular oral sucker.

In frontal section the sucker has an oval form with a broad rounded base, which gives origin to the esophagus. The oral pole of the sucker projects in a ring-like manner beyond the adjacent surface. A roomy perisuctorial space is present. The lumen of the sucker is closely beset by well-marked conical papillæ. The esophagus at first passes directly caudad in about the median sagittal plane, then bends ventrad and describes a short curve, or possibly forms only a moderate bend (the interpretation is difficult) with its convexity ventrad. It then passes caudo-dorsad and forks into the lateral intestinal ceca at or somewhat cephalad of the level of the genital pore. This relation could not be made out with precision from the sections. The thickness of the esophageal wall is substantially uniform throughout. Its lumen is lined with a cuticle-like layer. In about the equator of the esophagus and dorsally of it there is a transverse ganglionic cord. The intestinal ceca pass at first laterad and slightly cephalad at or slightly less than a right angle with the esophagus, then turn caudad pursuing a dorso-ventrally wavy course approximately parallel to the lateral body wall, terminating by blind extremities about 5 mm. caudad of the esophageal arch close to the corresponding dorso-lateral aspect of the acetabulum.

Genital system.—The sexual organs, with the exception of the vitellogene glands, are disposed in the intercecal area.

Male organs.—There are two lobate testes, one caudad of the other, their opposing aspects being in close apposition. The cephalically placed of the two is a little nearer the left and the caudally placed a little nearer the right lateral body margin. In some of the sections the testes appear somewhat wedge-shaped, the left edge of the cephalic testis and the right of the caudal testis being (vertically) the longer of the vertical edges of the 2 testes. As the testes are in fairly close apposition, the line of separation between them runs somewhat obliquely from the right to the left and caudad, and consequently their zones overlap to a slight extent (fig. 54). A vas efferens springs from each testis; that from the caudal gland passes cephalad with a slight tilt dorsad between the cephalic testis and the right gut, and is of considerable transverse diameter; that from the cephalic testis passes at first dorsad, then to the left and cephalad. The latter is of a smaller caliber and soon reaches the upper part of the space between the dorsolateral aspect of the gland from which it springs and the left gut, and then dilating rather abruptly it curves cephalo-mediad to unite with its fellow of the right side, which likewise curves cephalo-mediad to meet it, and the two thus form the vas deferens. The vasa efferentia in uniting form a transverse arch at a level apparently slightly cephalad of that of the superior margin of the cephalic testis; beneath this arch the uterus is seen to pass as it arches cephalo-ventrad over the cephalic testis. The vas deferens presents at first a much dilated, thin-walled, coiled vesicula measuring about 0.27 mm. in diameter; this is succeeded by a long, thick-walled, coiled pars musculosa of about 180μ in diameter and with a thickness of wall of about 60μ. Between the vesicula and the musculosa there is intercalated a relatively thick-walled segment measuring about 75μ in diameter. The musculosa is succeeded by a relatively short prostatica; this part of the vas deferens is inclosed in a thick layer (75μ) of prostatic cells and passes directly ventrad. The prostatic

Fig. 53.

portion is succeeded by a ductus ejaculatorius which, with the metraterm, is inclosed in a thin layer of an ill-defined muscular mesh and opens with, but just above, the metraterm into a frontally transverse slit-like chamber. From this chamber a duct passes ventrad, apparently piercing a papilla, the form of which can not satisfactorily be

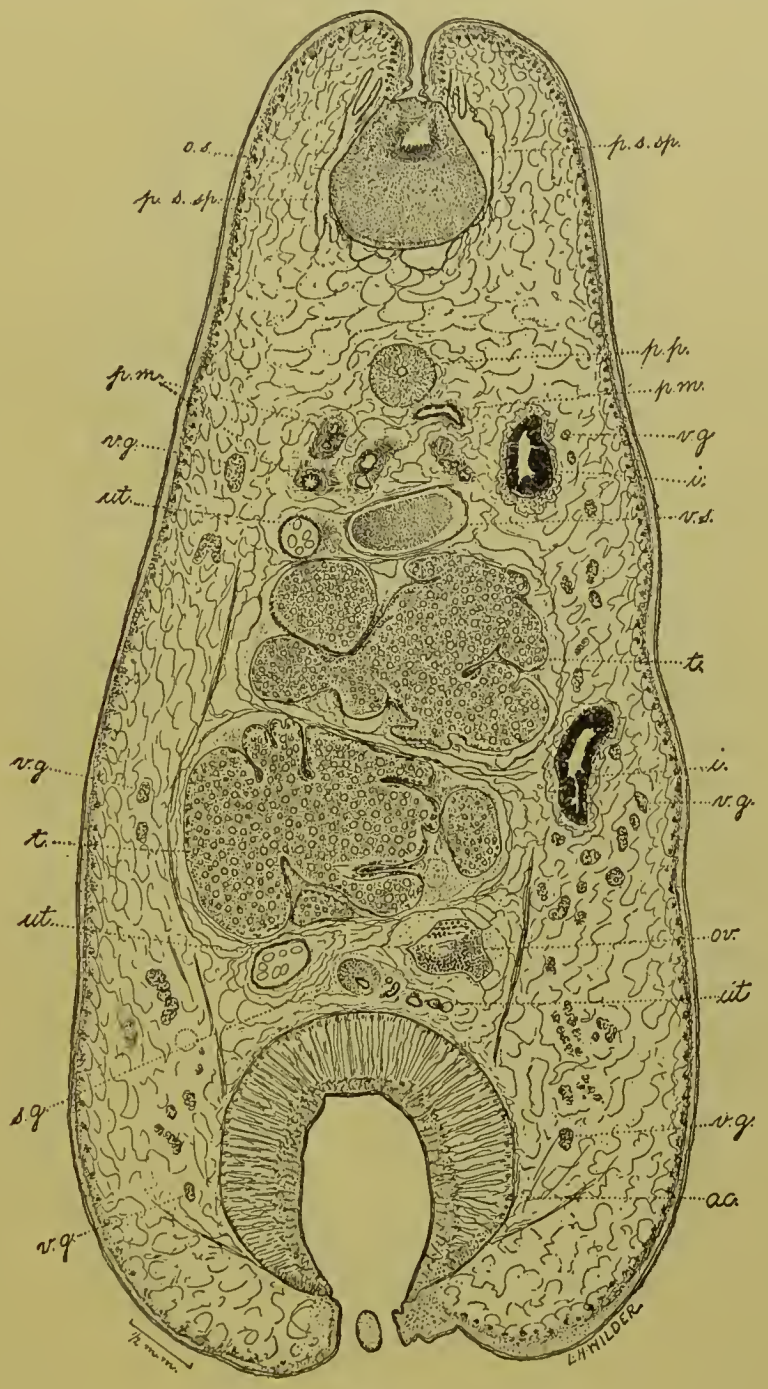

FIG. 54.

made out. This papilla projects ventrad into a chamber (from the dorsal wall of the latter as it were) so that the duct piercing it opens into this chamber. This chamber in its turn communicates with the crateriform, papillated ventral genital chamber (previously described) by

a very short and quite narrow duct. This series of atria and connecting ducts of the hermaphroditic copulatory apparatus seems to resemble that of *Paramphist. shipleyi*. The marked and striking difference between the two, so far as one can judge from the sections avail-

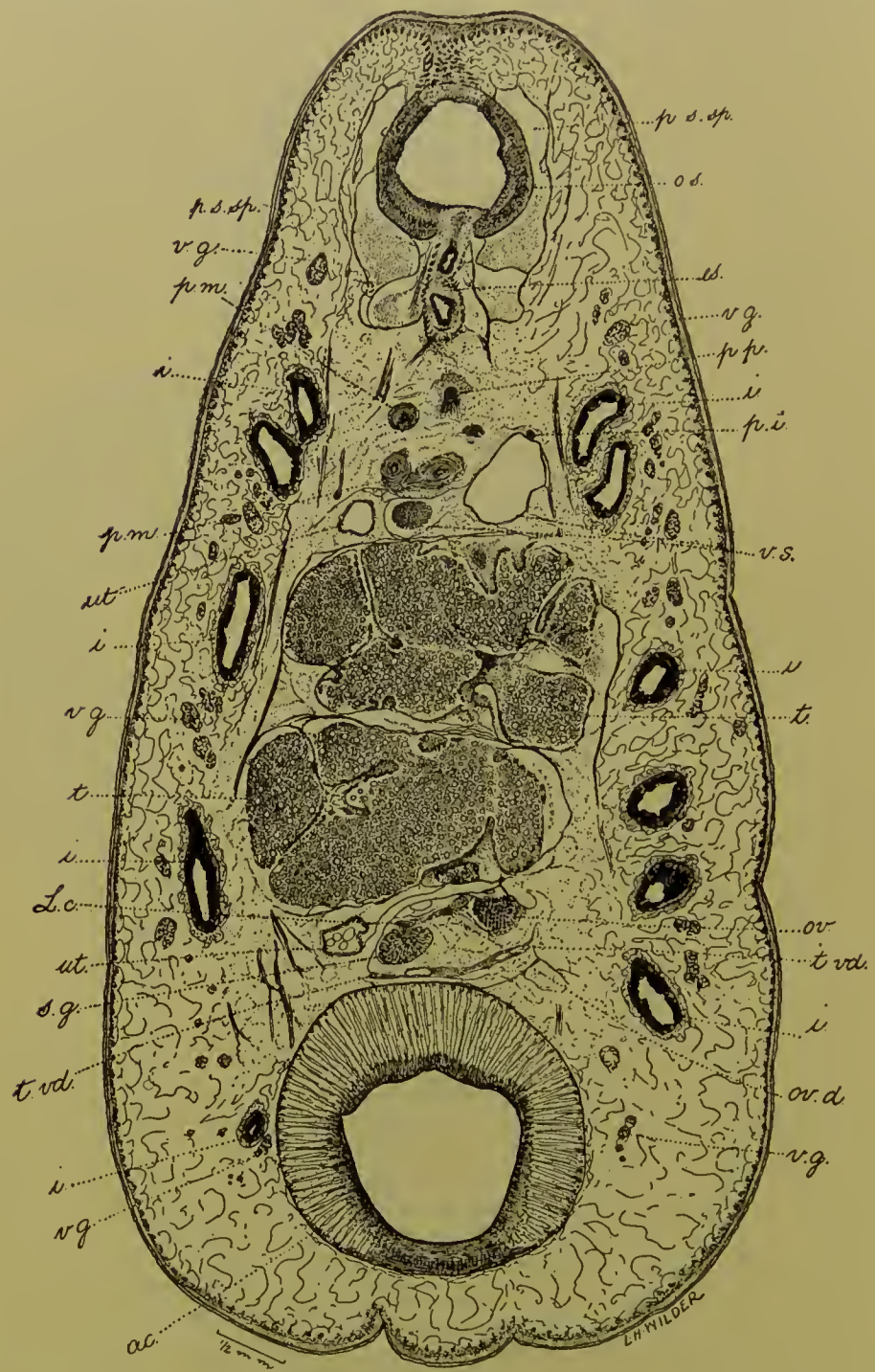

FIG. 55.

able for study, consists in the difference (1) in the size and form of the genital pore (that of *P. papilligerum* is large, elliptical, and measures 610μ in transverse diameter, while that of *P. shipleyi* is small, approximately circular, and measures about 75μ in transverse

diameter); and (2) in the size and form of the ventral chamber of the genital atrium), which in *P. papilligerum* is large crateriform,

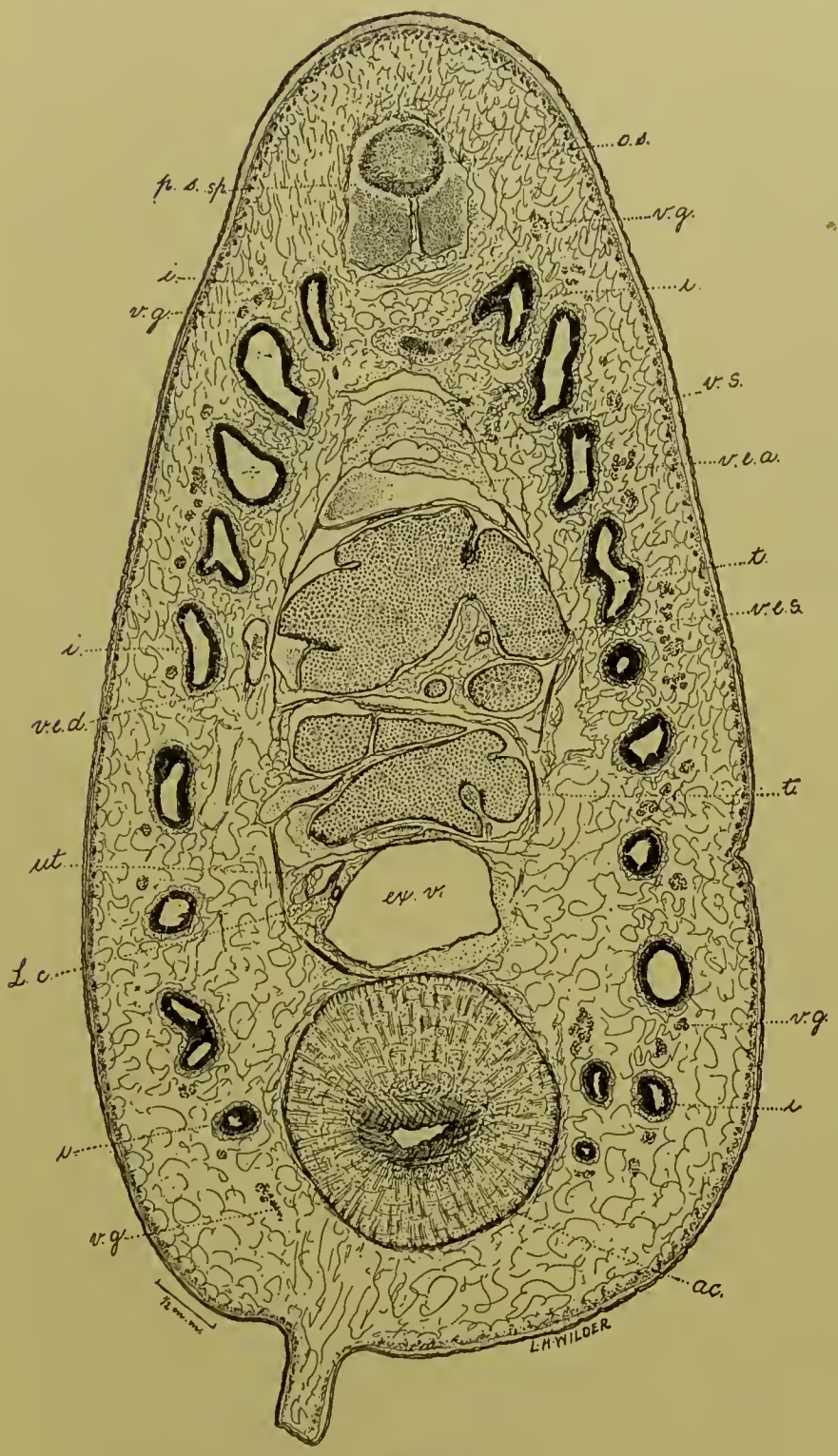

FIG. 56.

with its surface beset by well developed nipple-like papillæ, while in *P. shipleyi* the ventral chamber is small, slit-like, and without papillæ on its surface.

Female organs.—The ovary and shell gland are in the caudal portion of the worm, between the caudal testis and the acetabulum, and nearer the venter than the dorsum. The ovary is the larger of the two female glands and is also the nearer to the venter and is placed a little to the left of the median sagittal plane. The oviduct springs from the dorsal pole of the ovary; it passes to the right, curving gently caudad as it proceeds toward the shell gland, close to the cephalic aspect of which it forks. One limb of the fork, which may be regarded as the continuation of the oviduct, turns sharply caudad to penetrate the shell gland; the other limb bends dorso-caudad and, as Laurer's canal, at first skirts the right side of the dome of the excretory vesicle, but as it tends more and more caudad it crosses the right side of the vesicle and eventually reaches the dorsum a little to the right of the median sagittal plane and about, or perhaps a little less than 0.52 mm. caudad of the excretory pore. The shell gland is close to the right caudo-lateral aspect of the ovary, close to the ventro-cephalic aspect of the excretory vesicle, and in about the median sagittal plane of the worm.

As already described, it is penetrated on its cephalic aspect by the oviduct which unites in the substance of the gland with the common vitello-duct. The latter duct penetrates the gland at its caudal aspect. The union of these ducts results in the formation of the ootype, which is directed ventrad in the substance of the gland. The ootype is continued as the uterus, which emerges from the ventral pole of the gland. After emerging, the uterus dips caudad and to the left, then doubling back it forms coils ventrally of the ovary and shell gland, then winds its way dorsad to the right of the shell gland beneath the caudal testis, close to and on the right of Laurer's canal. On reaching the space between the caudal testis and the dorsum it begins to wind its way cephalad. Eventually it reaches the level of the superior margin of the cephalic testis, where it bends ventrad, passing, as already mentioned, beneath the arch of union of the vasa efferentia to gain the ventro-lateral aspect of the coiled vas deferens. Here it bends cephalad, ascending in close relation to the vas deferens, ultimately arching ventrad close to the caudal aspect of the pars prostatica and ductus ejaculatorius to open, as has been described, just beneath the latter into a small slit-like chamber. The uterus is distended more or less in various portions of its course by eggs and by masses of spermatozoa. The eggs are oval in form; some of them measured 135μ in length by 67μ in width.

The vitellaria consist of sparsely scattered well developed follicles in the extracecal areas. Vertically they extend from about the level of the base of the oral sucker to or perhaps slightly caudad of the level of the cecal ends of the gut. Their zone, therefore, is about coextensive with the combined zones of the esophagus and intestinal

ceca. A transverse vitello-duct from each gland passes mediad ventrally of the corresponding intestine. These ducts unite close to the ventro-caudal aspect of the shell gland. The common vitello-duct thus formed passes dorsad close to the shell gland, the caudal aspect of which it eventually penetrates.

Excretory system.—This seems well developed. A large vesicle lying dorsad of the acetabulum is present. An excretory duct leaves the dorsal, probably caudo-dorsal, aspect of the vesicle and passes to about the median vertical line of the dorsum to open at a point in a transverse plane slightly cephalad of that of the pore of Laurer's canal.

RELATION TO OTHER SPECIES.

This species appears most nearly related to *Param. bothriophoron*, from which it differs mainly in the structure of the copulatory apparatus. In *P. papilligerum* the genital chamber is papillated and the genital pore is without a sphincter; in *P. bothriophoron* the chamber is not papillated and the genital pore is encircled by a sphincter. Besides this, large papillæ line the suctorial lumen of *P. papilligerum;* they are absent in *P. bothriophoron*.

ILLUSTRATIONS.

Fig. 53.—Optical section through genital bulging near its vertex. Shows papillæ in genital atrium. Enlarged. Original.

Fig. 54.—Optical section. Shows depression at oral pole leading to the mouth; oral sucker (*o. s.*) with papillæ, perisuctorial space (*p. s. sp.*), pars prostatica (*p. p.*), pars musculosa (*p. m.*), vesicula seminalis (*v. s.*), uterus (*ut.*), lobate testes (*t.*), ovary (*ov.*), shell gland (*s. g.*), intestine (*i*) of left side, vitellaria (*v. g.*), and acetabulum (*ac.*). Enlarged. Original.

Fig. 55.—Optical section. Shows oral sucker and papillæ (*o. s.*), perisuctorial space (*p. s. sp.*), esophagus (*es.*), point of change from musculosa to prostatica (*p. p.*), pars musculosa (*p. m.*), pars intermedia (*p. i.*), vesicula seminalis (*v. s.*), uterus (*ut.*), testes (*t.*), ovary (*ov.*), oviduct (*ov. d.*), shell gland (*s. g.*), Laurer's canal (*L. c.*), transverse vitello-ducts (*t. vd.*), intestinal ceca (*i.*), vitellaria (*v. g.*), and acetabulum (*ac.*). Enlarged. Original.

Fig. 56.—Optical section. Shows portion of oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*) with granular coagulum, intestinal ceca (*i.*), vesicula seminalis (*v. s.*), arch of union of vasa efferentia (*v. e. a.*), right vas efferens (*v. e. d.*), left vas efferens (*v. e. s.*) passing dorsad from its point of origin on one of the testicular indentations, testes (*t.*), excretory vesicle (*ex. v.*), Laurer's canal (*L. c.*), uterus (*ut.*), acetabulum (*ac.*), and vitellaria (*v. g.*). Enlarged. Original.

CAULIORCHIS,[a] new subgenus.

SUBGENERIC DIAGNOSIS.—*Paramphistomum* (p. 73): Ceca distinctly wavy, end in acetabular zone; esophagus without muscular thickening. Acetabulum very large, terminal, tilts ventrad, aperture likely to be rather small. Excretory vesicle not elongate-club shaped, but distended and bag-shaped, its canal rather short, directed dorsad and may extend slightly cephalad or caudad, its pore in vesicular zone. Ventral chamber (?) of genital atrium.

Male organs: Testes very much smaller than acetabulum, cauliflower-like, in pre- or acetabular zones, testicular zones separate, or overlap or coincide, fields separate or overlap or coincide; musculosa well developed, may be enormous, coiled.

Female organs: Ovary ventral to ventro-cephalic of vesicle; Laurer's canal crosses excretory vesicle or canal, its pore is in vesicular zone, caudad to caudo-laterad of excretory pore, the two pores may be quite close to each other.

TYPE SPECIES.—*P. cauliorchis* n. sp.

At least 2 species (*cauliorchis* and *crassum*), probably a third species (*papillosum*), and possibly, but doubtfully, two other species (*indicum* and *calicophorum*) may be placed in this subgenus.

PARAMPHISTOMUM CAULIORCHIS new species.

[Figs. 57 to 70.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 6 to 7.5 mm. long by 3.66 to 4.25 mm. in maximum breadth; grayish buff in color (alcohol specimens); viewed ventrally, pear shaped; viewed laterally, reminds one of an infant's shoe (the caudal end representing the top, the dorsal angle representing the heel, and the oral pole representing the toe); greatest diameter about at junction of equatorial and caudal thirds; tapers rapidly, then gradually to bluntly pointed, rather truncated conical oral pole; caudal end bluntly rounded when viewed ventrally, truncated when viewed laterally; sagittal line of dorsum markedly convex, almost circular at broadest diameter; transverse section nearly circular. Surface with transverse grooves, especially ventrally; oral pole with small conical papillæ; surface folds around aperture of acetabulum. Genital pore ventro-median, about one-fourth of body length from oral pole and at or somewhat caudad of oral sucker and intestinal bifurcation; the pore is situated on large, 0.7 mm., hemispherical, erectile, retractile, bulging structure, the latter encircled by a ridge; it leads into an atrium into which from its dorsal wall, extends an elongate genital papilla, bearing at its vertex the porus hermaphroditicus; the genital papilla is closely encircled by a broad band-like muscular wall of the atrium; atrium divided into a larger dorsal and a smaller ventral portion by a deep circular groove; when the erectile bulging structure is retracted the encircling ridge forms a pair of transverse labia, between which is a transverse slit. Acetabulum anatomically terminal, but because of bending of body of worm it comes to lie ventro-subterminal; sunken into body of worm; very large, 2.5 mm. in dorso-ventral, 3 mm. in transverse diameter, aperture about 0.95 mm., directed ventro-caudad; cavity very deep. Mouth terminal, buccal cavity crateriform, papillated; oral sucker large, 1 to 1.1 mm. long or one-fifth to one-sixth of body length, 0.74 mm. thick, 0.98 mm. broad, pyriform, its papillated lumen broad and flat; sucker lies in a perisuctorial cavity and is bound to parenchyma dorsally and ventrally by mesenterium-like bands; esophagus tortuous, about as long as (at least not shorter than) oral sucker; bifurcation usually cephalad of genital pore; ceca long,

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[a] From *caulis* (from *καυλός*), a cabbage stalk, a cabbage [*Brassica oleracea* is the cauliflower], and *'όρχις*, testicle.

extending in wavy course to near caudal margin of acetabulum. Excretory pore dorso-median at or near plane of caudal margin of aperture of acetabulum, 60 to 320μ caudad of Laurer's canal; excretory canal thick walled, arises about on border between third and fourth quarter of length of vesicle; excretory vesicle dorsal of acetabulum, of moderate dimensions.

Male organs: Testes immediately caudad of equator, in same transverse plane, though one may extend very slightly farther cephalad, and farther dorsad also, than the other; irregular in outline, cauliflower-like in section; vas efferens arises from lateral aspect, passes in an arch medio-cephalo-dorsad, then caudad, then medio-dorso-caudad about to plane of origin, then mediad to unite with its fellow to form vas deferens; vas deferens very highly developed, occupying most of intercecal area cephalad of testes; vesicula seminalis intricately coiled; pars musculosa enormously developed, attains 0.4 mm. in thickness; pars prostatica nearly straight, attains 1.2 mm. in length, runs cephalo-ventrad or almost directly ventrad; ductus ejaculatorius rather short, straight, opens into dorsal dilatation of ductus hermaphroditicus cephalad of metraterm. Ductus hermaphroditicus with dorsal dilatation and runs through genital papilla.

Female organs: Ovary considerably smaller than testes, right or left of median line but caudo-mediad of one testis; shell gland smaller than ovary, median and caudad or cephalad of ovary; vitellaria with sparsely scattered small follicles, lateral, extends from about equator of oral sucker about to end of ceca; uterus runs in loops ventrally from shell gland, then turns dorsad, extends cephalad in dorsal portion of median field, bends ventrad under arch of vas deferens, cephalad ventrally of pars musculosa to open into dilated portion of ductus hermaphroditicus; Laurer's canal runs from oviduct, crosses on right or left of excretory vesicle, and opens slightly to right or left of median line, 60 to 320μ cephalad of excretory pore.

Eggs: Not observed.

Type: U.S.N.M. 7155. Cotype U.S.B.A.I. 15026.

Habitat.—In (organ? of) *Bos indicus*, Sanawaar, Punjab, India.

Source of material.—Four specimens were found in a bottle bearing the U.S.N.M. number 5775 and three in a bottle bearing B.A.I. number 1723. These were renumbered U.S.N.M. 7155 and 15026, respectively. Aside from the difference in the numbers the labels in the two bottles bear the following legend:

"Name *Amphistoma crumeniferum*. Locality, Sanawaar, Punjab, India. Host, *Bos indicus*. Collected by Dr. Giles. Date, III, 1893. Determined by Dr. Giles. Date, 1893. Presented by Dr. Giles. Date, 1893."

EXTERNAL CHARACTERS.

Size.—The 7 specimens forming the collection vary from 6 to 7.5 mm. in length. The greatest width varies from 3.66 to 4.25 mm. in 3 of the 7 specimens in which this diameter was measured.

Color.—The worms were of a grayish buff tint.

Form.—The form is typically shown in figs. 57–60. In transverse section the body of the worm is approximately circular and its greatest transverse and dorso-ventral diameters are at about the junction of the equatorial with the caudal third of the body. From this region of the body these diameters become gradually reduced in the direction of both poles; toward the oral pole the reduction is rapid for a short

distance, then it becomes very slow, the total reduction being considerable; while toward the aboral pole it progresses uniformly, but the total is slight. In consequence of this the worm is bluntly pointed and the cephalic portion of the body appears somewhat cylindric and distinctly attenuated as contrasted with the massive ventrally bent caudal portion.

Fig. 57.

Surface.—The surface cuticle is unarmed; that is, it is devoid of scales or spines, but at the oral pole close to the aperture of the mouth the surface is provided with small rounded and conical papillæ. It is also marked by transverse grooves, which are best defined on the venter. At the caudal extremity around the aperture of the acetabulum the worm is deeply wrinkled, forming rounded folds and tabs which encroach upon and apparently reduce the size of the acetabular aperture (figs. 57, 60).

Genital pore.—In the median line of the ventral surface at about the junction of the first with the second fourth of the body is the genital pore (figs. 57–59, 61–63, 67). This pore, which measured 0.08 mm. in diameter in one specimen, is at the vertex of a hemispherical bulging which measured about 0.7 mm. in diameter. Encircling the base of this bulging structure is a ridge in the form of a transverse ellipse. The genital pore leads into a cylindrical dorso-ventrally running atrium, from the dorsal wall of which arises a somewhat elongate trumpet-shaped genital papilla. This papilla projects ventrad into the atrium for about two-thirds the length of the latter and is closely embraced by the encircling muscular ring-like atrium wall (figs. 62, 67). The atrium wall is divided into two unequal rings by a deep narrow circular groove; the larger or dorsal of the rings forms about two-thirds of the atrium wall and is the portion which has just been described as closely embracing the genital papilla. In section it is seen that these rings differ markedly in structure, the larger or dorsal ring being of a dense muscular structure, whereas the structure of the smaller ring is loose and but slightly muscular.

Fig. 58

The hemispherical bulging which bears the genital pore at its vertex, is of an erectile nature, and the worm has the power of causing its retraction. In the retracted state the ridge which has been described as forming an encircling ellipse about the base of the hemispherical bulging, forms two transverse lips continuous laterally (figs. 59, 63).

Between these lips is a transverse more or less slit-like aperture which gives entrance to an irregular dorso-caudally directed passage which leads directly to the hermaphroditic pore.

Acetabulum.—The acetabulum is in the caudal terminal portion of the worm, but on account of the more or less decided bending ventrad of this portion of the body the acetabular aperture is tilted in the same direction. In one of the sectioned specimens this muscular organ, with an aperture measuring about 0.95 mm. in diameter, measured 2.5 mm. in dorso-ventral, 3 mm. in transverse diameter.

FIG. 59.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The bluntly pointed cephalic extremity presents a circular crateriform depression which is beset by conical papillæ; it leads into the oral sucker through a small circular opening which may be designated its oral aperture. The sucker is large and muscular, varying in length between 1.08 and 1.18 mm., or from one-fifth to one-sixth the body length as measured in sections of 5 specimens. In one of these (figs. 61, 62) the extreme dorso-ventral and transverse diameters were 0.74 mm. and 0.98 mm., respectively; its form in median sagittal plane is shown in figure 62. It will be noticed that it resembles the retracted pear-shaped sucker of *P. calicophorum*, as described and pictured by Fischœder (1893h, p. 542, fig. 30). The sucker as a whole may, for purpose of description, be regarded as consisting of a dorsal and a ventral muscle, continuous one with the other laterally. These two muscles are each thickest in the median sagittal plane; they grow less thick as they extend laterad, being thinnest laterally where they are continuous one with the other. The opposing faces of these muscles are closely approximated, so that the lumen of the sucker is reduced to a dorso-ventrally very narrow slit-like space; the latter is lined with a cuticle-like layer in anatomical continuity with that of the surface

FIG. 60.

and is beset by very small closely aggregated papillæ. These papillæ are largest and most prominent in about the equatorial region of the sucker, becoming gradually smaller and less distinct as the oral and esophageal apertures are approached, close to both of which these papillæ do not appear to be present. Except at the oral and the esophageal ends the sucker is separated from the body parenchyma by a distinct circumsuctorial space, strongly suggestive of a body cavity, which is traversed here and there by mesenterium-like strands attaching the sucker, particularly the dorsal and ventral walls, to the inclosing parenchyma. The space contains, but does not appear to be at all filled with, a granular material and a few nuclei (?), the cell bodies of which are not clearly definable.

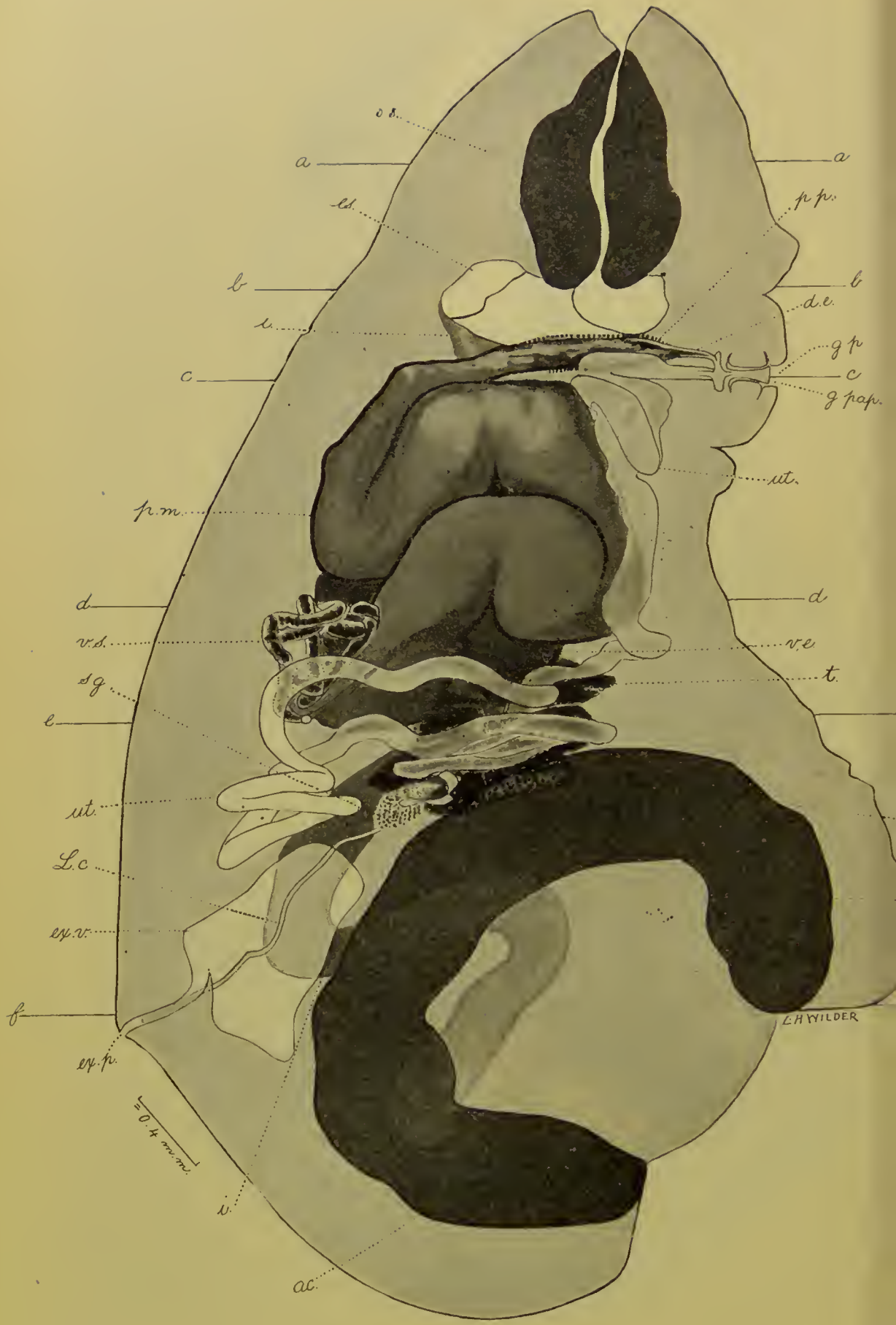
Dorsally of the circumsuctorial cavity and on a plane near the caudal end of the sucker is found the brain.

The esophagus takes origin at the base of the sucker. At a point about midway between its point of origin and the dorsal wall of the worm and at about the same or slightly lower (more caudad) level, namely, at from two-sevenths to one-fourth the body length from the oral margin, the esophagus divides into two intestinal ceca. The path pursued by the esophagus between its point of origin and its bifurcation was found to vary according to two general types; in one (figs. 61, 62, 64), to which 3 of the 5 sectioned specimens conformed, the esophagus almost immediately after leaving its point of origin tends ventrad and to either the left (2 specimens) or the right (1 specimen), curving around and skirting more or less closely the base of the sucker until it gains either the left or right dorso-lateral aspect of the latter, beyond which it proceeds in a more direct course to its point of bifurcation. In the second type (fig. 63), to which 2 of the 5 specimens conformed, the esophagus passes from its point of origin in a direction caudad and at the same time more or less ventrad for a variable distance. It then abruptly doubles back on itself, describing a U-shaped course in about the median sagittal plane of the body. The dorsal limb of the U quickly assumes a more or less direct course dorsad to the point of its bifurcation.

From their point of origin the intestinal ceca pass at first almost horizontally laterad, then curve gently latero-caudad and slightly ventrad to reach a point about 0.33 mm. from the body wall. Occasionally one or both ceca may arch slightly cephalad of their point of origin as they pass laterad. The ceca terminate at slightly different levels, but close to the dorso-lateral aspect of the acetabulum and a little above the plane of the caudal margin of the latter. In their path caudad the ceca describe a wavy course approximately parallel to the dorso-lateral aspect of the body wall (figs. 61, 62).

The lumen of the esophagus is lined with a continuation of the cuticle-like layer of the sucker. The intestines are lined with a

FIG. 61.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L.H.WILDER

FIG. 62.

layer of epithelium, which begins abruptly at the bifurcation of the esophagus.

Genital organs.—Excepting the vitellaria, both the male and the female genital organs are situated in the intercecal area.

Male organs.—The testes are in the zone immediately caudad of the equatorial plane, one on either side of the median sagittal plane. Further than this, however, the relation which they bear one to the other and to the acetabulum is subject to marked variation. Their superior (cephalic) margins may be in the same (3 specimens) or in different (2 specimens) transverse planes; in 2 specimens in which the latter condition obtained the superior margin of the left testis was 0.2 mm. cephalad of that of the right in one case, while in the other it was the superior margin of the right testis that was cephalad of that of the left, and in this instance the difference was 0.26 mm. Furthermore, in each of these 2 specimens the higher (cephalad) testis was also the farther dorsad. In 2 of the 3 specimens in which the superior margins of the testes were found in the same transverse plane the right testis was a little farther dorsad than the left; in the third of these specimens both testes were in about the same frontal plane. It may be observed in this connection that a certain relation appears to exist between the position of the testes and that of the ovary and shell gland, namely, in 4 of the 5 specimens in which one of the testes was placed farther dorsad than the other the ovary and shell gland were found on that side of the median sagittal plane to which the dorsally placed testis belonged.

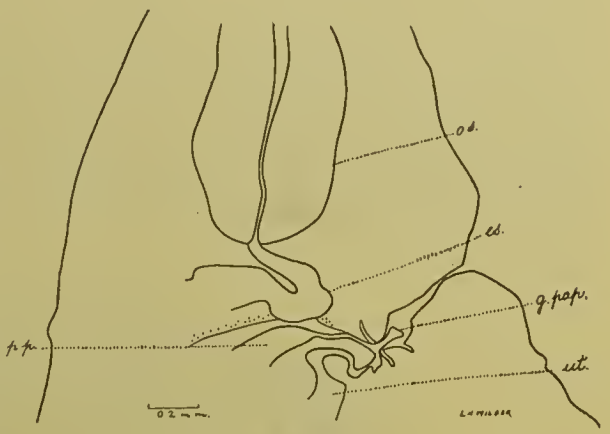


Fig. 63.

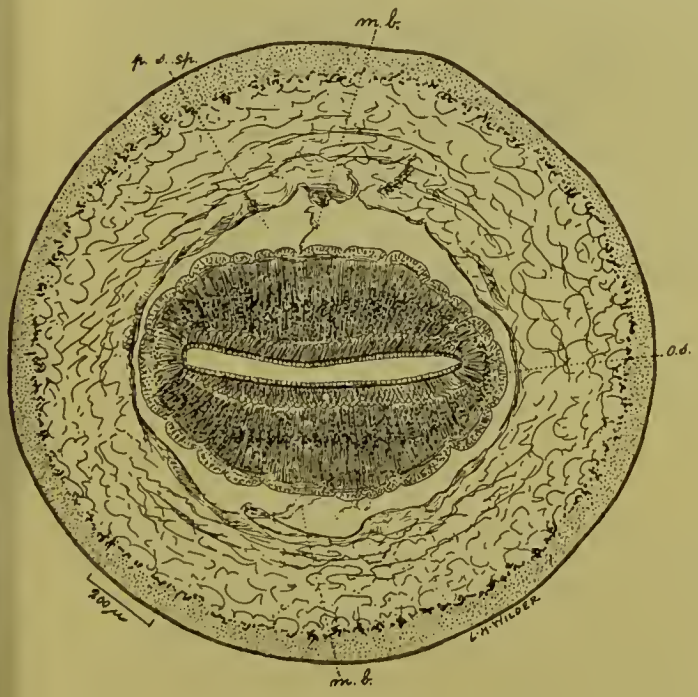


Fig. 64.

In 2 of the specimens the testes were immediately cephalad of the superior margin of the acetabulum; in 2 others they were immediately caudad of this level, and in a fifth they were at this level. They are greatly branched, cauliflower-like in sections, and differ slightly in size in the same and in different specimens. Measurements, from projections, of the left testis in one of these worms gave 1.2 mm. for the greatest dorso-ventral, 0.6 mm. for the greatest transverse, and 0.64 mm. for the greatest longitudinal diameter. A vas efferens arises from the external lateral aspect of each testis; these unite to form the vas deferens. The point of union of the vasa efferentia is generally at about the same level as the point of origin

Fig. 65.

of one or both the vasa efferentia and more or less dorsad of the mid point in the ventro-dorsal diameter. The path pursued between their point of origin and their union is peculiar and differs from that in any of the other forms studied. Each vas at first passes medio-cephalo-dorsad for a variable distance, in some of the specimens considerably above the superior margin of the testis (figs. 61, 62) from which one or both originates. Each then turns caudad, describing a more or less well-marked curve, with its convexity cephalad, and then proceeds medio-dorso-caudad to about the level at which one or both originated, where they pass more or less directly inward to unite, as

as already been said, in the formation of the vas deferens. The sa are fairly thick-walled ducts, measuring 60 to 75 μ in diameter one of the specimens.

The vas deferens is very highly developed and occupies most of ie space in the axial region of the body between the intestinal ceca ephalad of the testes. As in the other forms of this group, it is early differentiated into four portions. The first portion, or vesi- la, is an intricately coiled, thin-walled, and but slightly dilated duct, hich is succeeded by a strikingly large, thick, muscular-walled second ortion, or pars musculosa, which measured 0.4 mm. in diameter, with thickness of wall of 0.15 mm. in one specimen. The change from esicula to musculosa is abrupt and is marked not only by the normous increase in the diameter of the duct and in the thickness

FIG. 66.

of its wall, but by the interposition of a short section, which from its arrangement probably serves the purpose of a valve. This valvular segment—or pars intermedia (*p. i.*, fig. 68), as it may be designated—is a direct continuation of the vesicula, but the caliber of its lumen is greatly reduced, its walls are thick and muscular, but its total diameter is little, if at all, greater than that of the vesicula. Its distal end pierces the enormously thick muscular wall of the pars musculosa, into the lumen of which it projects in a manner resembling the projection of the cervical portion of the uterus into the human vagina. The musculosa is compactly coiled; the windings run in a vertical direction and, unlike those of the vesicula, can be traced without much difficulty. The musculosa is succeeded by the pars prostatica; the change from one to the other is marked by a structure suggesting

a valvular function (fig. 67). Except that there is not interposed an intermediate section between the musculosa and the prostatica, the valve-like arrangement appears to be exactly like that at the junction of vesicula and musculosa, with the further difference that the former is considerably smaller in diameter. As this point is approached, the musculosa becomes gradually reduced in diameter and its wall in thickness. The prostatica is not coiled; it pursues an almost straight or slightly sinuous course ventrad or cephalo-ventrad. In the latter case it describes a slight curve in a sagittal plane, with

FIG. 67.

the convexity of the curve cephalad. Throughout its length it is inclosed in a mass of cells; in projection of one specimen the prostatica measured 1.2 mm. in length.

The diameter of this portion of the vas deferens becomes gradually reduced in its course ventrad. The reduction is for the most part at the expense of the lumen, for the walls remain highly muscular and but slightly reduced in thickness. The pars prostatica is succeeded by the fourth or terminal portion of the vas deferens. This portion, or ductus ejaculatorius, is a direct continuation of the prostatica, the

change from one to the other being defined only by the cessation of the cell mass characteristic of the prostatica. It passes directly ventrad and opens by a minute pore into the dorsal dilated vesicle-like portion of the ductus hermaphroditicus immediately above and quite separate from the aperture of the metraterm (fig. 62). It measures about 0.24 mm. in length in one specimen. The ductus hermaphroditicus is a delicate duct which pierces the axial region of the genital papilla to open externally as the porus hermaphroditicus. It leads from an atrium or vesicle which may perhaps be regarded as the dilated internal extremity of the duct. Into this vesicle or atrium there open the ductus ejaculatorius and the metraterm.

FIG. 68.

Female organs.—The ovary varies somewhat in size, form, and position, and in its relation to the shell gland. It is considerably smaller than either testis, close to one of which it is placed. In 3 of 5 specimens studied the ovary was on the right side of the median line close to the ventro-mesio-caudal aspect of the right testis; in the other 2 specimens it was on the left side, in one slightly caudad of the testis and in the other close to the ventro-mesio-caudal aspect of the left testis. The shell gland is smaller than the ovary but like the latter varies somewhat in size, form, and position; in 4 of 5 specimens it was close to the mesio-dorso-caudal aspect of the ovary; in the fifth specimen it lay close to the mesio-cephalic aspect of the ovary. The oviduct springs from the dorsal pole of the ovary and

passes to the shell gland which it penetrates at some point on its dorsal aspect, describing in its more or less horizontal course a well-marked curve with its convexity dorsad.

Laurer's canal leaves the oviduct from some point more or less close to the shell gland and opens on the dorsum by a minute pore slightly to the right (twice) or to the left (fig. 70) (three times) of the median line and from about 60μ to 320μ cephalad of the excretory pore. It will be remembered that in the 5 specimens studied the ovary was found on the right side in 3; in 1 only of these 3 specimens did Laurer's canal open to the right of the median line, in the other 2 it opened to the left of this line. In the 2 of the 5 specimens in which the ovary was found on the left side, Laurer's canal opened on the left side in one and to the right in the other. It may therefore be easily understood that the path described by Laurer's canal in its course to the dorsal opening varies widely. In general it may be said that this canal, after leaving the oviduct, passes diagonally to the other side of the median line over the excretory vesicle to gain the dorsal aspect of the latter, then proceeds dorso-caudad to the opening on the dorsal surface. In the minority of cases (2 in 5) the canal remains on the side (either right or left) in which it takes origin, skirts the lateral margin of the excretory vesicle as it proceeds dorso-caudad, gains the dorsal aspect of the vesicle and opens on the dorsal surface on the same side of the median line with its point of origin.

FIG. 69.

The vitellaria, consisting of sparsely scattered insignificant follicles, occupy the lateral fields of the body external to the intestinal ceca. They extend longitudinally from about the level of the equator of the sucker to about the level of the cecal extremities of the intestines. A duct leaves each gland at a point a little caudad of the level of the superior margin of the acetabulum and passes transversely inward with a more or less marked tilt cephalad, ventrally of the correspond-

ing testis, to unite with its fellow close to the caudo-ventral aspect of the shell gland. From their point of union a duct passes dorsad skirting the caudal or one of the caudo-lateral margins of the shell gland to penetrate the latter at some point at its caudo-dorsal aspect.

Within the shell gland this vitello-duct joins with the oviduct to form a common canal which almost immediately forms a fusiform ootype. The direction of the ootype is ventrad or ventro-cephalad, sometimes with a slight tilt to either the right or left. The ootype is continued as the uterus which emerges at some point on the ventral or ventro-lateral aspect of the shell gland. After emerging the uterus forms some coils ventrad or ventro-mediad of the shell gland; it then winds its way dorsad over the excretory vesicle or skirts one side of the superior portion of the latter. Dorsad of the excretory vesicle several loops dip caudad; it then winds its way cephalad in the dorsal part of the median field, then bends ventrad winding its way beneath the arch of the vasa efferentia close to the caudal aspect of the coiled pars musculosa to reach the ventral aspect of the latter; having reached this point the uterus bends abruptly cephalad and with but few windings maintains this relation to the vas deferens throughout the remainder of its course, opening, as has already been mentioned, into the dilated vesicle-like portion of the ductus hermaphroditicus immediately beneath the opening of the ductus ejaculatorius.

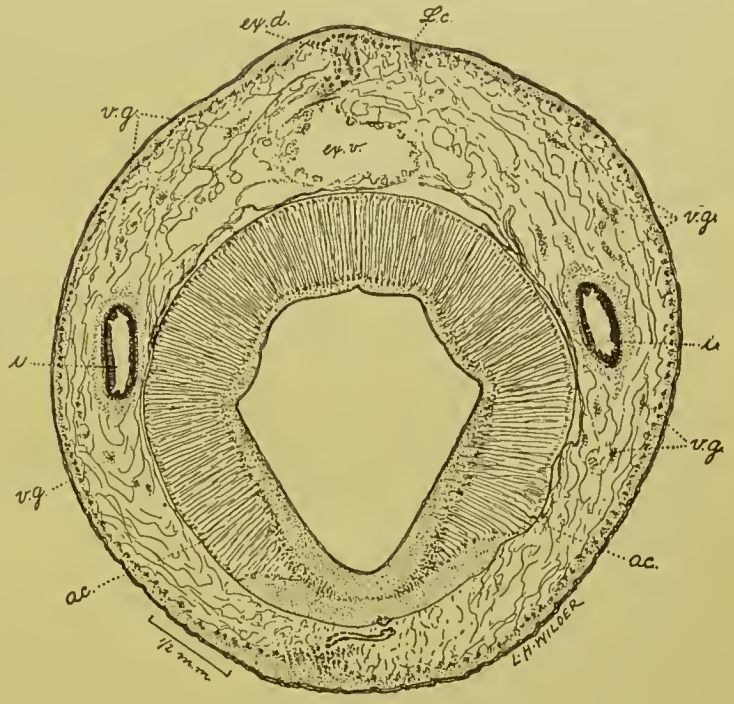


FIG. 70.

Eggs.—Eggs were not observed in any of the specimens.

EXCRETORY SYSTEM.—The excretory system is well developed. A vesicle of moderate dimensions lies dorsally of the acetabulum. From the dorsal aspect of this vesicle from a point which varies considerably in position, but which may be described as at about the junction of the third with the fourth quarter of the length of the vesicle, there arises a moderately thick excretory duct. This duct of somewhat variable length passes at a variable angle caudo-dorsad to open in the

median line of the dorsal surface at or somewhat caudad of the level of the caudal margin of the aperture of the acetabulum, and, as has been described, from 60μ to 320μ caudad of the aperture of Laurer's canal.

ILLUSTRATIONS.

FIG. 57.—Ventral aspect of *P. cauliorchis*, copulatory apparatus evaginated. Enlarged. Original.

FIG. 58.—Profile of same.

FIG. 59.—Ventral aspect, copulatory apparatus invaginated. Enlarged. Original.

FIG. 60.—Profile of same.

FIG. 61.—Ventral projection of *P. cauliorchis* shown in figs. 57 and 58. *g. p.*, position of genital pore; *es.*, esophagus; *i.*, intestinal ceca; *o. s.*, oral sucker; *ov.*, ovary; *s. g.*, shell gland; *t.*, testes; *v. e.*, vasa efferentia. Uterus and vas deferens not shown; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 62.—Profile projection of *P. cauliorchis* shown in figs. 57 and 58. *ac.*, acetabulum; *g. p.*, genital pore; *d. e.*, ductus ejaculatorius; *es.*, esophagus; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *g. pap.*, genital papilla; *i.*, intestinal ceca; *L. c.*, Laurer's canal; *o. s.*, oral sucker; *ov.*, ovary; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, left testis; *ut.*, uterus; *v. e.*, left vas efferens; *v. s.*, vesicula seminalis; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 63.—Profile projection showing genital papilla retracted and lips of genital aperture slightly ajar. Lettering as in fig. 62. Slightly diagrammatic. Enlarged. Original.

FIG. 64.—Transverse section at *a–a*, figs. 61 and 62. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), mesenterium-like strands (*m. b.*). Enlarged. Original.

FIG. 65,—Transverse section at *b–b*, figs. 61 and 62. Shows base of oral sucker (*o. s.*), the esophagus (*es.*), origin of intestinal ceca (*i.*), and some vitelline follicles (*v. g.*). Enlarged. Original.

FIG. 66.—Portion of a transverse section to show valve at junction of pars musculosa (*p. m.*) and pars prostatic (*p. p.*).; *i.*, intestinal ceca; *va.*, metraterm. Enlarged. Original.

FIG. 67.—Portion of a transverse section at *c–c*, figs. 61 and 62, to show evaginated copulatory apparatus. *g. pap.*, genital papilla; *va.*, metraterm; uterus (*ut.*). Enlarged. Original.

FIG. 68.—Transverse section at *d–d*, figs. 61 and 62. Shows pars musculosa (*p. m.*), vesicula seminalis (*v. s.*), pars intermedia (*p. i.*), valve at junction of vesicula and musculosa (*v. m.*), uterus (*ut.*), right vas efferens (*v. e.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 69.—Transverse section at *e–e*, figs. 61 and 62. Shows position and relations of the cauliflower-like testes (*t.*), uterus (*ut.*). Caudal margin of pars musculosa (*p. m.*), arch of union of the vasa efferentia (*v. e.*), the intestinal ceca (*i.*), and the vitellaria (*v. g.*). Enlarged. Original.

FIG. 70.—Transverse section at *f–f*, figs. 5 and 6. Shows acetabulum (*a c.*), excretory vesicle (*ex. v.*), excretory duct (*ex. d.*), Laurer's canal (*L. c.*), vitellaria (*v. g.*), and intestines (*i.*). Enlarged. Original.

PARAMPHISTOMUM CRASSUM, new species.

[Figs. 71 to 80.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 6.12 to 6.5 mm. long by 4.2 to 4.76 mm. broad; color drab (alcohol material); in ventral view broad pyriform, greatest transverse diameter at junction of equatorial and caudal thirds; tapers gradually cephalad to plane of genital pore, then abruptly, then gradually to blunt oral pole; caudad it tapers rapidly, so that caudal margin is very bluntly rounded; longitudinal axis curved, convexity dorsad; in transverse section transversely elliptical. Surface with transverse grooves, more marked on venter; cephalic cone with acne-like papillæ, which become more acuminate and slender around oral aperture. Genital pore ventro-median in suctorial zone at junction of oral with second fifth of body; at this point there is a slight ventral elevation. Acetabulum large, ventral, 3.1 mm. in transverse, by 2.74 mm. in dorso-ventral diameter, sunken into body, cavity deep, aperture very small, 0.5 mm. in transverse diameter, directed slightly ventrad. Mouth subterminal; oral sucker very large, 1.34 mm. long, 1.26 mm. broad, 0.98 mm. thick, its lumen broad and shallow, papillated; perisuctorial space narrow; esophagus shorter than sucker, bent U-shaped, convexity ventrad; ceca run at first latero-cephalad, then in wavy to zigzag course to zone of acetabular aperture, then turn slightly cephalad and end about at equator of acetabulum. Excretory pore opens at postovarial plane; canal short, thick; vesicle large, dorsal of acetabulum, extends from preovarian plane into zone of acetabular aperture, and is crossed by Laurer's canal.

Male organs.—Testes large, cauliflower like, in intercecal area, diagonal, zones overlap, fields overlap; vasa efferentia arise from lateral aspect, run cephalad, then dorso-mediad, uniting slightly postequatorial, in zone of anterior testis; vesicula seminalis loosely coiled; musculosa complexly and compactly coiled, connected with vesicularis by a pars intermedia; prostatica nearly straight; ductus ejaculatorius pierces a well-developed muscle mass and opens with metraterm into a slit-like space at base of minute genital papilla, and continued as ductus ejaculatorius, which opens at apex of genital papilla.

Female organs.—Ovary dextral of median line, in acetabular zone, partly in testicular zone, in field of anterior testis, smaller than testis; shell gland dorso-caudad of ovary and nearer median line; vitellaria consist of sparsely scattered follicles, extending from plane of genital pore to slightly postcecal; uterus extends in coils from shell gland cephalad, turns caudad ventrally of left testis, cephalad dorsally of same, under arch of vasa efferentia, ventrally of vesicle to the same slit-like space into which the ejaculatorius discharges; Laurer's canal extends from oviduct dorso-caudad, crosses excretory vesicle and opens submedian, about 0.7 mm. caudad of excretory pore.

Eggs.—Not observed.

TYPE.—U.S.N.M. 7156 (Coll. Hassall).

HABITAT.—In (organ ? of) *Bos indicus*, India.

SOURCE OF MATERIAL.—The material consisted of 3 specimens found with other forms in bottle 5775, collected by Doctor Giles in 1893 in India (Sanawaar, Punjab), from *Bos indicus*. These specimens were given the number U.S.N.M. 7156.

EXTERNAL CHARACTERS.

SIZE.—Two of the specimens, measured in glycerin alcohol, were 6.5 mm. long; the third specimen measured in sections was 6.12 mm. long. The greatest transverse diameter of one of the specimens, measured in glycerin alcohol, was 4.20 mm., while that of another specimen measured in sections was 4.76 mm.

COLOR.—The worms are of a drab color.

FORM.—The form of these worms is shown in fig. 71. They somewhat resemble *Paramphist. cauliorchis*. The greatest transverse diameter is at about the junction of the equatorial with the caudal third of the body length. From this region, in the direction of both poles, the breadth of the animal becomes progressively reduced, rapidly toward the caudal pole, making this extremity broad and rounded, more gradually toward the oral pole until the level of the genital pore is reached. Here there is a rather abrupt reduction in the transverse diameter, clearly shown in fig. 71. Beyond this point the progressive reduction in breadth is very gradual, so that the lateral margins of this oral portion of the worm are very nearly straight lines, whereas the other portions of the lateral margins of the worm are decidedly curved. The dorsoventral diameter is relatively shorter in this form than in *Paramphist. cauliorchis*, so that when viewed ventrally it gives the impression of being more decidedly flattened. Viewed in profile it is seen that the longitudinal axis of the worm is curved with the concavity of the curve ventrad. The outline of the worm in transverse section is transversely elliptical.

FIG. 71.

SURFACE.—The surface cuticle is without spines or hooks, but is marked by transverse grooves, which are best defined and deepest on the ventral surface. The cephalic cone-like portion is beset by acne-like papillæ. In the region immediately around the oral aperture the papillæ become somewhat acuminate and appear slender and somewhat more raised above the general cuticular surface.

Genital pore.—In the median line of the ventral surface, at about the junction of the oral with the second fifth of the body, there is a transverse buttonhole-like slit, measuring in one alcohol specimen

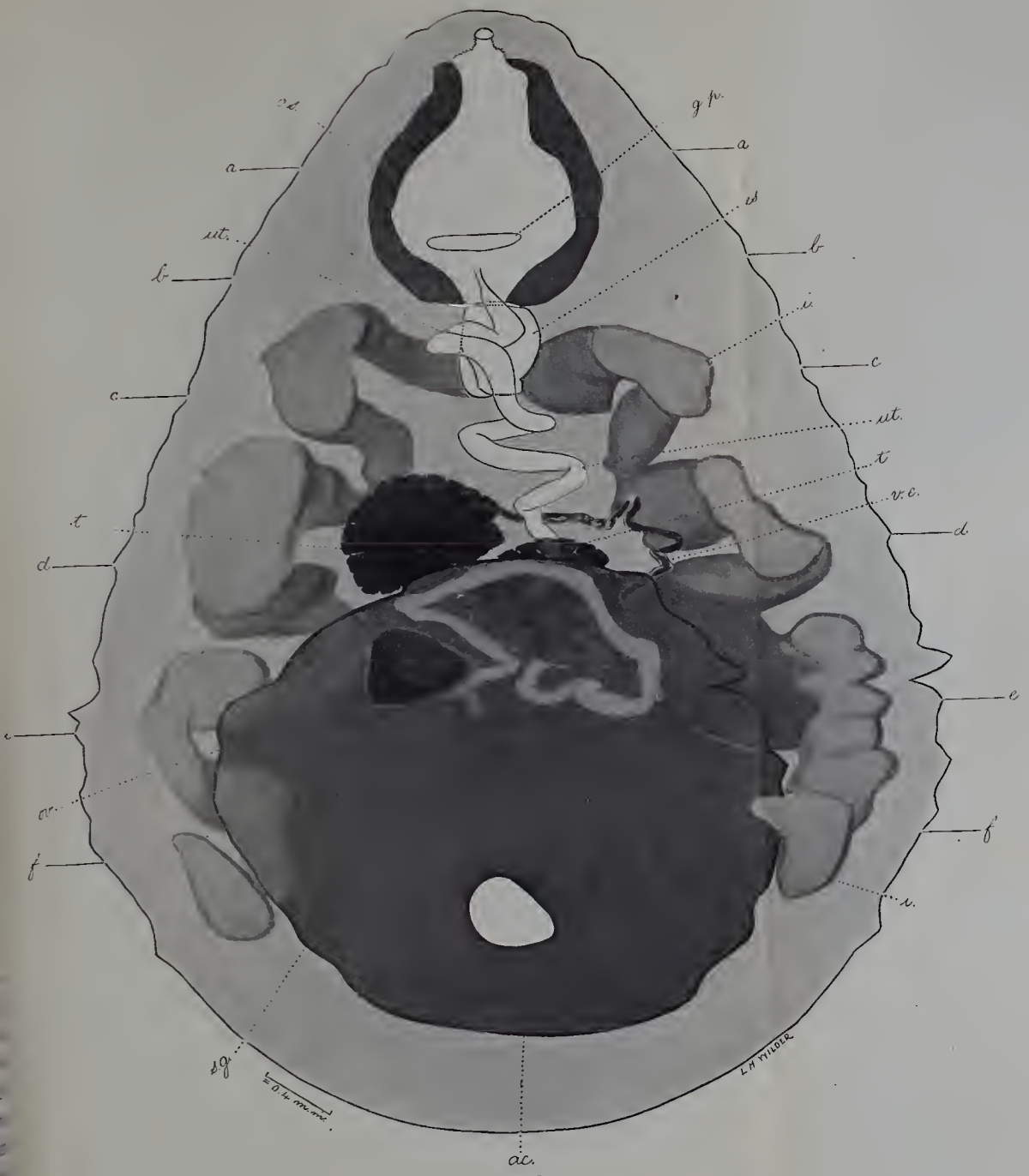
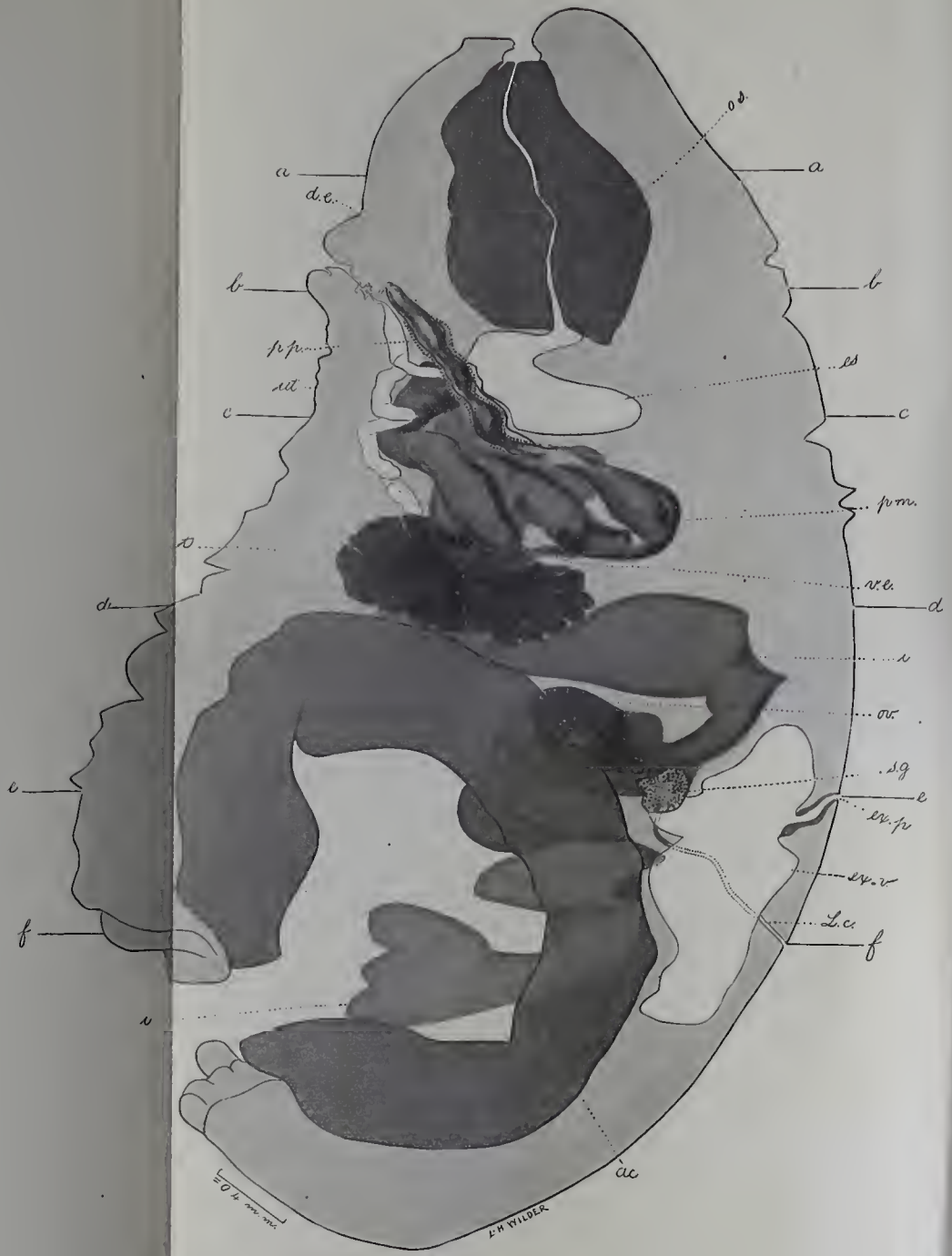


FIG. 72.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L.H. WILDER

FIG. 73.

about 0.45 mm. in length. This slit, or slit-like depression, is at the vertex of a moderate, transversely elongate elevation, and represents the genital pore.

Acetabulum.—The acetabulum is large, and, as in the other forms of this group, it is in the caudal portion of the body. Its relatively small aperture is directed slightly ventrad on account of the curve of the body. Measurements taken from the projection of one sectioned specimen give 2.74 mm. as the greatest dorso-ventral and 3.10 mm. as the greatest transverse diameter of the acetabulum, with 0.34 mm. as the greatest verticle and about 0.50 mm. as the greatest transverse diameter of the acetabular aperture. The true aperture of the acetabulum is somewhat reduced in size by being

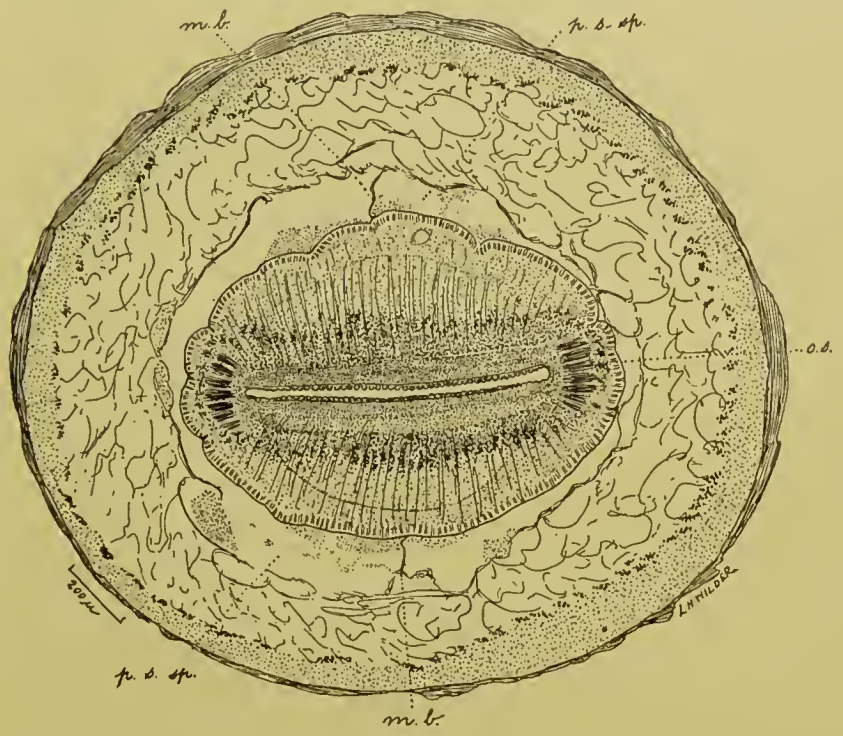

FIG. 74.

encroached upon by folds of the adjacent body surface, much as in the case of *Paramphist. cauliorchis.*

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The cephalic pole is marked by an irregularly circular aperture, measuring in section 90μ by 120μ in diameter. This aperture leads into a shallow irregular cavity which gives entrance to the oral sucker. The latter is a large muscular organ, which in projection of one specimen measured 1.34 mm. in longitudinal axis, 0.98 mm. in greatest dorso-ventral diameter, and 1.26 mm. in greatest transverse diameter. The dorsal and ventral walls are thick, measuring 0.46 mm. and 0.50 mm. in thickness, respectively,

when measured in the greatest dorso-ventral diameter of the sagittal plane. Laterally these muscular plates are thinner and continuous one with the other. The organ is inclosed in a narrow space in the body parenchyma (figs. 74, 75), in which it is retained in position by attachments at its two poles and by dorsal and ventral mesenterium-like strands. The lumen of the sucker is a dorso-ventrally, very narrow, but transversely quite broad, cavity. In transverse sections it appears as a transverse slit lined by a thin cuticle-like layer, which is beset by short conical papillæ; the latter are largest in the oral half of the lumen, become gradually smaller and more slender in the direction of the esophageal end, near which they disappear altogether. The esophagus springs from the caudal or basal aspect of the sucker, then describes a more or less well-marked U-

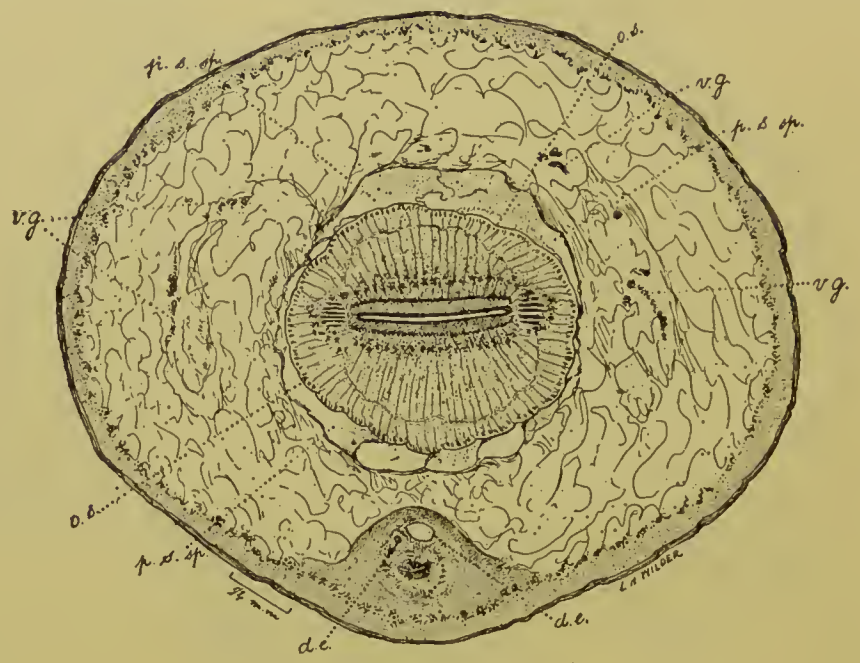

Fig. 75.

shaped course with the base of the U ventrad. The caudal limb of the U is much the longer and is directed almost horizontally dorsad, having only a slight tilt caudad; it divides into the 2 intestinal ceca. These at first pass laterad with a tilt cephalad to a plane slightly above their plane of origin, describing at the same time a slight curve having its convexity dorsad. After approaching the ventro-lateral aspect of the body wall, each of the intestinal tubes bends caudad and describes a decidedly wavy, almost zigzag, course caudad, approximately parallel to the lateral body wall of the worm. The cecal extremities are directed ventrad close to the sides of the acetabulum and at about the level of the upper margin of the acetabular aperture.

The lumen of the esophagus is lined by a cuticle-like layer continuous with that of the oral sucker, but terminating abruptly at the

point of origin of the ceca. The latter are lined by an epithelial cell layer.

Genital system.—With the exception of the vitellaria, the genital organs are disposed in the interccecal space.

Male organs.—The testes are in the equatorial zone of the worm, one laterad of the other, and separated by a moderate interspace. They are in separate but more or less overlapping testicular zones and fields (fig. 72). In both of two sectioned specimens the right testis was the more cephalad. In transverse sections the testes appear to be composed of numerous lobules suggesting a cauliflower-like appearance (fig. 78). From the external aspect of each testis there emerges a vas efferens, which tends at first cephalad, then dorsomediad, finally uniting with its fellow to form the vas deferens (fig. 72). The vas deferens is distinctly divisible into a vesicula, musculosa, prostatica, and ductus ejaculatorius. The vesicula is loosely but complexly coiled, thin walled, and but slightly dilated. It is succeeded by a complexly and somewhat more compactly coiled musculosa. The muscular walls of this portion of the vas deferens are well developed, but not nearly so much as in *Paramphist. cauliorchis;* measured at a favorable point the diameter of the duct was 0.24 mm., with a thickness of wall of 0.067 mm. There is in this, as in *Paramphist. cauliorchis,* a short intermediate segment or pars intermedia between the vesicula and musculosa. This segment is muscular but of less diameter and both much thinner walled and of smaller caliber than the musculosa. The change from musculosa to prostatica is clearly marked by a change in the structure of the wall and by the appearance of a thin layer of cells which inclose this third portion of the vas deferens. The prostatica is not coiled, but pursues a direct course cephaloventrad. As it nears a prominent somewhat globular muscular mass, which incloses the terminal genital (copulatory) apparatus, the prostatic cells are lost, and the prostatica now continues as the ductus ejaculatorius. It penetrates this muscular mass in close relation to the dorsal aspect of the terminal portion of the uterus. This portion of the male duct is still of considerable caliber and thin walled, giving the impression of a vesicle, but after a very short course becomes abruptly reduced to a relatively very narrow and short canal, which is interpreted as opening with the terminal portion of the uterus into a minute slit-like space at the base of a minute genital papilla (fig. 75). The latter is pierced in its long axis by a very delicate canal, interpreted as the ductus hermaphro-

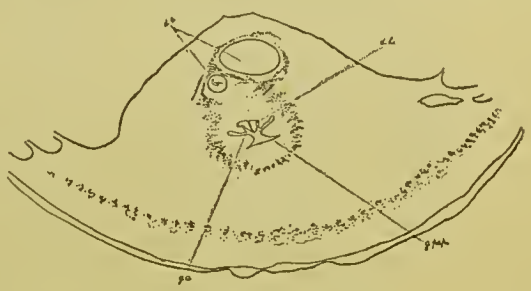

Fig. 76.

diticus. The genital papilla is interpreted as retracted into the body of the worm. Leading from it is a canal, which terminates at the surface in the genital pore. The walls of this canal are indented as seen in figure 73. When evaginated a structure is probably produced, which may in a general way resemble the corresponding structure in *Paramphist. cauliorchis*. The termination of the ductus hermaphroditicus at the vertex of the minute genital papilla is the porus hermaphroditicus, and in the evaginated condition of this terminal (copulatory) apparatus this pore would probably appear on the surface. None of the 3 specimens, the subject of this study, presented this structure in an evaginated state.

FIG. 77.

Female organs.—In both of the sectioned specimens the ovary was to the right of the median line (fig. 72), considerably caudad of the right testis. Its zone overlaps the zone of caudal portion of that of the left testis to a variable extent. The oviduct arises from the caudal aspect of the ovary, passes in a more or less sinuous course to the left toward the shell gland, the right aspect of which it penetrates. The shell gland lies a little to the left of the ovary in both of the sectioned specimens. In one of these this places the shell gland in the median line, in the other slightly to the right of this line. In both of the sectioned specimens the zone of this gland slightly overlaps the caudal portion of the ovarian zone, and in one also the caudal portion of the left testicular zone. The common vitello-duct penetrates the caudal aspect of the shell gland and is joined at an angle in the sub-

stance of the latter by the oviduct to form the ootype which is continued as the uterus. The latter (fig. 72) emerges from the cephalic aspect of the gland, cephalad of which it describes some coils. It then winds its way cephalad at first close to the left of the ovary, then toward the right ventrad of the ovary. It then again turns cephalad, forming coils between the ovary and the right testis, then passes sinistro-caudad in front of the left testis, gains the left latero-ventro-caudal aspect of this testis where, after forming some coils, it passes dorsad and obliquely to the right to gain a position directly ventrad of the dome of the excretory vesicle. Here it turns, winding its way cephalad, at first between the dorsum on the one hand and the left testis and ovary on the other, later for a short distance between the dorsum and the right testis. It then bends ventrad,

FIG. 78.

passes to the left of the right testis beneath the transverse arch formed by the union of the vasa efferentia and over the left testis to reach the ventral aspect of the pars musculosa. The uterus now again bends and proceeds cephalad, maintaining throughout the remainder of its course the ventral relation to the pars musculosa and prostatica. Its terminal portion greatly reduced in caliber penetrates, as already described, the muscular mass inclosing the copulatory apparatus and opens immediately beneath the ductus ejaculatorius into the minute, slit-like space already described.

Laurer's canal (fig. 73) leaves the oviduct just as the latter is about to penetrate the shell gland. It then proceeds dorso-caudad, skirting either the right or the left aspect of the excretory vesicle in about the equatorial zone of the latter, and opens on the dorsal sur-

face a little to the right or to the left of the median line; in one sectioned specimen, about 0.72 mm. caudad of the excretory pore.

The vitellogene glands consist of sparsely scattered follicles in the area between the intestinal ceca and the ventro-lateral, lateral, and dorso-lateral margins of the body. They extend in a vertical direction from about the level of the genital pore to a plane slightly caudad of the cecal terminations of the intestines. From each gland a duct passes more or less directly transversely inward, ventrad of the corresponding intestine, to unite with its fellow near the ventro-caudal aspect of the shell gland, between the latter and the acetabulum. From their point of union a duct, the common vitello-

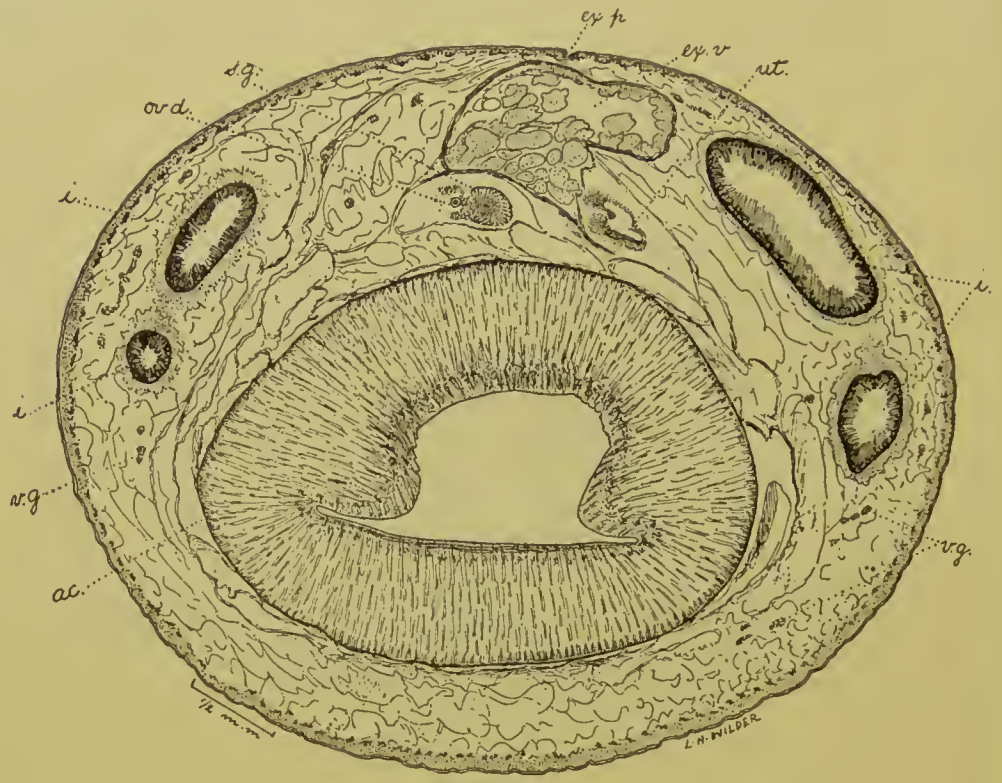

FIG. 79.

duct, passes to the shell gland, penetrating it on its caudal aspect as has already been described.

EXCRETORY SYSTEM.—The excretory system is well developed. A fairly large excretory vesicle is situated between the dorso-cephalic aspect of the acetabulum and the dorsum of the worm. A little caudad of the dome of this vesicle a thick duct leaves it and passes obliquely dorso-cephalad to open on the dorsal surface a little caudad of the superior margin of the acetabulum.

ILLUSTRATIONS.

FIG. 71.—Ventral aspect. Enlarged. Original.

FIG. 72.—Ventral projection of specimen shown in fig. 71: *ac.*, acetabulum; *g. p.*, position of genital pore; *es.*, esophagus; *i.*, intes-

inal ceca; *ov.*, ovary; *o. s.*, oral sucker; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. e.*, vasa efferentia; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, planes of section. Slightly diagrammatic. Enlarged. Original.

Fig. 73.—Profile projection of same: *ac.*, acetabulum; *d. e.*, ductus ejaculatorius; *es.*, esophagus; *ex. v.*, excretory vesicle; *ex. p.*, excretory pore; *i.*, intestines; *L. c.*, Laurer's canal; *ov.*, ovary; *o. s.*, oral sucker; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, right testis; *ut.*, uterus; *v. e.*, right vas efferens; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, planes of section. Slightly diagrammatic. Enlarged. Original.

Fig. 74.—Transverse section at *a–a* figs. 72 and 73. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*) and mesenterium-like strands (*m. b.*). Enlarged. Original.

Fig. 75.—Transverse section at *b–b*, figs. 72 and 73. Shows caudal portion of oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), ductus ejaculatorius (*d. e.*), and vitellaria (*v. g.*). Enlarged. Original.

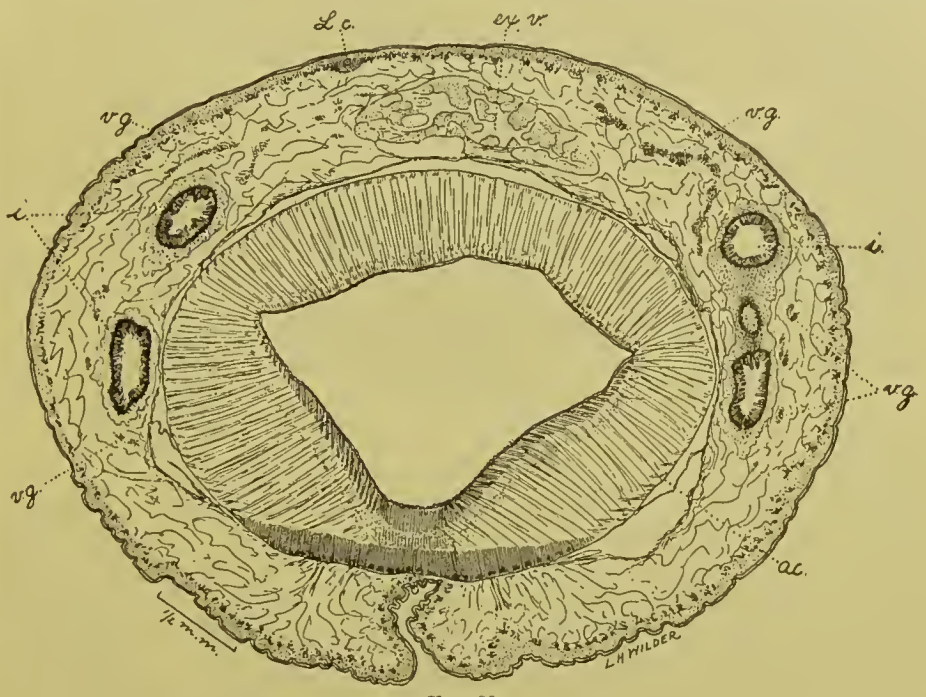

Fig. 80.

Fig. 76.—Portion of fig. 75. To show on a larger scale the copulatory apparatus: *d. e.*, ductus ejaculatorius; *d. h.*, ductus hermaphroditicus; *g. a.*, genital atrium; *g. pap.*, genital papilla. Enlarged. Original.

Fig. 77.—Transverse sections at *c–c*, figs. 72 and 73. Shows esophagus (*es.*) forking into the intestinal ceca (*i.*), the uterus (*ut.*), pars musculosa (*p. m.*), pars prostatica (*p. p.*), and vitellaria (*v. g.*). Enlarged. Original.

Fig. 78.—Transverse section at *d–d*, figs. 72 and 73. Shows the testes (*t.*), uterus (*ut.*), intestinal ceca (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 79.—Transverse section at *e–e*, figs. 72 and 73. Shows excretory pore (*ex. p.*), excretory vesicle (*ex. v.*), shell gland (*s. g.*), oviduct (*ov. d.*), uterus (*ut.*), vitellaria (*v. g.*), intestinal ceca (*i.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 80.—Transverse section at *f–f*, figs. 72 and 73. Shows pore of Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), vitellaria (*v. g.*), intestinal ceca (*i.*), and acetabulum (*ac.*). Enlarged. Original.

PARAMPHISTOMUM PAPILLOSUM, new species.

[Figs. 81 to 91.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body between 5.12 and 6 mm. long by 2.6 mm. in maximum breadth; gray-brown ocher tint (alcohol specimen); somewhat conical, greatest diameters (transverse and sagittal) about at border of equatorial and caudal thirds; tapers gradually to quite a blunt oral extremity; caudal extremity broadly rounded when viewed ventrally or dorsally, but beveled on its ventral aspect; lateral margins nearly straight; transverse section circular; surface coarsely grooved transversely, especially on venter; oral pole with numerous very minute conical papillæ. Genital pore ventro-median, about one-fourth the length from oral margin, and at transverse plane of caudal margin of pharynx. Acetabulum ventro-subterminal, sunken beneath surface, relatively large, 1.8 to 1.9 mm. in diameter, with small 0.36 mm. circular aperture, mouth terminal crateriform, closely beset with small digitate papillæ; oral sucker large, 0.8 mm. long, 0.9 mm. broad, 0.64 mm. in sagittal diameter, the oral two-thirds of its lumen with small papillæ; esophagus short, strongly flexed ventrad, extends beyond genital pore about to border between oral and equatorial thirds of body; intestinal ceca very long, at first transverse, then turned caudad and extend in very wavy course, each about midway between median line and corresponding lateral margin, more dorsal than ventral, nearly or quite to aperture of acetabulum; slings distinctly dorso-ventral and somewhat parallel to body wall. Excretory pore dorso-median, slightly caudad of cephalic margin of acetabulum and cephalad of Laurer's canal; excretory vesicle well developed, broad; excretory canal arises about from equator of vesicle, short, runs directly dorsad to its pore.

FIG. 81.

Male organs.—Testes deeply branched, cauliflower like, in axis of equatorial region of body, close together one caudo-dorsad of the other; each vas efferens arises from lateral aspect, passes cephalo-dorsad, then mediad, uniting with its fellow somewhat cephalo-dorsad of anterior testis to form the much-coiled vesicula seminalis; pars musculosa thick walled, coiled, ventral of vesicula; pars prostatica relatively straight, passes ventro-cephalad, ventral of esophagus, is continued in a short ductus ejaculatorius which opens into dilated ductus hermaphroditicus; the latter pierces the axial region of genital papilla, which is separated from a papillated cylindrical antechamber by a nonpapillated ridge or ring; the papillated chamber opens externally through the apparent genital pore. Cirrus pouch absent.

FIG. 82.

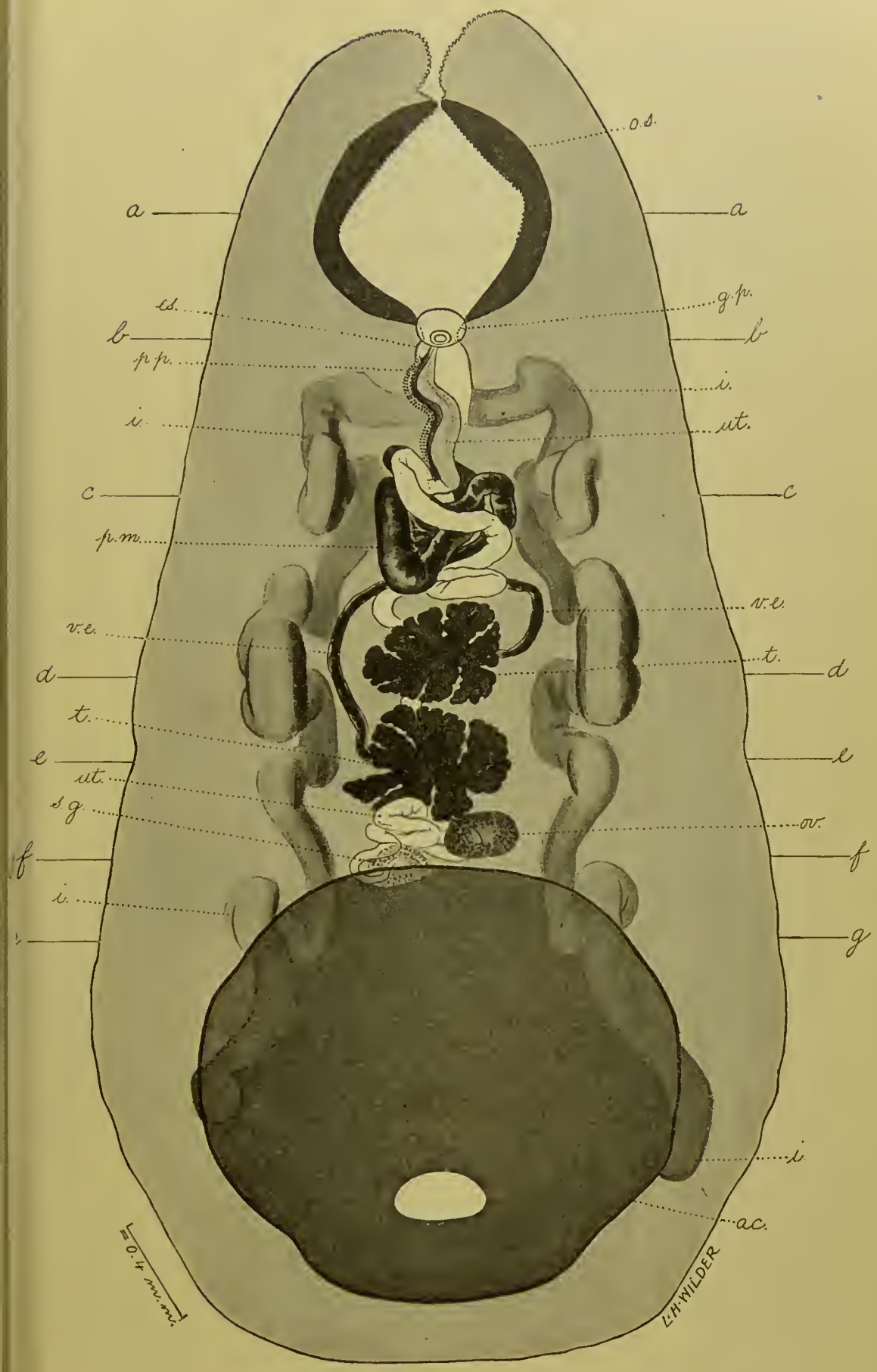
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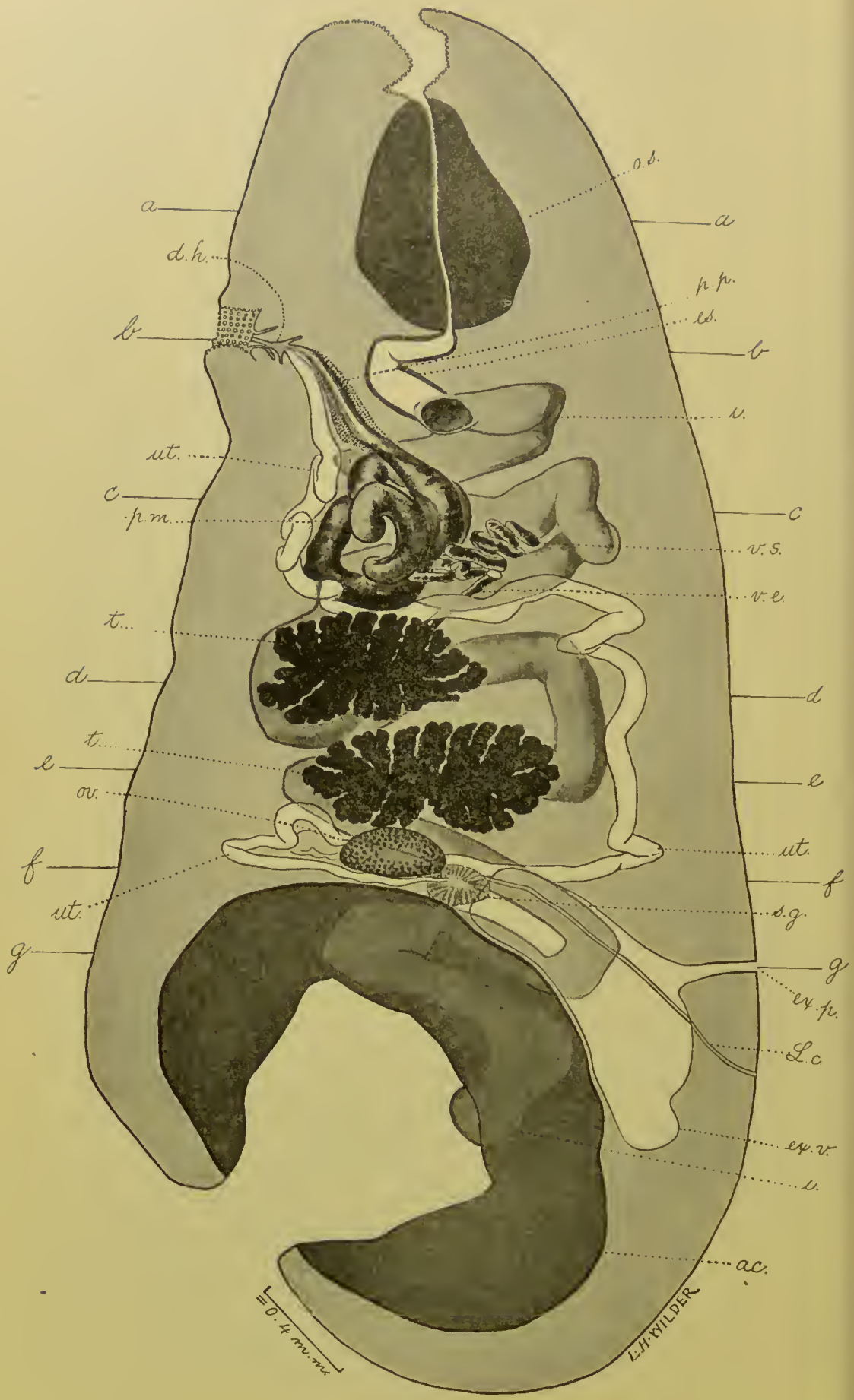
FIG. 83.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L.H.WILDER

FIG. 84.

Female organs.—Ovary slightly sinistral, slightly ventral, immediately cephalad of acetabulum; shell gland smaller than and dorso-dextro-caudal of ovary; also slightly dextral of median line; vitellaria with sparsely scattered small follicles, lateral of ceca, extending from base of oral sucker to caudal end of ceca; uterus passes from shell gland ventrad caudally of ovary, then coils ventrally of ovary, then passes dorsad between shell gland and testis on right of ovary, dorsally around testes, ventrad beneath vasa efferentia, cephalad ventrally of vas deferens, opening ventrally of ductus ejaculatorius into ductus hermaphroditicus. Laurer's canal runs dorso-caudad at right of excretory vesicle to a point 0.4 mm. caudad of excretory pore, and slightly dextral of median line.

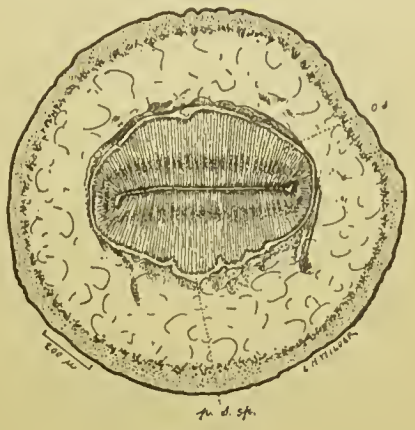

FIG. 85.

Eggs.—Not observed.

TYPE.—U.S.B.A.I. 15025, sectioned.

HOST.—The Zebu (*Bos indicus*) at Sanawaar, Punjab, India.

SOURCE OF MATERIAL.—This single specimen was found in a bottle with other forms bearing the B. A. I. No. 1723; it was renumbered 15025. The label in this bottle reads as follows:

Name *Amphistomum crumeniferum*. Host *Bos indicus*. Locality Sanawaar, Punjab, India. Collected by Doctor Giles. Date III. 1893. Determined by Dr. Giles. Date III. 1893. Presented by Dr. Giles. Date III. 1893.

EXTERNAL CHARACTERS.

SIZE.—Measured from sections the worm was 5.12 mm. long and 2.6 mm. in greatest width; in alcohol it was 6 mm. long.

FIG. 86.

COLOR.—The worm was of a gray-brown ocher tint.

FORM.—The form of this worm is well shown in figs. 81 and 82. The worm has a somewhat conical shape, having its greatest transverse and dorso-ventral diameters in the region of junction of the middle with the caudal third whence it tapers gradually to quite a blunt oral extremity. The aboral pole is broad and rounded from side to side, but beveled on its ventral aspect where it presents the aperture of the acetabulum. In transverse section the outline is circular.

SURFACE.—The surface cuticle is coarsely grooved transversely, particularly on the venter. At the oral pole there appear to be numerous very minute conical papillæ.

Genital pore.—In the median longitudinal line of the venter about one-fourth the length from the oral extremity is a small aperture, the genital pore, measuring about 0.20 mm. in diameter.

Acetabulum.—The acetabulum is in the caudal portion of the body, distinctly sunken beneath the body surface in the specimen examined. It is relatively large, measuring about 1.8 to 1.9 mm. in diameter, but is provided with a rather small circular aperture which measures 0.36 mm. in diameter; the portion of the rim of the aperture formed by the body of the worm (as distinguished from the portion formed by the acetabulum) is slightly puckered (fig. 82).

INTERNAL ANATOMY.

Digestive tract.—The oral pole of the worm presents an irregularly crateriform depression, closely beset by numerous, small digitate papillæ. This depression leads by a minute irregularly circular aperture into a large muscular oral sucker. The latter is about 0.86 mm. long, about 0.90 mm. in greatest width and 0.64 mm. in greatest ventro-dorsal diameter; it lies in a cavity (fig. 85), suggestive of a rudimentary body cavity, and is bound to the body parenchyma at its oral and aboral poles and by distinct mesenterium-like bands on both its dorsal and its ventral median aspects. In median sagittal section it is somewhat pyriform in outline; in frontal section it is almost circular, while in transverse section (fig. 85) it is elliptical in outline. The muscular wall is thickest in the ventro-dorsal and thinnest in the transverse axis. The lumen is a transversely broad, dorso-ventrally narrow slit-like space and is lined by a thin cuticle-like layer seemingly (no sagittal sections available for confirmation) in anatomical continuity with the surface cuticle. In about the upper (cephalic) two-thirds of the lumen the lining is beset by very small slender conical papillæ; these give to the cuticle a serrate appearance (transverse sections), with the papillæ of the dorsal wall fitting into the interspaces between the papillæ of the ventral wall.

Fig. 87.

At the two extremities of the oral sucker the lumen becomes contracted so as to form at each end a small circular aperture; at the

caudal extremity this aperture gives entrance into the esophagus; very slightly caudally of this point may be distinguished a well developed ganglion-complex (fig. 86), lying dorsally of the esophagus and sending off strong nerve strands in various directions. The esophagus passes from the base of the sucker and describing a U-shaped course with the base of the U ventrad, divides into two intestines at about the level of junction of the cephalic with the middle third of the body. The intestinal tubes pass one to the right and the other to the left in a transverse plane latero-dorsad to a point about midway between the longitudinal axis and the body wall; they then pursue a wavy course caudad (figs. 83, 84), to terminate by cecal extremities latero-dorsad of the acetabulum about in the transverse plane of the upper (cephalic) margin of the aperture of the acetabulum. In their wavy course caudad the ceca continue in a general way about midway between the longitudinal body axis and the body wall but approaching closer to the dorsal than to the ventral median longitudinal line; furthermore, the slings or coils have a distinctly dorso-ventral direction (figs. 84, 87, 89, 90) and run somewhat parallel to the body wall. The lumen of the esophagus is lined by a thick cuticular layer, which ceases abruptly at the point of origin of the intestines. The latter are lined by an epithelial cell layer.

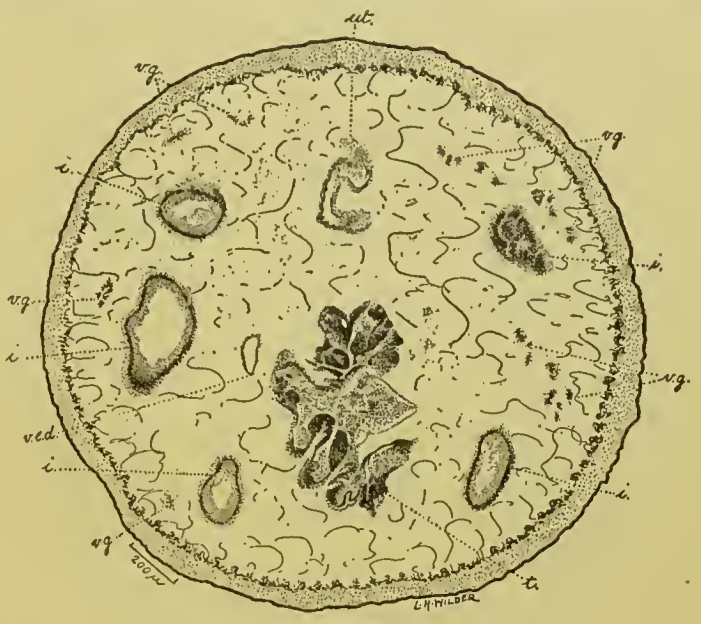

FIG. 88.

GENITAL SYSTEM.— *Male organs.*—The testes, one caudad of the other, are in the axial portion of the equatorial region of the body, though in general slightly nearer the venter than the dorsum (figs. 84, 88, 89); of the two, the superior (cephalic) testis is nearer the venter, and, being somewhat smaller, is also farther from the dorsum than is the inferior (or caudal) testis. The opposing aspects of the testes are closely approximated. Both testes are much branched, suggesting a cauliflower in appearance (figs. 88, 89). (The projections do not show this well.) From the right lateral aspect of the caudal, and from the left lateral aspect of the cephalic testis there

spring the corresponding vasa efferentia; these pass cephalo-dorsad, then mediad, describing an arch as they unite a little above the superior testis to form the vas deferens (fig. 84). Beneath this arch, and between it and the superior testis, the uterus passes ventrad. The vas deferens presents at first a much coiled thin walled portion, (vesicula) the lumen of which in the single specimen studied was not noticeably dilated. This is succeeded by a coiled quite thick walled (45μ) portion, pars musculosa, measuring about 150μ in diameter, which is situated ventro-cephalad of the coiled thin-walled portion. The caliber of this muscular portion appears somewhat greater than that of the vesicula. The muscular portion is succeeded by a relatively straight pars prostatica of moderate length, the walls of which, though thick and muscular at first, rapidly become thinned and are inclosed in a mass of cells. This portion passes ventro-cephalad, being in relation to the ventral aspect of the esophagus, and in still closer relation to the dorsal aspect of the terminal portion of the uterus; it is finally succeeded by a short duct (by homology, the ductus ejaculatorius) not inclosed in prostatic cells and opens by a minute pore immediately above the metraterm into a small slit-like atrium at the base of the genital papilla. This atrium may be regarded as the dilated dorsal portion of the ductus hermaphroditicus which pierces the axial region of the genital papilla. The genital papilla is embraced by a ring, one aspect of which is applied to it and separated from it only by a narrow slit; the other aspect forms the dorsal wall of a relatively large cylindrical atrium (figs. 84, 86); this latter is beset by small papillæ (hence the specific name *papillosum*), which do not occur, however, on either surface of the ring embracing the genital papilla. The genital pore gives entrance and exit to this chamber, and, as will be seen from figure 84, it is at or slightly caudad of the level of the base of the oral sucker.

FIG. 89.

Female organs.—The ovary is in the axial region of the body, though a little to the left of the median sagittal plane, and a little nearer to the venter than to the dorsum and just above (cephalad of) the acetabulum. From its dorso-median aspect there arises the

oviduct which passes to the right and dorso-caudad toward the shell gland. The shell gland, somewhat smaller than the ovary, lies a little to the right, and a little dorso-caudad of the ovary (figs. 83, 84, 90) and also slightly to the right of the median sagittal plane of the body of the worm. It is penetrated on its dorso-median aspect by the oviduct and on its dorso-caudal aspect by the vitello-duct. These unite in the substance of the shell gland to form the ootype, which is continued as the uterus, the latter emerging from the ventral aspect of the gland (fig. 90). Laurer's canal leaves the oviduct just before the latter penetrates the shell gland; it then passes to the right and dorso-caudad, skirting the upper portion of the right lateral aspect of the excretory vesicle (figs. 84, 91), and opens on the dorsum about 0.40 mm. caudad of the excretory pore, slightly to the right of the median line.

FIG. 90.

The vitellogene glands, composed of sparsely scattered insignificant follicles, lie in the lateral regions of the body between the intestinal ceca and the body walls. They extend longitudinally from about the level of the base of the oral sucker to the level of the termination of the intestinal ceca. From each gland there arises a duct, which passes transversely inward ventrally of the intestines; the two unite at the level of the superior margin of the acetabulum and close to the ventro-median aspect of the shell gland. From their point of union a duct is given off which skirts the caudal aspect of the shell gland, penetrating the latter at the caudo-dorsal aspect.

The uterus, as already described, emerges from the ventral aspect of the shell gland (fig. 90), passes ventrad, then for a short distance cephalad forming some coils ventrally of both ovary and shell gland; it then passes dorsad to the right of the ovary and between the shell gland and caudal testis. Having reached the space between the caudal testis and dorsum it passes cephalad behind (dorsally of) both testes, then ventrad above (cephalad of) the superior testis and beneath the arch of union of the vasa efferentia, to gain the ven-

tral aspect of the coil formed by the pars musculosa. It next passes in a general way cephalad and reaches the ventral aspect of the pars prostatica; this relation it maintains in the remainder of its course ventro-cephalad to terminate by a minute pore immediately beneath the pore of the ductus ejaculatorius in the manner already described. In its course the uterus is moderately coiled. Neither eggs nor spermatozoa were observed in its lumen.

Excretory system.—The excretory vesicle (figs. 84, 90, 91) lies dorsally of the acetabulum between the terminal portions of the intestinal ceca. Its transverse diameter is greater than its ventro-dorsal diameter; it discharges by a thick walled duct which arises from about the middle of its dorsal aspect; this duct passes almost directly dorsad to open, in the median line, somewhat (about 0.28

Fig. 91.

mm.) below the level of the upper margin of the acetabulum, and about 0.4 mm. cephalad of the pore of Laurer's canal.

ILLUSTRATIONS.

Fig. 81.—Ventral aspect. Enlarged. Original.

Fig. 82.—Profile of same. Enlarged. Original.

Fig. 83.—Ventral projection of specimen shown in figs. 81 and 82: *ac.*, acetabulum; *g. p.*, genital pore; *es.*, esophagus; *i.*, intestinal ceca; *ov.*, ovary; *o. s.*, oral sucker; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. e.*, vasa efferentia. *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 84.—Profile projection of specimen shown in figs. 81 and 82: *ac.*, acetabulum; *d. h.*, ductus hermaphroditicus; *es.*, esophagus; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *i.*, intestine; *L. c.*, Laurer's canal; *ov.*, ovary; *o. s.*, oral sucker; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. e.*, vas efferens; *v. s.*, vesicula seminalis; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 85.—Transverse section at *a–a*, figs. 83 and 84. Shows oral sucker (*o. s.*), and perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 86.—Transverse section through *b–b* figs. 83 and 84. Shows papillated genital ventral chamber (*g. a. c.*), genital dorsal chamber (*g. a.*), genital papilla (*g. pap.*), esophagus (*es.*), esophageal ganglion (*e. g.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 87.—Transverse section at *c–c* figs. 83 and 84. Shows uterus (*ut.*), pars musculosa (*p. m.*), intestinal ceca (*i*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 88.—Transverse section at *d–d* figs. 83 and 84. Shows superior testis (*t.*), intestines (*i.*), uterus (*ut.*), right vas efferens (*v. e. d.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 89.—Transverse section at *e–e* figs. 83 and 84. Shows caudal testis (*t.*), origin of right vas efferens (*v. e. d.*), uterus (*ut.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 90.—Transverse section at *f–f* figs. 83 and 84. Shows uterus (*ut.*), right transverse vitello-duct (*t. v. d.*), caudal portion of ovary (*ov.*), shell gland (*s. g.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 91.—Transverse section at *g–g* figs. 83 and 84. Shows acetabulum (*ac.*), intestines (*i.*), excretory vesicle (*ex. v.*), Laurer's canal (*L. c.*), excretory pore (*ex. p.*), and vitellaria (*v. g.*). Enlarged. Original.

PARAMPHISTOMUM INDICUM, new species.

[Figs. 92 to 102.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 5.25 to 9.5 mm. long by 2 to 3 mm. in maximum breadth; gray-brown ochre (alcohol specimens); somewhat conical, greatest transverse diameter about at border of equatorial and caudal thirds; tapers moderately to blunt, almost truncated oral extremity; caudal extremity rounded on ventral view, but with tendency to beveled ventro-lateral aspect on lateral view; lateral margins nearly straight to slightly curved; body bent, with venter rather strongly concave (longitudinally) and dorsum convex; transverse section circular anteriorly, but with greater transverse than dorso-ventral diameter from near genital pore for some distance caudad, then the dorso-ventral diameter becomes the greater. Surface coarsely wrinkled transversely; cephalic half provided with irregular, transverse rows of papillæ which are more numerous, acutely conical in circumoral region, but more scattered, shorter, broader, and blunt elsewhere. Genital pore ventro-median about at border between cephalic and equatorial thirds of body, caudad of esophagus, but nearer to this than to anterior testis. Acetabulum terminal, but aperture appears ventro-subterminal because of curvature of body, sunken beneath surface,

rather large, 1.6 mm. in longitudinal diameter, very slightly less in transverse diameter, with rather circular to somewhat irregular, 0.53 mm. to 0.65 mm. aperture which appears ventrad and slightly caudad. Mouth terminal, hour-glass form, provided with papillæ; oral sucker large, oval, 0.96 mm. long, 0.84 mm. broad, 0.58 mm. in greatest dorso-ventral diameter, the oral two-thirds of its lumen with small blunt papillæ; esophagus about half as long as sucker, at first directed caudad, then suddenly dorsad, does not extend to genital pore; intestinal ceca long, pursue dorso-ventrally wavy course about to anterior margin of aperture of acetabulum. Excretory pore dorso-median, cephalad of acetabulum, about on caudal plane of caudal testis, and about 1 mm. cephalad of pore of Laurer's canal; excretory duct short, runs from pore to dorso-cephalic aspect of very large excretory vesicle which lies dorsally of cephalic portion of acetabulum.

FIG. 92.

Male organs: Testes deeply notched (lobulated), in transverse section cauliflower like, in axis of body, one caudad of the other, slightly caudad of equatorial plane, very slightly nearer to venter than to dorsum, one very slightly nearer each lateral margin than is the other; each vas efferens arises from dorsal aspect of testis, passes cephalo-mediad, unites with its fellow about 0.5 mm. cephalad of superior testis to form vas deferens; vesicula seminalis and pars musculosa both much coiled and extend in ventrocephalic direction; pars prostatica short, nearly straight, directed ventrad; pars ejaculatorius very short, unites with metraterm dorsally of pore to form ductus hermaphroditicus, which pierces a small papilla to discharge into a narrow nonpapillated atrium, which in turn discharges at the genital pore; cirrus pouch absent.

Female organs: Ovary right or left of median line, just cephalad of acetabulum; shell gland smaller, dorso-median and slightly caudad of ovary; vitellaria with sparsely scattered, very small follicles, lateral to dorso-lateral of ceca, from base of oral sucker to cephalic margin of acetabulum (not quite to end of ceca); uterus passes in wavy course ventrally of shell gland, dorsad caudally of posterior testis, cephalad of both testes, ventrad under arch of vasa efferentia, cephalad ventrally of vas deferens, to ductus hermaphroditicus; Laurer's canal arises from oviduct about midway between ovary and shell gland, runs dorso-caudad at right of excretory vesicle to pore situated on dorsum, 0.8 to 1.0 mm. caudad of excretory pore, and either median or very slightly to the right of median line.

FIG. 93.

Eggs: Not observed.

TYPE.—U.S.B.A.I. 1723; cotype U.S.N.M. 5775.

HOST.—The Zebu (*Bos indicus*) in Punjab, India.

SOURCE OF MATERIAL.—These worms were found with some other forms in 2 bottles, bearing the numbers "B.A.I. 1723" and "U.S.N.M. 5775," respectively. The other material in question has been separated out and renumbered.

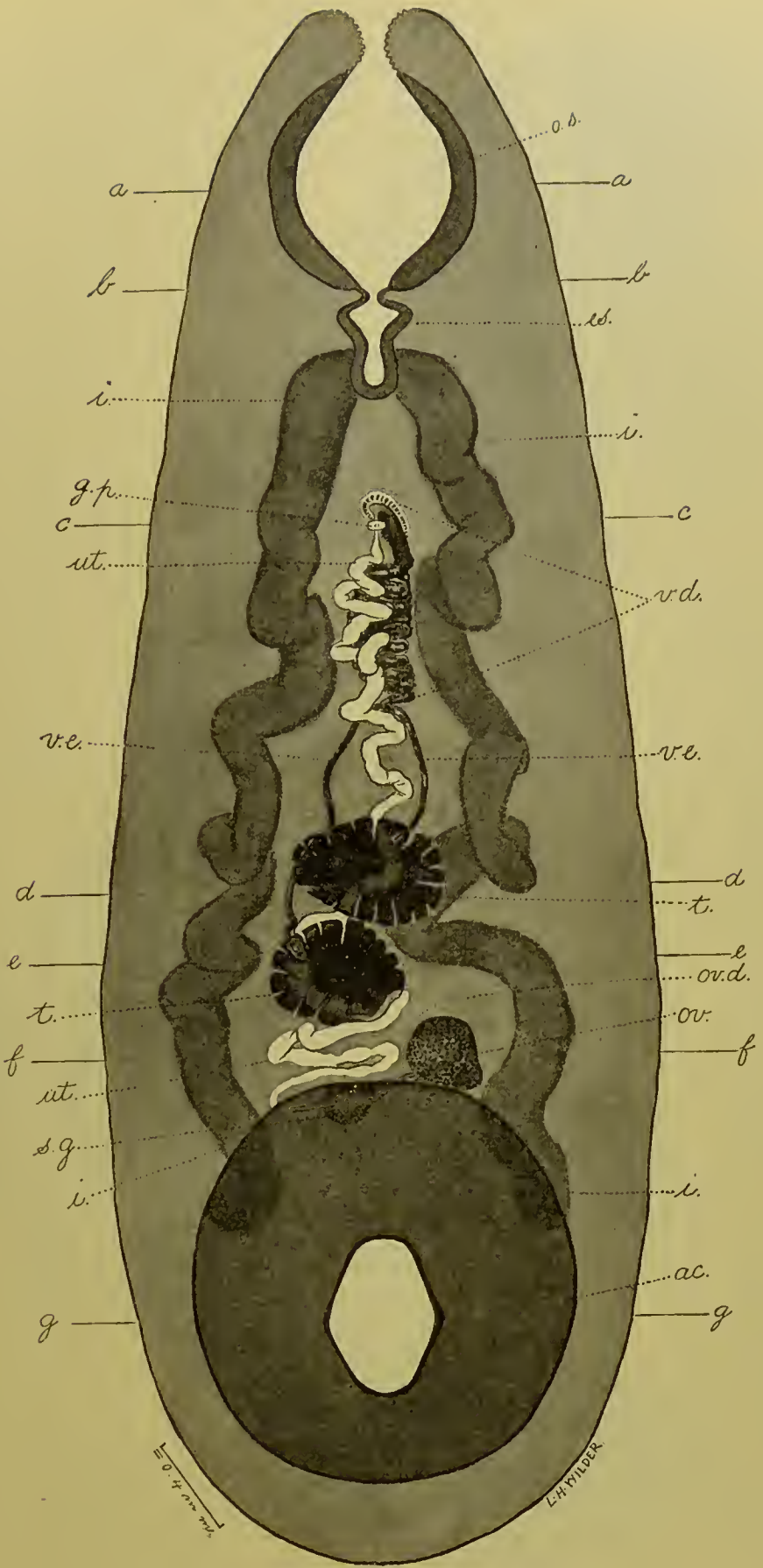
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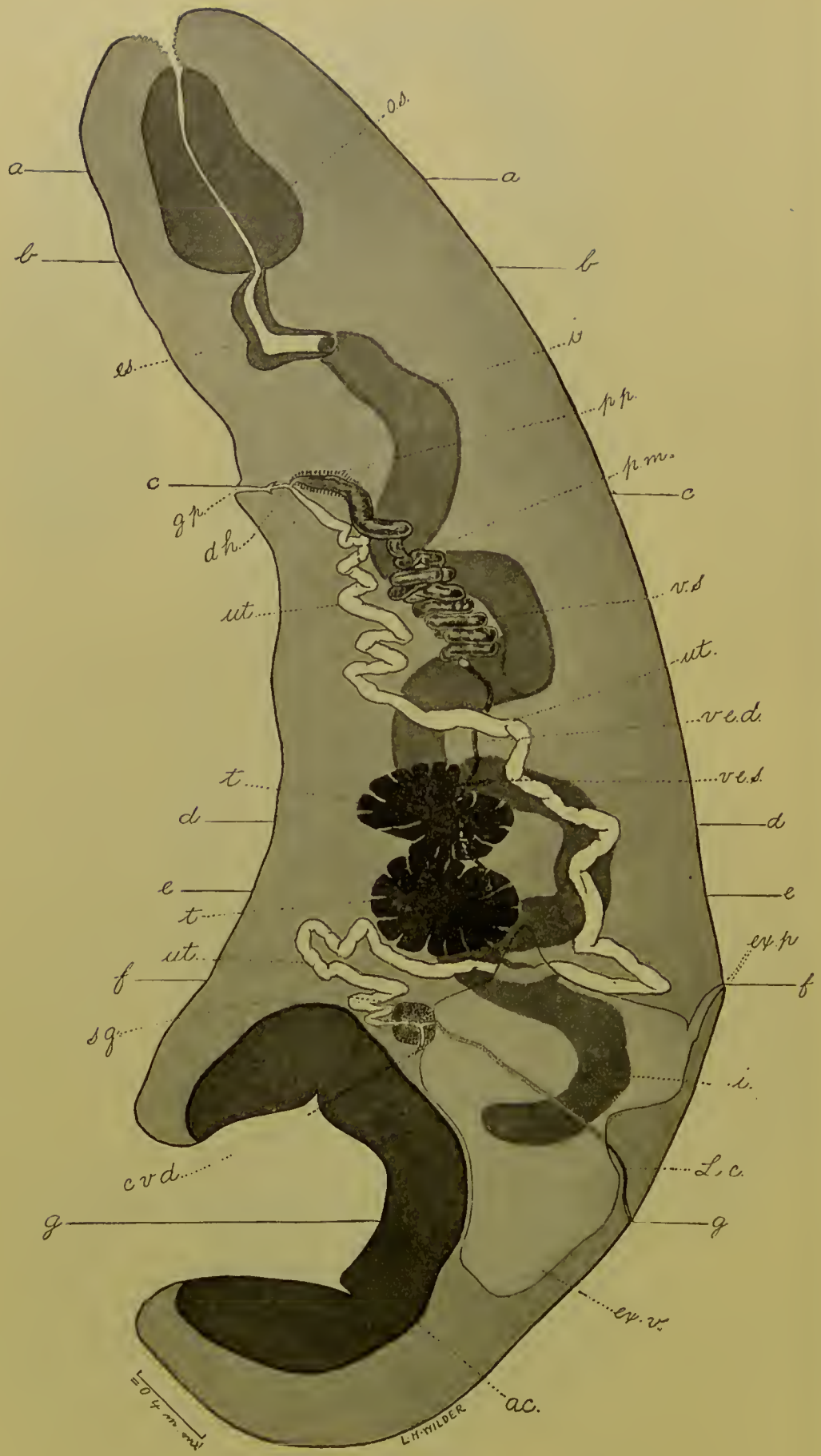
FIG. 94.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L.H.WILDER

FIG. 95.

SIZE.—The alcohol preserved specimens—14 in all—measured from 5.25 to 9.5 mm. in length. On account of the damaged condition of 6 of them the width could be measured in 8 only, and in these the maximum breadth varied from 2 to 3 mm.

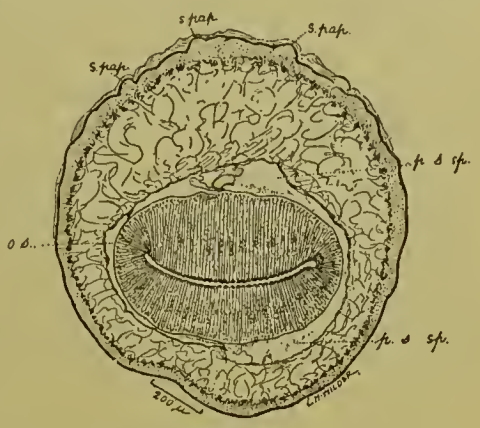


FIG. 96.

COLOR.—The worms are of a gray-brown ocher.

FORM.—The specimens are somewhat conical in form (figs. 92, 93) and the ends are bent more or less ventrally, so that the longitudinal axis is a curve with a concave venter and a strongly convex dorsum. The greatest transverse diameter is near the junction of the equatorial with the caudal third of the body; the worm tapers moderately to a blunt, and in some specimens, slightly bulbous oral extremity. On transverse section the cephalic portion is circular, but beginning slightly cephalad of the genital pore the outline undergoes a slight change, the transverse diameter becoming greater than the dorso-ventral diameter; near the caudal end the outline again changes, the dorso-ventral diameter being the greater.

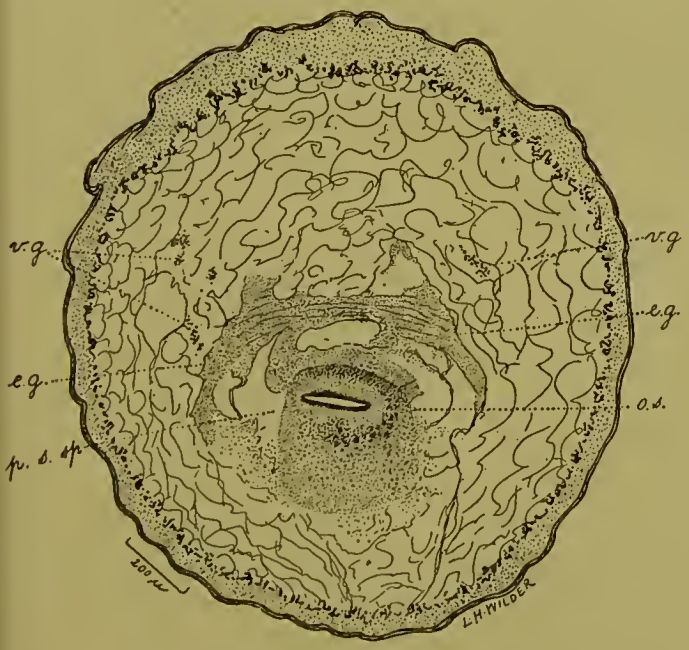


FIG. 97.

SURFACE.—The surface of the worms, except for some transverse wrinkling, is smooth in the caudal half of the animal; in the cephalic half, however, the cuticle is provided with numerous papillæ, which are acutely conical in the circumoral region, but relatively shorter, broader, and more blunt over the remaining portion of the surface covered by them; at least some of these appear to be of sensory nature. The papillæ around the oral aperture are

fairly numerous and closely aggregated; the others are relatively less numerous, more scattered, and arranged in irregular transverse rows.

Genital pore.—In the median longitudinal line of the ventral surface, at about the junction of the cephalic with the middle third of the body, is the genital pore (figs. 94, 95, 98). This gives entrance into a canal which leads into a small nonpapillated atrium, the dorsal wall of which is formed by a short papilla in the center of which is the porus hermaphroditicus. Sections show the genital atrium to be inclosed in considerable muscular mass (figs. 95, 98).

Acetabulum.—This is terminal anatomically, but appears ventro-subterminal because of the curvature of the body. In one of the sectioned specimens it measured about 1.6 mm. in greatest (longitudinal) diameter. Its more or less circular aperture is directed ventrad and slightly caudad, appearing ventro-subterminal, and in 7 specimens varies from 0.53 to 0.65 mm. in diameter.

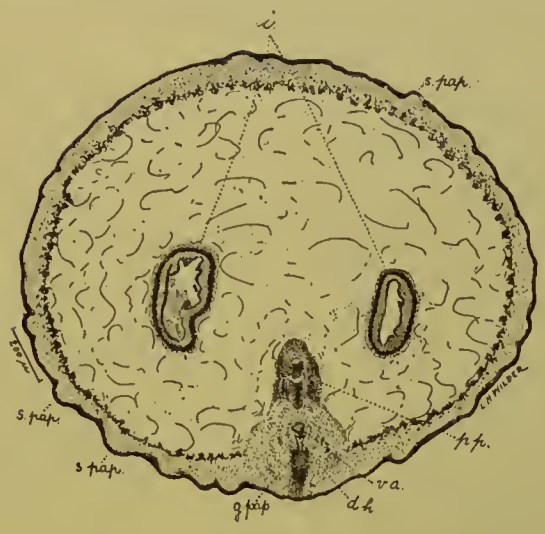


FIG. 98.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The mouth, which pierces the cephalic blunt extremity, leads into a large muscular oral sucker of oval form and rather similar to that of *P. papillosum*. The cephalic two-thirds of the lumen of this sucker is beset with small but distinct bluntly pointed conical papillæ (fig. 96); in the esophageal third there is a slight indication of much more minute papillæ. The sucker lies in a cavity suggestive of a rudimentary body cavity, held in place by its attachments at its poles and by mesenterium-like bands extending from the dorsal and ventral aspects through the cavity to the body parenchyma. The sucker leads into the esophagus, and dorsally of the point of union there is a distinct nervous band giving off branches in various directions (fig. 97). At first the esophagus passes almost directly caudad, then bending at almost right angles it is directed for the remainder of its short course dorsad to fork into two intestinal ceca. The length of the esophagus is equal to about one-half of that of the sucker. The intestinal ceca pursue a dorso-ventral wavy course (approximately parallel to the body wall) caudad to terminate dorsally of the acetabulum and in a transverse plane just above (cephalad) of the acetabular aperture (figs. 94, 95).

Genital system.—*Male organs.*—The testes are in the axial region of the cephalic portion of the caudal half of the body, between the equatorial plane and the plane of the cephalic margin of the acetabulum (figs. 94, 95), somewhat nearer to the venter than to the dorsum. The testes are deeply indented or lobulated, so that in transverse section they appear as if branched in cauliflower-like fashion (figs. 99, 100). They are situated almost directly caudad one of the other, their opposing surfaces being either in the same or in slightly separated transverse planes. From the dorsal aspect of each testis arises a vas efferens; in one (figs. 94, 95) of the two sectioned specimens the right vas belonged to the inferior, and in the other to the superior testis. The vasa efferentia pass cephalad, and about 0.5 mm. above the superior testis unite in the axial region of the body to form the much coiled vas deferens. The first portion of the latter is thin walled (vesicula), and its general course is ventro-cephalad. The second portion, also much coiled, is provided with thick muscular walls. The third portion of the vas deferens is short, fairly straight, directed almost horizontally ventrad, and its walls are inclosed in a mass of cells; this, the pars prostatica, becomes suddenly greatly reduced both in the caliber of its lumen and the thickness of its walls, and now devoid of prostatic cells this terminal (fourth) portion represents a very short ductus ejaculatorius, which unites with the metraterm to form a short ductus hermaphroditicus (fig. 95).

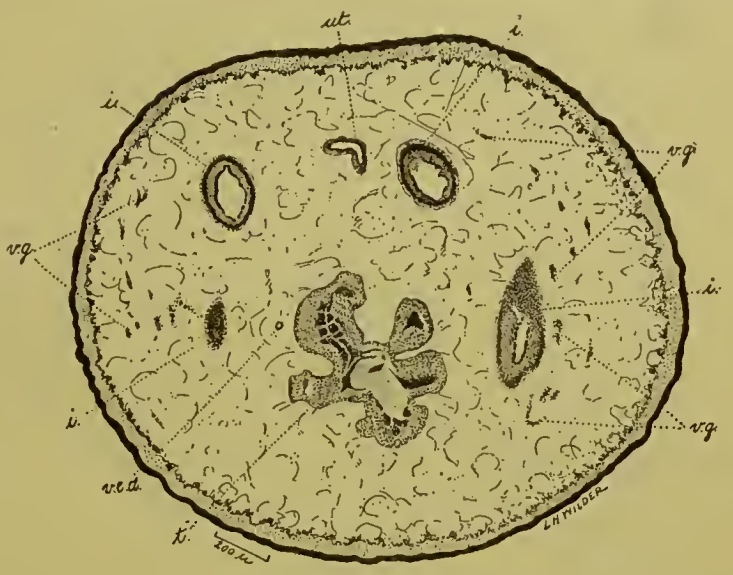


Fig. 99.

Female organs.—The ovary lies in the superior (cephalic) part of the caudal third of the axial region of the body (fig. 101), a little either to the right or to the left of the median sagittal plane. Its cephalic aspect is in the same transverse plane as, or in the plane immediately caudad of, the plane of the caudal aspect of the caudal testis. The shell gland lies on the dorso-median aspect of the ovary, slightly caudad of and either close to or somewhat removed from the latter. The oviduct springs from the ovary from the aspect nearest the shell gland in one specimen, but very slightly more dorsally in another; it passes toward the shell gland which it penetrates. In the substance

of the shell gland the oviduct unites with the vitelline duct to form the ootype. Laurer's canal leaves the oviduct at a point about midway between the ovary and the shell gland, or slightly nearer the ovary, and passes dorso-caudad, skirts the right side of the excretory vesicle (both in the specimen with dextral and in the one with sinistral ovary), and reaches the dorsal body surface at a point about on a level with the middle of the acetabular aperture and between 0.80 mm. and 1 mm. caudad of the excretory pore. In the specimen with the dextral ovary the pore of Laurer's canal is median, while in the specimen with sinistral ovary it is very slightly to the right of the median line. The vitellogene glands, consisting of sparsely scattered insignificant follicles, lie in the lateral and dorso-lateral regions of the body, between the intestinal ceca and the body surface, and extend longitudinally between the plane of the base of the sucker and that of the upper margin of the acetabulum. The transverse vitello-ducts unite dorsad of the acetabulum and immediately caudad of the shell gland. From their point of union, which is not dilated into a reservoir, a duct springs which penetrates the caudal aspect of the shell gland.

FIG. 100.

The uterus, as a continuation of the ootype, emerges from that ventro-lateral aspect of the shell gland which is away from the ovary, and then forms coils ventrad of the shell gland and ovary as it winds its way for a short distance cephalad before it turns dorsad beneath the caudal testis. In its course dorsad it passes to the right of the upper portion of the excretory vesicle. On reaching the region dorso-caudally of the caudal testis it resumes its course cephalad between the dorsum and the testes; just above the plane of the cephalic aspect of the superior testis it bends ventro-cephalad, passing beneath the arch formed by the union of the vasa efferentia, and gains the ventral aspect of the vas deferens; this relation it maintains in the remainder of its course, its terminal portion or metraterm uniting with the

ductus ejaculatorius to form the ductus hermaphroditicus. Eggs were not observed in the uterus of either of the specimens studied.

Excretory system.—The excretory vesicle is large and lies dorsally of the acetabulum, its fundus extending caudad to a plane somewhat above the caudal margin of the acetabulum. The vesicle opens by a short duct which leaves it from the dorso-cephalic aspect and opens on the dorsum a little above the plane of the upper margin of the acetabulum and as already stated almost 1.00 mm. cephalad of the pore of Laurer's canal.

RELATION TO KNOWN SPECIES.

This species resembles most closely *Paramphist. gracile* Fischœder. It differs from the latter in possessing an esophagus that is only about one-half as long as the sucker; in the position of the testes which in this species are placed relatively farther caudad than in *P. gracile;* in the position of the ovary which in this form is separated little, if at all, in a longitudinal direction from the caudal testis; and in the position of the pore of Laurer's canal which in this form is very much farther caudad, opening about opposite the middle of the acetabular aperture whereas in *P. gracile* it opens in the plane of the superior aspect of the ovary some distance above the upper margin of the acetabulum.

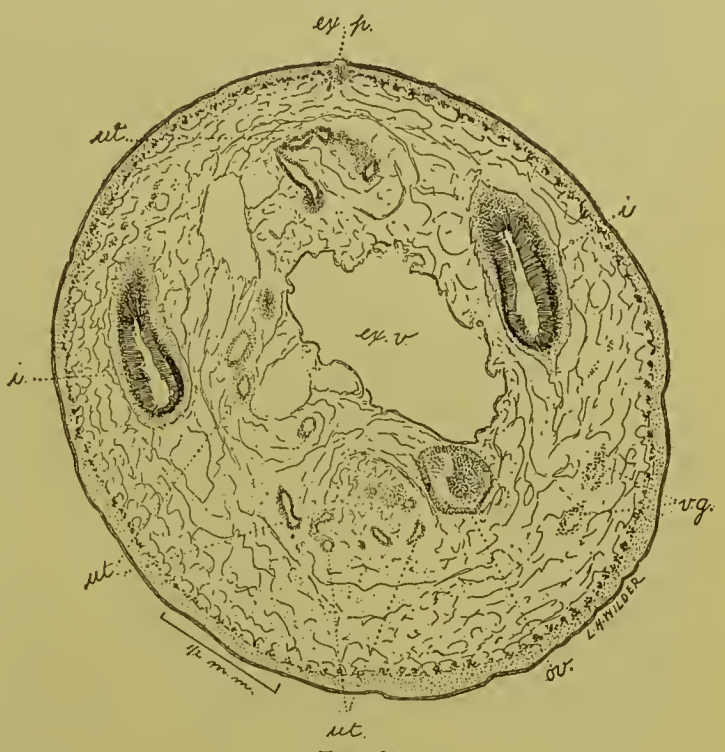


Fig. 101.

ILLUSTRATIONS.

Fig. 92.—Ventral aspect. Enlarged. Original.

Fig. 93.—Profile view of same. Enlarged. Original.

Fig. 94.—Ventral projection of specimen shown in figs. 92 and 93: *ac.*, acetabulum; *g. p.*, genital pore; *es.*, esophagus; *i.*, intestines; *ov.*, ovary; *ov. d.*, oviduct; *o. s.*, oral sucker; *s. g.*, shell gland; *t.*, testes; *v. d.*, vas deferens; *v. e.*, vasa efferentia; *ut.*, uterus. *a–a*, *b–b*, *c–c*,

d–d, e–e, f–f, g–g, planes of section. Slightly diagrammatic. Enlarged Original.

Fig. 95.—Profile projection of specimen shown in figs. 92 and 93: *ac.*, acetabulum; *g. p.*, genital pore; *c. vd.*, common vitello-duct; *es.*, esophagus; *d. h.*, ductus hermaphroditicus; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *i.*, right intestinal cecum; *L. c.*, Laurer's canal; *o. s.*, oral sucker; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, testes; *v. e. d.*, right vas efferens; *v. e. s.*, left vas efferens; *v. s.*, vesicula seminalis; *ut.*, uterus. *a–a, b–b, c–c, d–d, e–e, f–f, g–g,* planes of section. Slightly diagrammatic. Enlarged. Original.

Fig. 96.—Transverse section at *a–a* figs. 94 and 95. Shows surface papillæ (*s. pap.*), oral sucker (*o. s.*), and perisuctorial space (*p. s. sp.*). Enlarged. Original.

Fig. 97.—Transverse section at *b–b* figs. 94 and 95. Shows base of oral sucker (*o. s*), perisuctorial space (*p. s. sp.*), esophageal ganglion (*e. g.*), and vitellogene glands (*v. g.*). Enlarged. Original.

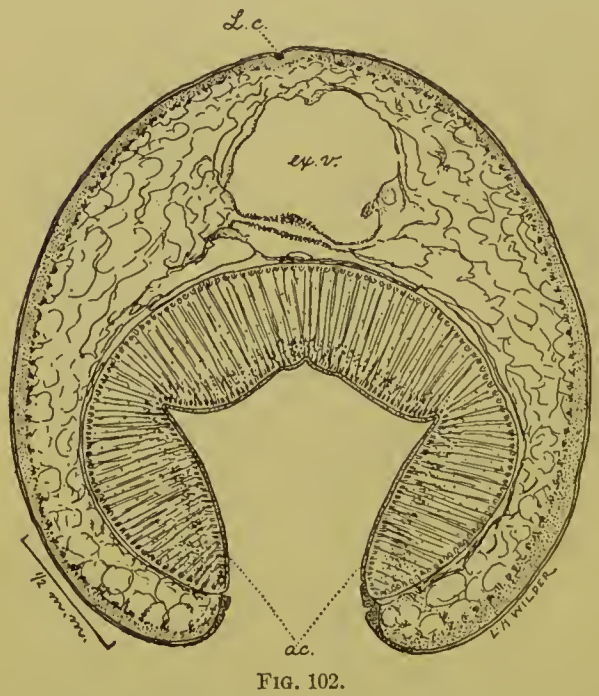


Fig. 102.

Fig. 98.—Transverse section at *c–c* figs. 94 and 95. Shows genital papilla (*g. pap.*), ductus hermaphroditicus (*d. h.*), metraterm (*va.*), pars prostatica (*p. p.*), intestinal ceca (*i.*), and surface papillæ (*s. pap.*). Enlarged. Original.

Fig. 99.—Transverse section at *d–d* figs. 94 and 95. Shows superior testis (*t.*), right vas efferens (*v. e. d.*), the uterus (*ut.*), intestines (*i.*), vitellaria (*v. g.*). Enlarged. Original.

Fig. 100.—Transverse section at *e–e* figs. 94 and 95. Shows caudal testis (*t.*), origin of right vas efferens (*v. e. d.*), uterus (*ut.*), intestines (*i*), and vitellaria (*v. g.*). Enlarged. Original.

Fig. 101.—Transverse section at *f–f* figs. 94 and 95. Shows ovary (*ov.*), excretory pore (*ex. p.*), excretory vesicle (*ex. v.*), uterus (*ut.*), and intestines (*i.*). Enlarged. Original.

Fig. 102.—Transverse section at *g–g* figs. 94 and 95. Shows acetabulum (*ac.*), excretory vesicle (*ex. v.*), and pore of Laurer's canal (*L. c.*). Enlarged. Original.

SUBGENERIC POSITION UNCERTAIN.

The subgeneric position of the following species is left open for the present:

Paramphistomum fraternum, close to the subgenus *Paramphistomum*, very close to *P. explanatum*.
P. siamense, close to subgenus *Paramphistomum*, very close to *P. explanatum*.
P. shipleyi, close to *P. parvipapillatum* and *P. scoliocœlium*.
P. parvipapillatum, close to *P. shipleyi* and *P. scoliocœlium*.

PARAMPHISTOMUM FRATERNUM, new species.

[Figs. 103 to 113.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 9.75 mm. long, at least 4.5 mm. in maximum breadth; grayish olive green in color (alcohol specimens); viewed ventrally, conical; viewed laterally, gourd shape; greatest diameter at junction between equatorial and caudal thirds; tapers gradually but considerable to truncated conical oral pole; caudal end bluntly rounded when viewed ventrally, beveled ventrally when viewed laterally; long axis curved moderately, concavity ventrad; dorsum arches both longitudinally and tranversely; venter concave longitudinally, convex transversely; transverse sections in general elliptical to semicircular with rounded angles. Surface with fine transverse striations, no papillæ. Genital pore apparently slightly sinistrad (due to torsion?) in suctorial zone about one-eighth of body length from oral pole; shallow genital atrium; genital papilla only slightly elevated. Acetabulum large, ventro-subterminal, 3.75 mm. long, 3.25 mm. broad, aperture 1.85 by 1.52 mm., margins projecting slightly, cavity very deep. Mouth terminal, crateriform, not papillated; oral sucker 0.96 mm. long, 0.98 mm. broad, 0.52 mm. thick, rather oval in outline; perisuctorial space narrow; esophagus about three-fourths as long as sucker; ceca pass at first laterad, then caudad to end at equator of acetabulum, about at junction of third with caudal fourth of body, the ends bending medio-caudad. Excretory pore opens on preacetabular plane (about five-ninths of body length from oral pole) and one-fifth of body length cephalad of pore of Laurer's canal; excretory vesicle crosses Laurer's canal, long, extends postovarian, beyond equator of acetabulum.

Male organs.—Testes equatorial, pre- and acetabular, zones and fields overlap, in extra-, inter-, and cecal areas, very large, lobate; vasa efferentia unite about at junction of oral and equatorial thirds of body; vas deferens highly developed; vesicula seminalis much coiled, extending about from pretesticular plane nearly to bifurcal plane; musculosa short, nearly straight, extends nearly to postsuctorial plane; prostatica much shorter than musculosa; ejaculatorius and ductus hermaphroditicus very short.

Female organs.—Ovary about at equator of acetabulum, at end of ceca, slightly dextrad; shell gland in ovarian zone, slightly sinistrad; vitellaria large, follicles large, in extra-, inter-, and cecal areas, dorsal and ventral of ceca, from slightly above postsuctorial plane to caudal margin of shell gland, hence slightly postcecal; uterus extends from shell gland a short distance cephalad, coils, then ascends a short distance, then coils and becomes very much distended by eggs, passing dorsally of testes and beneath arch of vasa efferentia, then runs in nearly straight course ventrally of vas deferens to discharge into ductus hermaphroditicus; Laurer's canal runs at first cephalo-dorsad, then dorsad to open slightly sinistrad of median line, slightly caudad of preovarial plane, about 1.72 mm. caudad of excretory pore.

Eggs.—Numerous, operculated, 120 by 67.5μ.

TYPE.—B.A.I. 3066.

HABITAT.—In (organ? of) *Bufflelus indicus*.

Source of material.—The 2 specimens forming the collection were in a bottle bearing the B.A.I. No. 3066, the label in which bore the following information:

Name *Amphistomum explanatum*. Host *Buffelus indicus*. Determined by Prof. A. Railliet. Date 1899. Presented by Prof. A. Railliet. Date 1899.

The specimens are in poor condition; one is greatly distorted, having its cephalic third bent acutely ventrad; the other also appears somewhat distorted by irregular shrinkage, but is sufficiently preserved for study, and the following description is based chiefly upon it.

Fig. 103.

EXTERNAL CHARACTERS.

Size.—Measured in alcohol this specimen was 9.75 mm. in greatest length and 4.5 mm. in greatest transverse diameter. After embedding and sectioning, the length (calculated from the sections) was found to be 8.94 mm., the greatest transverse diameter 4.10 mm., and the greatest dorso-ventral diameter 4.4 mm. The measurement of the greatest transverse diameter was unsatisfactory on account of the distortion by flattening in that region of the worm; this measurement is therefore regarded as considerably under what it would be in the perfect specimen.

Color.—The specimens were of a grayish olive-green color.

Form (figs. 103, 104).—The greatest dorso-ventral and tranverse diameters are in about the region of junction of the middle with the caudal third of the body. From this region it tapers gradually but considerably toward the oral pole, which appears relatively sharply pointed; a short length of the terminal portion is contracted into a small truncated cone. The aboral pole remains broad and thick and rounded, and may be considered as beveled at the expense of its ventral aspect, where it presents the terminal irregularly circular acetabular aperture. The longitudinal axis of the worm is moderately curved with its concavity ventrad.

Fig. 104.

The dorsum is arched both longitudinally and transversely, whereas the venter is concave longitudinally and convex from side to side; this convexity, however, is much less marked than that of the dorsum and in certain regions almost disappears. Transverse sections are in a general way elliptical in outline, but in the region where the transverse convexity of the venter almost disappears, the outline approaches that of a semicircle with rounded angles.

Fig. 105.

FIG. 106.

Surface.—The surface cuticle presents fine transverse striations, best marked near the oral extremity. There are also irregularities of the surface, which are probably due to irregularities in contraction in the process of fixing and in the preservation.

Genital pore.—On the ventral surface apparently slightly to the left of the median longitudinal line and at about one-eighth of the body length from the oral extremity is a small bulging, on the vertex of which may be noted a small (160μ) transversely elongate button-hole-like pore, the genital pore (figs. 104, 108). This pore leads into a relatively shallow chamber, which is almost entirely filled by a plump, slightly elevated, genital papilla which arises from what corresponds to the dorsal wall of the chamber. At the vertex of

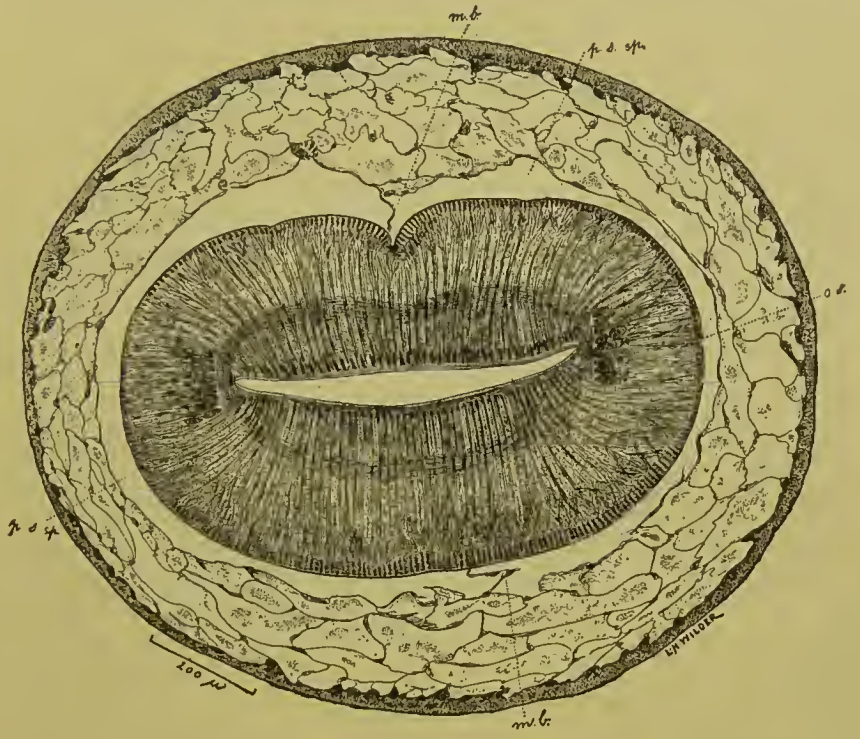


Fig. 107.

this papilla is an orifice, the porus hermaphroditicus, the external termination of the ductus hermaphroditicus.

Acetabulum.—This muscular organ is in the caudal portion of the body. On account of the curvature of the longitudinal axis of the worm its aperture is tilted slightly ventrad and gives the appearance of a ventral bevel to the caudal extremity of the worm. The dome of the acetabulum (measured in projection of one sectioned specimen) was about 3.75 mm. in vertical by about 3.25 mm. in transverse diameter with an aperture about 1.85 mm. in vertical by about 1.52 mm. in transverse diameter. The margin of the acetabular aperture is formed by the slightly projecting muscular rim of the acetabulum itself, a thin, closely applied layer of the body parenchyma extending to its margin but not overlapping it, so that the aperture

appears to have a narrow enclosing lip, which is readily discernible on the surface, where it is marked off from the general body surface by a shallow groove (figs. 104, 106, 112, 113).

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The cephalic extremity of the worm presents a transversely elliptical crateriform depression, the base of which presents the oral aperture. The latter leads directly into a muscular oral sucker. No papillæ were observed. The sucker is relatively small, measuring in projection about 0.96 mm. in length, with a maximum transverse diameter of 0.98 mm. and with a maximum dorso-ventral diameter (measured in median sagittal plane) of 0.52 mm. In both sagittal and frontal planes it is of an oval outline;

FIG. 108.

in transverse section it has the form of an ellipse with its major axis corresponding to the transverse diameter of the worm (fig. 107). The lumen of the sucker is a dorso-ventrally narrow, transversely broad space; in transverse section in the region of its equator the form of the lumen is somewhat that of a spindle. The body of the sucker is inclosed in a narrow perisuctorial space, in which it is retained in position by attachments at both its poles and by dorsal and ventral dorso-ventral strands. The lumen is lined by a thin, smooth, cuticle-like layer. The esophagus springs from the base of the sucker, passes directly caudad for about half its length, then bending slightly, passes dorso-caudad to divide into two lateral ceca at a point slightly nearer the dorsum than the venter and about one-fifth of the body length from the oral extremity. The length of the esophagus is

about three-fourths that of the sucker. Its anterior extremity is slightly caudad of the level of the genital pore. In the first half of its course the lumen of the esophagus maintains substantially a uniform diameter; in the second half, however, it dilates moderately but distinctly and with some abruptness. The esophagus is lined by a cuticle-like layer and is inclosed in a scant layer of sparsely scattered cells.

The intestines pass at first laterad from their point of origin from the esophagus, then, describing a curve, they pass directly caudad in fairly close proximity to the dorso-lateral aspect of the body. Their form in transverse section is very irregular and their caliber varies greatly at different levels. They terminate by cecal extremities dorsad of the acetabulum and slightly caudad of the center of the

Fig. 109.

aperture, or at a level somewhat caudad of the junction of the third with the caudal fourth of the body. They are lined by an epithelial cell layer.

Genital system.—With the exception of the vitellogene glands, the genital organs lie in the intercecal area.

Male organs.—The two testes are large irregular masses. One is a little to the right of the other and a little nearer the oral extremity, so that their zones and their fields overlap to a considerable extent (figs. 105, 106, 111). The testis from which the right vas efferens springs lies in the equatorial fifth of the worm and is a little to the right and at a slightly higher level than the testis from which the left vas efferens springs. The latter testis is therefore somewhat farther from the oral extremity and overlaps the left side of the caudal

portion of the ventral aspect of the right testis. Both testes are indented by deep fissures which mark off large lobes. A vas efferens emerges from the dorsal aspect of each testis. On account of the relative positions of the testes, the right vas is much the shorter. They at first pass more or less directly cephalad; then a little above the cephalic aspect of the right testis they pass transversely inward, forming an arch beneath which the uterus passes as they unite in the formation of the vas deferens. The first portion of the vas deferens is a relatively thin walled, long, intricately and compactly coiled vesicula, the lumen of which is dilated and filled with spermatozoa (figs. 105, 106, 110). It is succeeded by a relatively short, uncoiled, and almost straight pars musculosa (figs. 105, 106, 109). The change from one to the other is quite abrupt. The musculosa has a relatively small lumen and its walls, though more muscular and thicker than that of the vesicula, are not very greatly developed. Its direction is cephalo-ventrad.

Fig. 110.

At a point in a transverse plane slightly caudal of that of the base of the sucker this duct becomes inclosed in a mass of cells and its external layer of longitudinal muscle fibers becomes much thinned; this is the beginning of the pars prostatica. The pars prostatica (fig. 105) is both absolutely and relatively quite short and is succeeded by the ductus ejaculatorius. The ductus ejaculatorius is quite short, its walls more delicate than those of the prostatica, and the change from one to the other is marked by the disappearance of the prostatic cells. At the base of the genital papillæ the ductus ejaculatorius and the uterus unite to form the ductus hermaphroditicus which pierces the genital papilla and terminates at the vertex of the latter at the porus hermaphroditicus. The genital papilla and the wall of the genital atrium are inclosed in a sharply defined mass of muscular fibers (fig. 108).

Female organs.—The ovary lies in the caudal portion of the body, slightly caudad of the plane of junction of the third with the caudal fourth of the body, dorsad of the dome of the acetabulum, and a little to the right of the median sagittal plane. The oviduct springs from the caudo-mesial aspect of the ovary and passes transversely to the left toward the shell gland, near which it appears to fork into two ducts (fig. 113). The forking takes place in a transverse plane; one

of the forks is Laurer's canal, the other should be regarded as the continuation of the oviduct. The latter curves slightly cephalo-ventrad to penetrate the shell gland. Laurer's canal curves around the right latero-dorsal aspect of the shell gland to gain a position dorsad of the latter, then it passes cephalo-dorsad close to the left of the excretory vesicle and opens on the dorsum a little to the left of the median line at a point in a transverse plane slightly caudad of that of the cephalic aspect of the ovary and about 1.72 mm. (or about one-fifth of the total body length) caudad of the excretory pore. The shell gland is considerably smaller than the ovary and lies a little to the left of it and of the median sagittal plane.

On its mesio-caudal aspect the shell gland is penetrated by the oviduct and on its caudal aspect near its mesial margin by the

FIG. 111.

vitello-duct. These ducts unite almost at once to form the ootype. This fusiform canal pierces the shell gland obliquely cephalad and to the left, emerging from the left latero-cephalic aspect of the gland as the uterus. The uterus after emerging from the shell gland tends cephalad, curving around the dorsal aspect of the shell gland to gain the axial region of the worm. Here the uterus in its ascent cephalad describes intricate coils. It forms some loops in the space between the caudal portion of the left testis and the acetabulum, then doubles back passing underneath this testis somewhat obliquely to the left and turns cephalad in the space dorsad of this testis. It ascends in

this position in an almost straight course for a considerable distance before it again begins to form coils. These coils are in the intercecal space dorsad of the testes and at first ventrad of the excretory vesicle and duct, and later between the testes and dorsum. The coils are distended with very numerous oval, operculated eggs. As the level of the cephalic aspect of the right testis is approached, the coils tend cephalo-ventrad between the vasa efferentia and gradually gain the ventral aspect of the coiled vesicula, ascending cephalad in this relation for a short distance, after which the windings cease and the eggs disappear from its lumen. It now ascends in only a slightly wavy course close to the ventral aspect of the vas deferens to unite

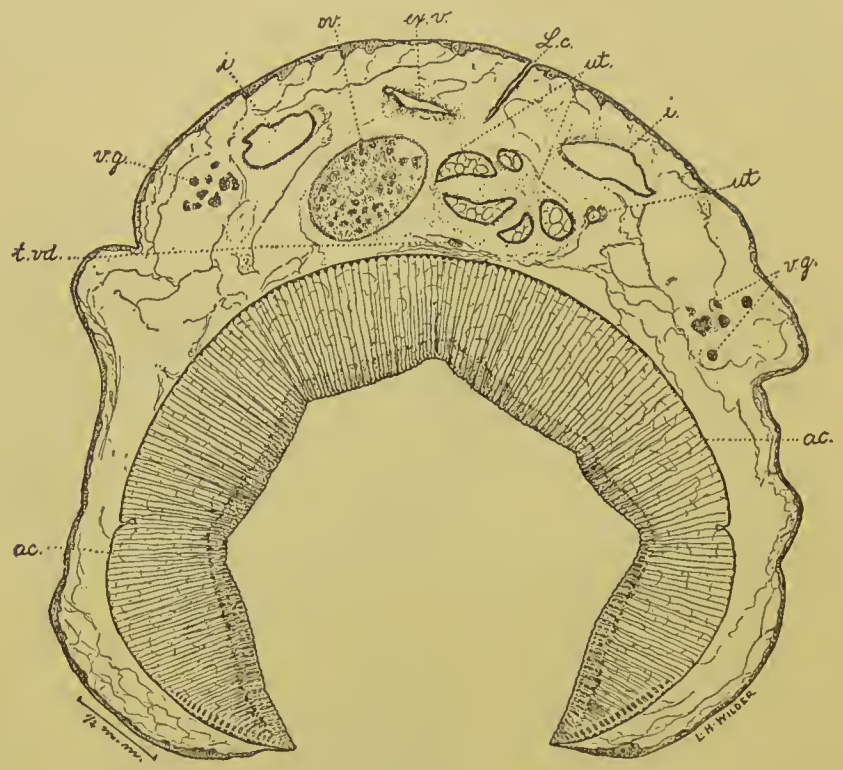


Fig. 112.

with the ductus ejaculatorius at the base of the genital papilla in the manner already described.

The vitellogene glands resemble those of *P. cervi*, but are not quite so highly developed. The follicles are large and prominent and occupy the extracecal areas, but extend along underneath the lateral margins toward both the ventral and dorsal median sagittal line, approaching closer, however, to the latter than to the former, and coming into relation with both ventral and dorsal aspects of the ceca. Vertically the glands extend from slightly above the level of the base of the sucker to about the level of the plane of the caudal margin of the shell gland. It will be observed, therefore, that in length they exceed that of the intestinal ceca; that is, they extend beyond the limits of the cecal zone.

A transverse vitello-duct leaves the caudal portion of each gland, passes obliquely caudo-mediad ventrally of the corresponding intestine to unite close to the dome of the acetabulum at a point in a transverse plane just above that of the cephalic aspect of the shell gland. Their union results in the formation of a common duct which passes caudo-dorsad, skirting the ventral and ventro-caudal aspect of the shell gland, finally to penetrate the latter at its caudal aspect as already described.

Eggs.—The eggs are operculated and very numerous. One of the eggs measured in section of the uterus was 120μ long by 67.5μ broad.

Excretory system.—The excretory vesicle is relatively small, being a rather long, and dorso-ventrally very narrow, almost slit-like

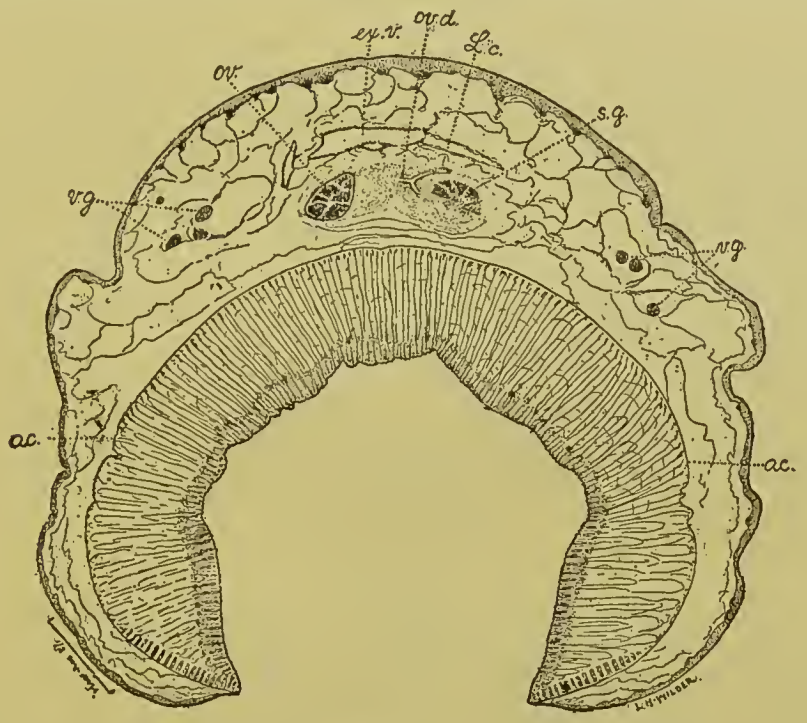


Fig. 113.

space. Its dome is in the caudal portion of the body about midway between the acetabulum and dorsum and about 1.48 mm. (or about one-sixth of the body length) from the caudal margin of the worm. From the dome the body of the vesicle extends cephalad, gradually coming nearer the dorsum as it ascends in the intercecal area. As it ascends also it gradually narrows in both transverse and dorso-ventral diameters until it becomes reduced to a cylindrical duct about 52μ in diameter and 240μ long, with thickened walls, which opens on the dorsum at about the level of the superior margin of the acetabulum, namely, about five-ninths of the total body length caudad of the oral margin, and, as already stated, about one-fifth the body length cephalad of the opening of Laurer's canal.

RELATION TO *P. explanatum* AS DESCRIBED BY FISCHŒDER.

Comparing our specimens with *P. explanatum*, as described by Fischœder, 1904, 454–458, figs. A, 1–3, the following differences are noticed: In *explanatum* the genital pore is immediately postbifurcal instead of suctorial; the ceca end at the cephalic margin of the acetabular aperture, instead of at the acetabular equator; excretory pore is equatorial, some distance cephalad of acetabulum, instead of on preacetabular plane; the excretory vesicle ends cephalad of acetabular equator instead of at its equator; the testes are distinctly farther cephalad, the anterior testis not reaching the acetabulum; the pars prostatica is longer instead of shorter than the pars musculosa; the ovary is at the anterior margin, instead of at the equator of acetabulum, and is distinctly and entirely in the intercecal area instead of at and caudad of end of ceca; Laurer's canal is distinctly preacetabular instead of at the equator of the acetabulum.

These differences would appear to indicate that we are dealing either with a distinct species, or a distinct subspecies, or with a rather marked case of individual variation; they are certainly more marked than the characters now being used to distinguish between some species of distomes. As it is easier to suppress a synonym than it is to disentangle anatomical and biological data of separate forms confused in one alleged species, we incline to the view (contrary to most authors) that in case of doubt the more conservative action consists in proposing a new species, hence we publish this form as such.

ILLUSTRATIONS.

FIG. 103.—Profile view. Enlarged. Original.

FIG. 104.—Ventral view of same. Enlarged. Original.

FIG. 105.—Profile projection of specimen shown in figs. 103 and 104. Shows oral sucker (*o. s.*), esophagus (*es.*), right intestinal cecum (*i.*), genital pore (*g. p.*), ductus hermaphroditicus (*d. h.*), pars prostatica (*p. p.*), pars musculosa (*p. m.*), vesicula seminalis (*v. s.*), right vas efferens (*v. e.*), right (*t. d.*) and left (*t. s.*) testis, ovary (*ov.*), shell gland (*s. g.*), uterus (*ut.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), and acetabulum (*ac.*); *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 106.—Frontal projection of specimen shown in figs. 103 and 104. Shows oral sucker (*o. s.*), esophagus (*es.*), intestinal ceca (*i.*), ovary (*ov.*), shell gland (*s. g.*), uterus (*ut.*), the right (*t. d.*) and left (*t. s.*) testis; the vasa efferentia (*v. e.*), vesicula seminalis (*v. s.*), and pars musculosa (*p. m.*), position of genital pore (*g. p.*), and the acetabulum (*ac.*); *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 107.—Transverse section at *a–a*, figs. 105 and 106. Shows form of body, form of oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and dorsal and ventral mesenterium-like strands (*m. b.*). Enlarged. Original.

FIG. 108.—Transverse section at *b–b*, figs. 105 and 106. Shows genital atrium (*g. a.*), genital papilla (*g. pap.*), oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and some vitelline follicles (*v. g.*). Enlarged. Original.

FIG. 109.—Transverse section at *c–c*, figs. 105 and 106. Shows pars musculosa (*p. m.*), uterus (*ut.*), esophagus (*es.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 110.—Transverse section at *d–d*, figs. 105 and 106. Shows position and relations of uterus (*ut.*), vesicula seminalis (*v. s.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 111.—Transverse section at *e–e*, figs. 105 and 106. Shows position and relations of the testes (*t.*), left vas efferens (*v. e.*), uterus (*ut.*), intestines (*i.*), superior margin of acetabulum (*ac.*), the excretory pore (*ex. p.*), and the vitellaria (*v. g.*). Enlarged. Original.

FIG. 112.—Transverse section at *f–f*, figs. 105 and 106. Shows positions and relations of ovary (*ov.*), uterus (*ut.*), excretory vesicle (*ex. v.*), Laurer's canal (*L. c.*), intestines (*i.*), vitellaria (*v. g.*), right transverse vitello-duct (*t. vd.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 113.—Transverse section at *g–g*, figs. 105 and 106. Shows origin of Laurer's canal (*L. c.*) from oviduct (*ov. d.*), the ovary (*ov.*), shell gland (*s. g.*), excretory vesicle (*ex. v.*), vitellaria (*v. g.*), and acetabulum (*ac.*). Enlarged. Original.

PARAMPHISTOMUM PARVIPAPILLATUM, new species.

[Figs. 114 to 122.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73); Body 3.1 to 3.9 mm. long by 1.8 to 2.3 mm. broad; buff color (alcohol specimens); rather oval, longitudinal outlines of lateral margins nearly straight; tapers very gradually; cephalic extremity slightly less bluntly rounded than caudal extremity; surface smooth. Genital pore postbifurcal, about one-fourth of body length from oral margin. Acetabulum subterminal, aperture about 0.5 to 0.6 mm. in diameter. Mouth terminal to ventro-subterminal (distortion?); oral sucker rather pyriform to oval; esophagus bulbous, short (?), about as long (?) as sucker, bifurcation about midway between oral margin and genital pore; ceca wavy, long, extending to or slightly caudal of equator of acetabulum. Excretory pore dorso-median, a little caudad of pore of Laurer's canal, dorsal of equator of acetabulum and not crossed by Laurer's canal; excretory vesicle dorsal of acetabulum.

Male organs: Testes occupy greater part of median field from equator to acetabulum; one caudad of the other; of irregular outline (in part artifact?); vasa efferentia unite in vas deferens; vesicula seminalis convoluted; pars musculosa short; pars prostatica short, but well developed; ductus ejaculatorius exceedingly short, unites with metraterm to form ductus hermaphroditicus, which opens on vertex of genital papilla; the latter is surrounded by an atrium into which projects a circular ridge bearing numerous

exceedingly minute papillæ which also extend over on to the genital papilla; cirrus pouch absent.

Female organs: Ovary median but extending more to the left than to the right, near dorsum, immediately caudad of caudal testis and on a plane of upper margin of acetabulum; shell gland on ventro-caudal aspect of ovary; vitellaria highly developed, close to lateral margins, lateral, dorsal, and ventral of ceca, extend about from base of sucker to or slightly beyond equator of acetabulum; uterus passes from ventrally of shell gland and ovary, dorsad between ovary and caudal testis, cephalad dorsally of testes, ventrad under arch of vasa efferentia, cephalad to ductus hermaphroditicus; it is coiled, and filled with a fairly large number of eggs; Laurer's canal passes from oviduct dorso-medio-cephalad and opens in median line.

Eggs: Numerous, oval, about 135 by 67μ.

Type.—U.S.P.H.& M.-H.S. 9962.

Habitat.—Reticulum of "calf" (*Bos indicus* var.) at Phrapatoom, Siam.

Source of material.—This material was sent to us by Dr. Paul G. Woolley, who collected it in Phrapatoom, Siam, on September 22, 1906, from the reticulum of a calf (*Bos indicus* var.).

EXTERNAL CHARACTERS.

Size.—The specimens vary from 3.1 mm. to 3.9 mm. in length and from 1.8 to 2.3 mm. in maximum breadth.

Color.—Alcohol specimens are of a buff color.

Form.—In the process of fixing and in the course of preservation the specimens appear to have undergone considerable distortion, so that from the material at hand it is difficult to more than suggest very roughly their original form (fig. 114). They are oval in outline, with lateral margins approximately parallel in the equatorial region and with extremities that are bluntly rounded. The dorsal (and perhaps also the ventral) surface is probably arched in the fresh state, but in our specimens they are marked by ridges and depressions due probably to the shrinking influence of the fixing and hardening solutions.

Surface.—The general surface is smooth, except for an indication of transverse wrinkles or striations. No surface papillæ are evident. The cephalic extremity is marked by the presence of a more or less circular oral aperture, and the caudal by the presence on its ventral aspect of a large subterminal acetabulum, distorted in form in most of the specimens in such a manner as to make its aperture longitudinally elliptical in outline, though one or two retained what is probably their normal circular form.

Genital pore.—The genital pore is ventro-median (figs. 114, 115, 119, 120) on a somewhat flattened rounded elevation or bulging about one-fourth the body length from the cephalic end and caudad of the bifurcation of the esophagus.

Acetabulum.—The acetabulum is distinctly subterminal in all specimens. It varies considerably in respect to form, position, and aperture, these variations being largely due, in all probability, to the

distorted condition of the body. Two specimens presented circular apertures 0.5 to 0.6 mm. in diameter; four specimens presented more or less elliptical apertures, varying from 0.6 to 0.7 mm. in longitudinal and 0.17 to 0.4 mm. in transverse diameter. The rim of the acetabulum appears to project beyond the body parenchyma in a manner very like that in *Pseudodiscus collinsii*, and there is a strong suggestion of a ring around the aperture similar to that which occurs in *Ps. stanleyii* and *Ps. collinsii*. As a matter of fact, however, the apparently projecting ring is covered by a thin layer of parenchyma. The deep narrow groove which marks off this ring in *Ps. stanleyii* and *Ps. collinsii*, while strongly suggested, is not so clearly recognizable in this species (figs. 116, 122). The dome of the acetabulum measures about 126μ to 135μ in thickness.

FIG. 114.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The more or less circular oral aperture gives entrance directly into a somewhat pyriform muscular oral sucker (fig. 116). In transverse section (fig. 117) the latter is elliptical in form, with its major axis in the transverse diameter of the body. Its lumen is a dorso-ventrally more or less narrow, transversely fairly broad space. It is lined by a thin cuticle-like layer which appears to have disappeared from some portions of the lumen, and bears some conical papillæ of moderate size on its surface. The sucker lies in a perisuctorial space (figs. 116, 117) suggestive of a rudimentary body cavity. Dorsally of its esophageal extremity there is a transverse ganglionic cord (fig. 115). The sucker is succeeded by the esophagus. From our preparations it is impossible to determine satisfactorily its length; it is estimated, however, that it is not shorter than the sucker. It passes at first for a short distance caudad, then bends abruptly and passes almost directly dorsad, but with an inclination caudad (fig. 118), terminates, and gives origin laterally to the intestinal ceca.

FIG. 115.

The esophagus has somewhat the form of an Indian club; its caudal half becoming, rather abruptly, very much swollen by a very great increase in thickness in its muscular layer (figs. 115, 118). The intestines, from their point of origin, pass at first in a nearly horizontally transverse plane laterad, describing in this part of their course a gentle curve nearly parallel to the dorsum. They then, rather abruptly, bend caudad and pursue a wavy path approximately parallel to the dorso-lateral aspect of the worm, terminating by blind extremities in slightly different planes at about the level of the equator of the acetabulum.

Fig. 116.

The lining of the lumen of the mouth, sucker, and esophagus appears to be a thin cuticle in anatomical continuation with that of the body surface. With the termination of the esophagus at its point of division into the intestinal ceca the cuticular lining ceases and is replaced in the intestinal ceca by a layer of epithelial cells.

Genital system.— *Male organs*.—The testes occupy almost all of the interspace between the intestinal ceca from the equator (or a little anterior of this) to the acetabulum. They are placed one directly caudad of the other, with but a slight interval between. Their form is very irregular (figs. 115, 116, 121), a result, perhaps, of the shrinking and distortion of the worm as a whole, but their surface is but little indented. A vas efferens rises from each testis; that from the posterior springs apparently from the superior aspect of its right extremity and passes cephalad between the anterior testis and the right intestine; that from the anterior testis springs from its dorsal aspect, passes cephalo-centrad to unite with the left vas to form a vas deferens. The vas deferens consists of:

Fig. 117.

a well-developed thin-walled vesicula, which is very much coiled; a short but well-developed pars musculosa; a short but very well-defined prostatica; and a terminal excessively short ductus ejaculatorius. The latter unites with the metraterm to form a ductus hermaphroditicus. The ductus hermaphroditicus pierces the axial region of a well-developed truncated conical genital papilla. The genital papilla (figs. 115, 119, 120) projects into an atrium, which it almost fills. Embracing the genital papilla is a ring-like collar, the surface of which is beset by excessively minute papillæ (hence *parvipapillatum*), which also extend to some extent over the base of the genital papilla. External to the ring-like collar and marked off from it by a groove is another ring. This latter ring almost disappears in some positions of extrusion of the copulatory apparatus, forming a shallow crater, in the center of which is the genital pore.

Female organs.—The ovary lies in the median line (fig. 121), close under the dorsum just caudad of the posterior testis, and at the level of the upper margin of the acetabulum. It appears somewhat elongated in the transverse diameter and compressed dorso-ventrally, hence somewhat pyriform, and extends somewhat more to the left than to the right of the median line. The point of origin of the oviduct was from the right extremity in one preparation and from the left in another; from its point of origin the oviduct passes to the opposing aspect of the shell gland. The latter lies close to the ventral aspect and lower margin of the ovary. The relation of the shell gland to the ovary varies somewhat in the different specimens studied. It is penetrated by the oviduct, which is then joined by the vitello-duct, after which the duct thus formed dilates somewhat to form the ootype; the latter is continued and emerges from the shell gland as the uterus. After emerging, the uterus passes at first caudad for a short distance, then turns, forms a loop, and passes cephalad in front of the shell gland and ovary, dorsad between the posterior testis and ovary, then cephalad between the testes and dorsum of the worm. In its progress it forms coils which are distended with eggs. At the level of the cephalic aspect of the anterior testis it takes a course ventrad beneath the arch of union of the vasa efferentia and penetrates the base of the genital papilla in company

FIG. 118.

with the terminal portion of the vas deferens, with which it opens into the ductus hermaphroditicus.

The yolk glands are highly developed. They consist of numerous closely aggregated follicles in the lateral portion of the body close to the lateral margins. They inclose dorsally, ventrally, and laterally the corresponding intestinal cecum. The gland of the left side extends somewhat farther toward the median line than that of the right side, so that it comes into relation with the dorsal and the ventral aspects of the left ends of both testes. The glands extend, longi-

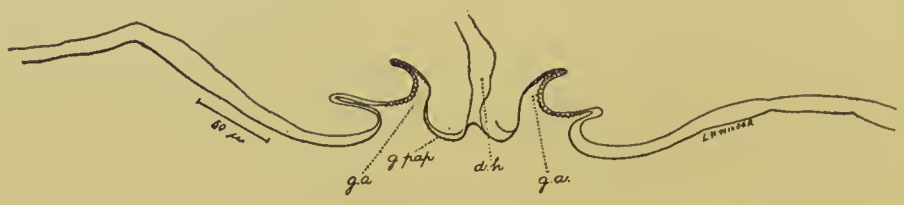


FIG. 119.

tudinally, from the termination of the sucker to about the equator of the acetabulum (or slightly caudad of the level of termination of the intestinal ceca). A little above the level of the caudal termination of the yolk glands the duct of either side is given off and passes toward the middle line, ventrally of the corresponding intestinal tube, to unite with the duct of the opposite side; by the union of these a duct is formed which passes dorsad toward the shell gland, which it penetrates on its caudal aspect to join the oviduct.

Laurer's canal leaves the oviduct about where the latter is on the point of penetrating the shell gland and passes dorso-mediad and very

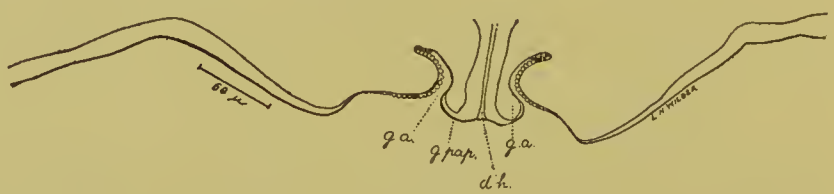


FIG. 120.

slightly cephalad to open on the dorsal surface about in the median line (fig. 122).

Eggs.—The eggs are numerous, oval in form, and as seen in the uterus they measure about 135μ by about 67μ.

EXCRETORY SYSTEM.—The excretory vesicle lies in the caudal portion of the body behind (dorsad of) the acetabulum. In the specimens studied it appears collapsed. From its caudo-dorsal aspect a short thick-walled duct passes dorsad to discharge through the excretory pore in the median line in a plane a little caudad of the opening of Laurer's canal and near the caudal extremity of the body. It is not crossed by Laurer's canal.

FIG. 114.—Ventral aspect: *ac.*, acetabulum; *g. p.*, genital pore; *m*, mouth. Enlarged. Original.

FIG. 115.—Sagittal section. Shows portion of oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*) containing granular coagulum, caudal

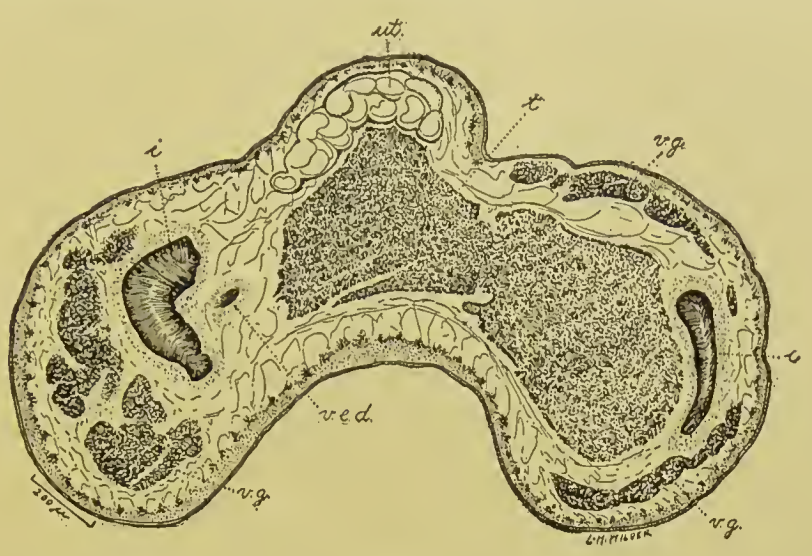


FIG. 121.

portion of esophagus (*es.*), left intestinal cecum (*i.*), esophageal ganglion (*e. g.*), genital papilla (*g. pap.*), ductus hermaphroditicus (*d. h.*), pars prostatica (*p. p.*), vesicula seminalis (*v. s.*) distended

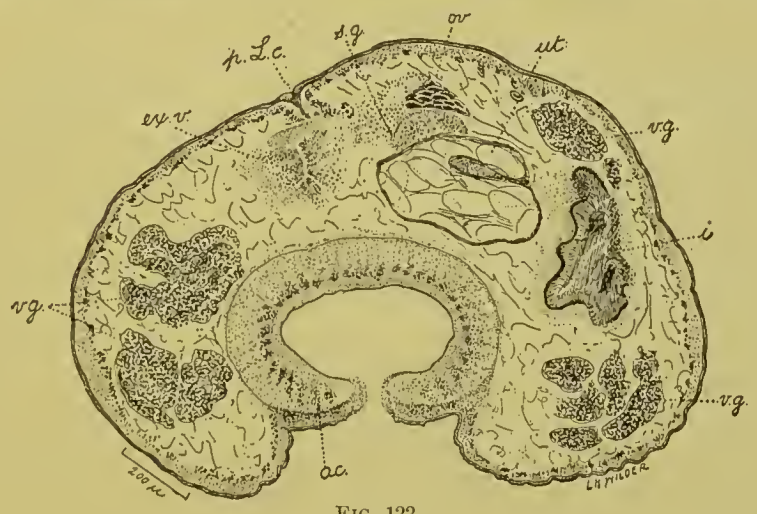


FIG. 122.

with spermatozoa, metraterm (*va.*), uterus (*ut.*) distended with eggs, testes (*t.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 116.—Sagittal section. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*) with granular coagulum, left intestinal cecum (*i.*), the two testes (*t.*), left vas efferens (*v. e. s.*), uterus (*ut.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 117.—Transverse section. Shows oral sucker (*o. s.*) and perisuctorial space (*p. s. sp.*) filled with a granular coagulum. Enlarged. Original.

FIG. 118.—Transverse section. Shows bulbous portion of esophagus (*es.*), right intestine (*i.*), vitellogene gland (*v. g.*). Enlarged. Original.

FIG. 119.—Transverse section of copulatory apparatus. Shows genital papilla (*g. pap.*), ductus hermaphroditicus (*d. h.*), genital atrium (*g. a.*), and minute papillæ on ring-like collar and base of genital papilla. Enlarged. Original.

FIG. 120.—Transverse section through copulatory apparatus to contrast with figure 119. Shows form of genital papilla (*g. pap.*) encircling papillated ring, slit-like dorsal chamber (*g. a.*), (*d. h.*) and shallow crater-like depression (ventral chamber) at vertex of genital bulging due to retraction of outer ring. Enlarged. Original.

FIG. 121.—Transverse section. Shows superior testis (*t.*), right vas efferens (*v. e. d.*), intestines (*i.*), and vitellaria (*v. g.*) and uterus (*ut.*) filled with eggs. Enlarged. Original.

FIG. 122.—Transverse section at level of pore of Laurer's canal. Shows pore of Laurer's canal (*p. L. c.*), caudal margin of ovary (*ov.*), caudal margin of shell gland (*s. g.*), uterus (*ut.*), excretory vesicle (*ex. v.*), left intestinal cecum (*i.*), vitellaria (*v. g.*) and acetabulum (*ac.*) with an apparent though not actual projecting rim. Enlarged. Original.

PARAMPHISTOMUM SHIPLEYI, new species.

[Figs. 123 to 130.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body apparently somewhere between 4.5 and 7 mm. long by 2.46 mm. broad by 2.26 mm. thick; color (?); greatest breadth about at junction of equatorial and caudal thirds; tapers toward bluntly pointed oral pole, diameters at genital pore 2 mm. (transverse) and 1.98 mm (dorso-ventral). Surface with minute papillæ on oral pole. Genital pore ventro-median, about 75μ in diameter, about at junction of cephalic and equatorial thirds, very slightly postesophageal and postbifurcal, in cecal zone; at this point there is an ill-defined slightly bulging area. Acetabulum ventrosubterminal; very slightly sunken below surface, 1.15 mm. in transverse, 1.95 mm. (?) in dorso-ventral diameter, aperture about 0.39 mm. Mouth nearly terminal, with ventrosubterminal tendency, in papillated depression; oral sucker rather large, pyriform, but somewhat flattened dorso-ventrally, its oral pole projecting slightly, its lumen papillate; lies in a well defined pseudobody-cavity; esophagus acutely bent, convexity ventrad, caudal half with greatly thickened muscular wall; ceca of very irregular diameter, wavy, extend about to equator of acetabulum. Excretory pore dorso-median, caudad of Laurer's canal, somewhat caudad of equator of acetabulum; thick walled excretory canal runs from pore slightly caudo-ventrad to dorso-caudal aspect of well-developed excretory vesicle, which lies dorsad of acetabulum, extending from near anterior plane of acetabulum to caudal acetabular plane.

Male organs.—Testes large, lobate, one ventro-caudad of the other, fields nearly coincide, zones overlap, nearer venter than dorsum; vasa efferentia run cephalad at side of testes, their point of union is undetermined; vas deferens composed of: (1) coiled vesicula seminalis, which lies dorsally of (2) a pars intermedia and (3) the

highly developed coiled pars musculosa, (4) pars prostatica straight, relatively short, but well developed, and separated from musculosa by a sphincter-like constriction; (5) thick walled ductus ejaculatorius; the latter opens into a slit-like space into which metraterm also discharges; from here a short duct passes ventrad to another slit-like atrium; from the latter a duct passes ventrad to open into a small atrium which opens to the exterior through the genital pore; this series of atria and canals is inclosed in a mesh of muscular fibers.

Female organs.—Ovary and shell gland dorso-caudal of and very much smaller than caudal testis, dorsal of cephalic portion of acetabulum, slightly dextral of median line; shell gland ventro-lateral of ovary; vitellaria with well developed, not numerous follicles, in extracecal areas, extend from slightly preesophageal zone to caudal end of cecal zone; uterus extends slightly caudad then cephalad, dorsally of testes, ventrally of the greater mass of pars musculosa, to open into same slit as does ductus ejaculatorius.

Eggs.—Oval, 135 by 71μ, operculated at smaller pole.

Type.—U.S.P.H. & M.H.S. No. 10717 (returned to Shipley).

Habitat.—In (? stomach of) *Cervus eldi*, locality (?).

Source of material.—The material, consisting of a series of transverse sections of one specimen, was loaned to us by Dr. A. E. Shipley. Host.—*Cervus eldi* (?), stomach.

EXTERNAL CHARACTERS.

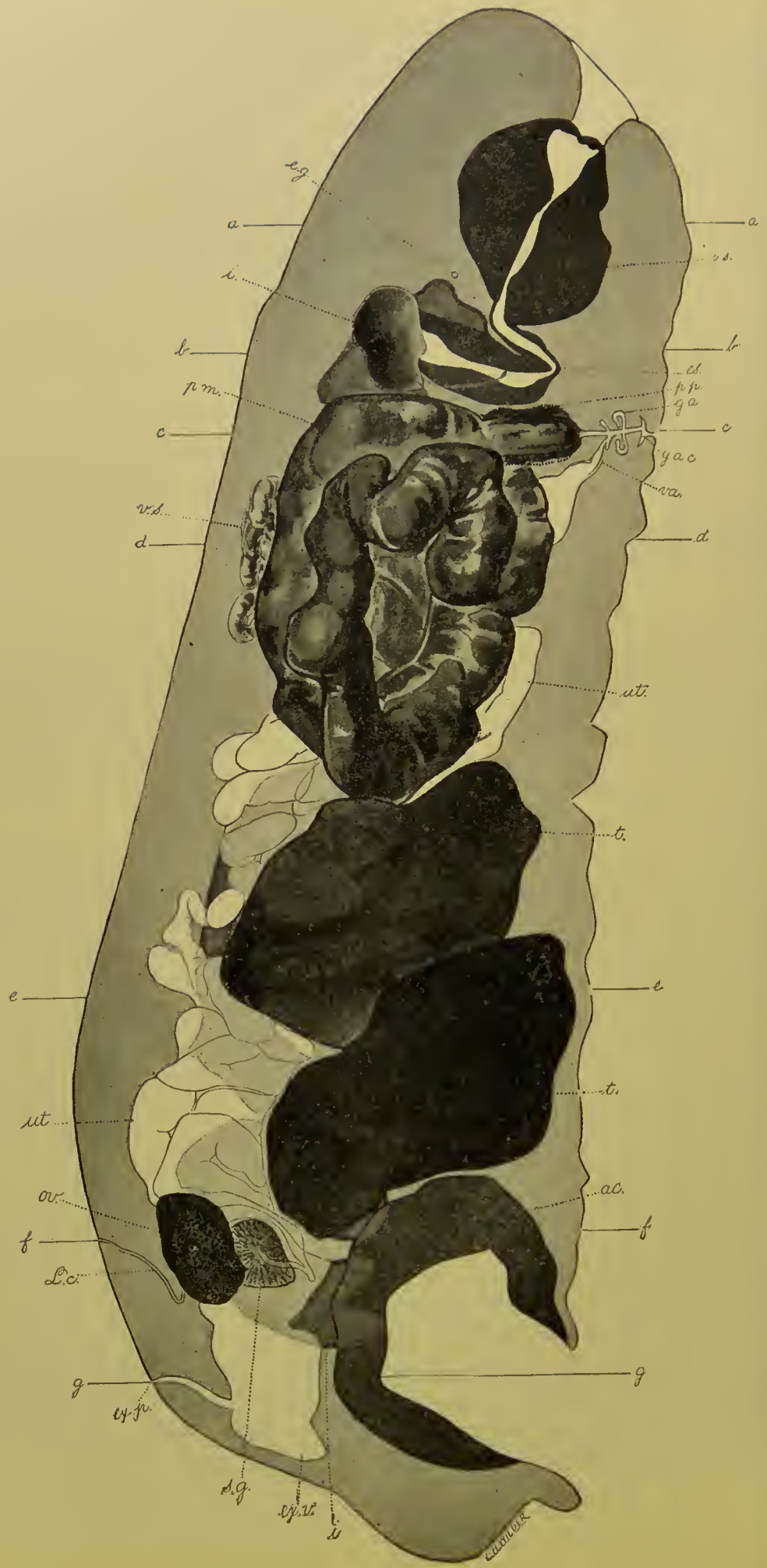
Size.—The specimen came to us already sectioned. We do not know the thickness of the individual sections, so can not do more than roughly estimate the length of the worm. It is probably not less than 4.5 mm. nor more than 7 mm. long, with a maximum dorso-ventral diameter of about 2.26 mm. and a maximum transverse diameter about 2.46 mm. as measured in sections.

Form.—The worm is broadest and thickest in the regions of junction of the middle with the caudal thirds of the body length. From this region the body tapers toward the oral pole, which is bluntly pointed and at about the level of the genital pore, measures about 2 mm. in width and about 1.98 mm. in dorso-ventral diameter.

Surface.—The surface cuticle is unprovided with hooks or spines, but minute papillæ could be made out at the oral pole.

Genital pore.—In the ventro-median line, about at the junction of the first with the middle third of the body length, is a small orifice about 75μ in transverse diameter, the genital pore. This is in the center of a circular, ill-defined, slightly bulging area.

Acetabulum.—The acetabulum is in the caudal portion of the body with, probably, a terminal (or subterminal) aperture, though this is shown as ventro-subterminal in the diagram (fig. 123). At the level of the excretory pore the acetabulum measures about 1.15 mm. in transverse diameter with an aperture of about 0.39 mm. in the same diameter. The rim of the acetabulum, although it does not project beyond the embrace of the body parenchyma, is covered only by a relatively thin layer of it for a distance of about 255μ (fig. 130) from


c.g.
a
a
v.s.
i.
o
b
b
cl.
p.p.
g.a
pm.
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y.a.c
v.a.
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d
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e
t.
ut
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f
L.c.
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g
v.p.
s.g.
v.v.
v

Fig. 123.

the margin of the aperture. Judging from the appearance of this in section, the unsectioned specimen probably presents corresponding to it a collar-like area immediately around the acetabular aperture delimited from the general surface by a shallow, more or less well-defined groove, somewhat like but not so well defined as that in *P. siamense*.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The mouth is at the bottom of a circumscribed depressed area at the vertex of the cephalic extremity. It is an irregular orifice which leads directly into the lumen of a well-developed sucker. The crater-like depression of the surface is beset with digitate papillæ. In form the sucker is pyriform though somewhat flattened dorso-ventrally. Its caudal pole is broad and rounded and gives origin to the esophagus; its oral pole projects in an irregular ring-like manner beyond the parenchyma and its aperture is the mouth. The sucker is placed in a well-marked perisuctorial space (fig. 124), which is traversed dorsally and ventrally by mesenterium-like strands. The suctorial wall may be regarded as consisting of a ventral and of a dorsal muscular plate, the two, however, being continuous laterally. The muscular fibers form a dense inner and a looser meshed and relatively thicker outer zone, as seen in transverse section. The lumen is a dorso-ventrally narrow, transversely broad space which caudally becomes reduced to a small circular aperture leading into the esophagus. It is lined by a thin cuticle which is beset by small hemispherical to conical papillæ. These are more numerous and larger near the oral pole. Close to the dorso-caudal aspect of the sucker, slightly above the level of the origin of the esophagus and just without the perisuctorial space, there is a well-defined transverse nerve trunk (fig. 123) which gives off branches cephalad and caudad; these, however, can not be traced satisfactorily.

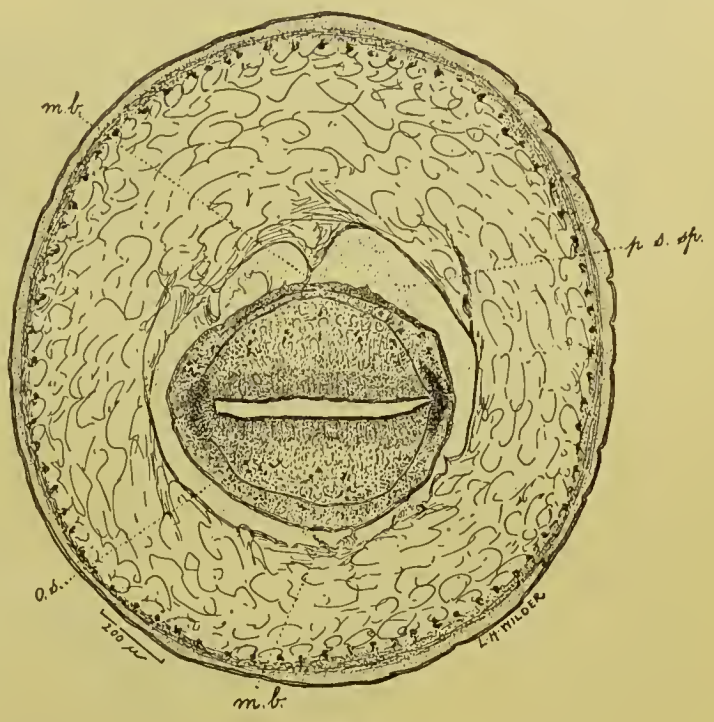

FIG. 124.

The esophagus passes at first ventro-caudad for approximately half its length, then, bending acutely, it turns dorsad, with a slight tilt cephalad, to fork into the lateral ceca at a point in a transverse plane slightly caudad of that of the base of the sucker and a little cephalad of that of the genital pore, and about or slightly more than one-third of the dorso-ventral diameter of the worm at that level from the dorsum. The muscular wall of this second portion of the esophagus is very greatly increased in thickness; the increase begins at about the point where the esophagus bends, and it augments progressively almost but apparently not quite to its caudal end. The esophageal lumen is lined by a fairly thick cuticle-like layer.

FIG. 125.

The intestinal ceca pass at first for a short distance laterad, then curve ventro-laterad, at the same time tilting caudad until they reach a point in a frontal plane somewhat dorsad of that of the bend or knee of the esophagus. Here each intestine rather abruptly curves dorsad and proceeds in this spirally, wavy course caudad until it reaches about the level of the cephalic margin of the acetabular aperture, where each intestine terminates by a cecal extremity.

The diameter of the gut varies at different points in its course, there being marked dilatations (fig. 126) succeeded by equally marked constrictions (fig. 127). The lumen of the ceca is lined by an epithelial cell layer.

GENITAL SYSTEM.—The sexual organs, with the exception of the vitellogene glands, are disposed in the intercecal area.

Male organs.—There are two large lobate testes, one of which is caudad of the other; the cephalic portion of the caudally placed testis overlaps the right ventro-lateral aspect of the caudal portion of the cephalically placed testis. They are nearer the venter than the dorsum in a zone which exceeds somewhat in vertical diameter one-fourth the body length, in other words, comprising the third and to some extent the fourth quarter of the body. Each testis gives origin to a vas efferens, that of the caudal testis passes to the left and that of the cephalic to the right, and then each proceeds cephalad. The left vas efferens (from the caudal testis) ascends at first close to the left lateral aspect of the cephalic testis (between it and the intestine) and later,

Fig. 126.

as it tends dorso-cephalad, it skirts the left lateral aspect of the coiled pars musculosa, eventually entering the coil complex of the vesicula, which is presumably formed by its union with the right vas; but this point can not be satisfactorily traced in the complexity of the coils. The course of the right vas (from the superior testis) is similar to that of the left, but is of course much shorter, and almost at once after its origin it begins to skirt the left lateral aspect of the coiled pars musculosa, eventually entering and becoming indistinguishable among the coils of the vesicula. The vesicula forms an easily distinguishable thin-walled coil complex placed close to the dorsal aspect of the coil formed by the pars musculosa. The latter is the second portion of the vas deferens, but there is intercalated, between the vesicula and

the musculosa, a short, relatively thick-walled narrow duct, which has been noted in some of the other forms and named the pars intermedia. The pars musculosa (fig. 127) is highly developed, thick, muscular walled, and very much coiled; measurements at favorable points give a diameter of about 225μ to 300μ, with a thickness of wall of about 45μ to 60μ. The caliber of the lumen of this part of the vas deferens considerably exceeds that of the vesicula. The musculosa is succeeded by a relatively short (420μ) but well-developed prostatica, a sphincter-like constriction marking the transition from one to the other. The prostatic cells are well developed and form a thick, encircling layer about the duct, the diameter of which is decidedly reduced

FIG. 127.

as compared with that of the musculosa, and its wall is much thinner than that of the latter. The pars prostatica is straight and passes almost directly ventrad. In its turn the prostatica is succeeded by a thick-walled duct about 75μ in diameter and about 120μ long; this may perhaps be regarded as the ductus ejaculatorius. The ductus ejaculatorius is directed ventrad and opens with, but separate from, and just above the uterus, into a small narrow slit-like space. From this space a short duct passes ventrad and may be regarded as piercing the axial region of a mushroom-like structure (figs. 123, 126) to open into another slit-like atrium somewhat larger, however, than the one into which the male and female ducts open. A duct about 30μ in diameter leads from this atrium and apparently pierces a stout conical

papilla, which may be regarded as the genital papilla, to open into a small genital atrium which connects with the exterior by the genital pore. The series of atria and ducts connecting them, between the termination of the ductus ejaculatorius and the genital pore, which may be regarded as forming the hermaphroditic copulatory apparatus, is inclosed in a cylindrical mesh of muscular fibers, which do not, however, form such a well-defined structure as is described, for example, in *Watsonius watsoni* or *Paramphist. crassum*.

Female organs.—The ovary and the shell gland, the latter close to the right ventro-lateral aspect of the former, are in the caudal portion of the intercecal space, caudo-dorsad of the caudal testis, dorsad of the cephalic portion of the acetabulum, and immediately to the right of

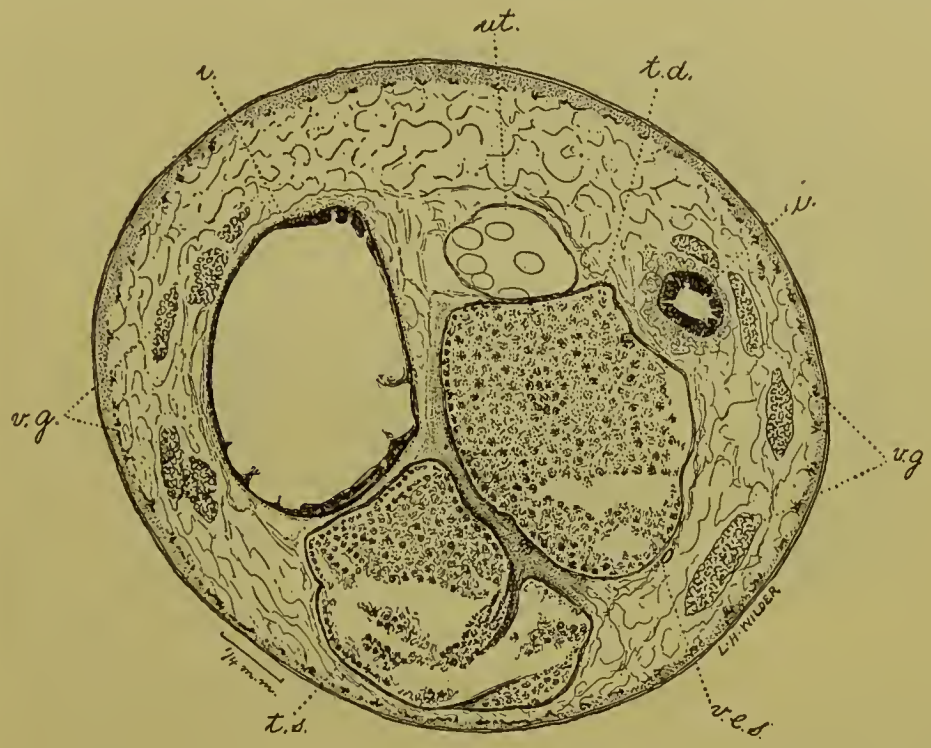

FIG. 128.

the median sagittal plane and the dome of the excretory vesicle. The ovary is the larger of the two glands. The oviduct takes origin from the left lateral aspect of the ovary, and at first, for a short distance, passes to the left, then again, for a short distance, it curves cephalad and to the right, after which it proceeds obliquely ventrad and to the right with a very slight tilt cephalad toward the shell gland, at the same time giving origin to Laurer's canal. This occurs in about the same transverse plane as the one in which the uterus is seen to emerge from the shell gland. The oviduct penetrates the left pole of the shell gland, in the substance of which it is joined by the common vitello-duct, the two uniting to form the ootype. The latter is directed obliquely to the right and ventro-caudad and is continued as the uterus. Laurer's canal, after parting from the oviduct, passes at

first directly caudad then with a tilt to the left and dorsad to a point slightly caudad of the level of origin of the oviduct, where it bends and passes cephalo-dorsad to open on the dorsum in about the median sagittal line at a point in a transverse plane slightly caudad of those of the cephalic margins of the ovary and the acetabulum and in about the plane of the caudal margin of the caudal testis (fig. 129).

The shell gland lies close to the right ventro-lateral aspect of the ovary; its major axis is directed obliquely from the left to the right and ventro-caudad. As already stated, it is penetrated at the left pole by the oviduct; at its left latero-cephalic aspect, it is penetrated by the common vitello-duct, the two uniting in the ootype. The uterus, which is the continuation of the ootype, emerges from the right pole

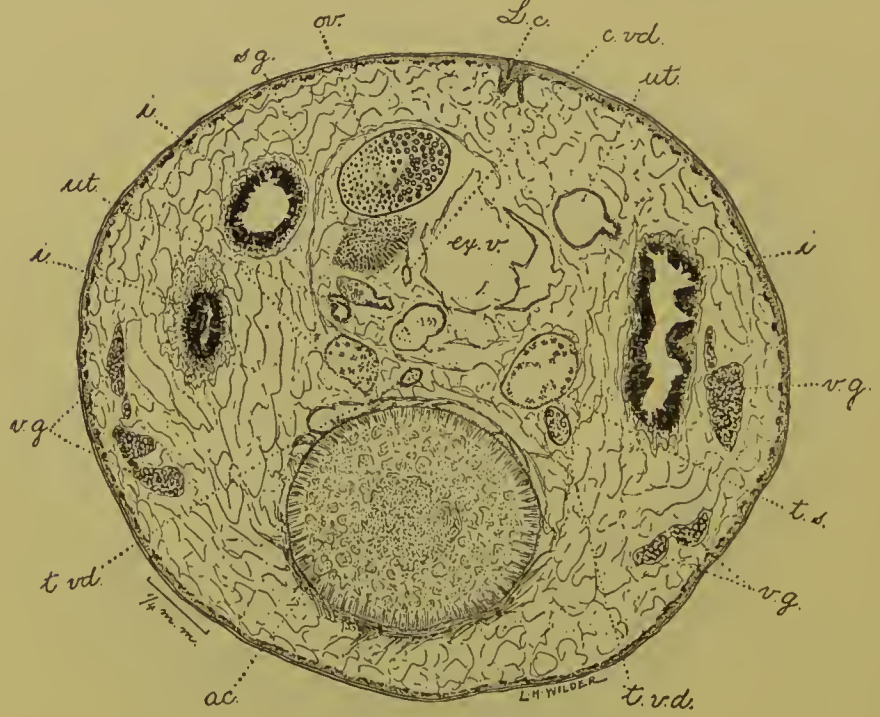

FIG. 129.

of the gland and turns to the left and cephalad. It forms some coils ventrally and to the left of the shell gland and ovary, then skirts the right and dorsal aspects of the dome of the excretory vesicle to reach the left dorso-lateral aspect of the dome of this vesicle. Here, in the area between the vesicle and the left intestine, it dips caudad for a short distance, then doubles sharply cephalad to begin its ascent. It forms winding ascending coils in the intercecal space between the dorsum and the testicles. At the level of the cephalic margin of the superior (cephalic) testicle, the uterus passes ventrad, skirting the caudal aspect of the coiled vas deferens, after having first, however, ascended a short distance between this coil and the dorsum. On reaching the ventral aspect of the coil, it ascends in close relation to it and with only slight and few windings which eventually cease altogether. It finally comes in close relation to the caudal aspect of the

ejaculatory duct, opening, as has already been stated, immediately caudad of the latter into a small slit-like chamber. The first portion of the uterus contains a considerable number of yolk cells; the coils which are between the testicles and the dorsum are distended to a variable degree with eggs, among which in the more proximal coils may also be seen some clumps of spermatozoa. The eggs are oval in form with a small operculum at the more pointed end and measure about 135μ by 71μ.

The vitellogene glands, consisting of well-developed but not numerous follicles, are disposed in the extra-cecal areas (between the intestine and lateral body wall), extending vertically from a little cephalad of the level of the esophageal fork—slightly cephalad of the base of the oral sucker to or very slightly caudad of the level of the cecal ends of the gut. At about the level of the cephalic margin of the acetabulum a duct leaves each gland and passes obliquely inward and caudad, ventrally of the corresponding intestine, then bends dorsad. The two transverse ducts unite in about the median sagittal plane at a point close to the acetabulum and close to the right ventro-lateral aspect of the dome of the excretory vesicle in about the same transverse plane as that in which Laurer's canal takes its departure from the oviduct. From their point of union the common vitello-duct takes its departure; it passes obliquely dorsad and to the right with a slight tilt cephalad in the direction of the shell gland which it penetrates at its left ventro-cephalic aspect and in the substance of which it unites with the oviduct. Both the transverse and common vitello-ducts contain yolk cells, but the ducts are not notably distended and no vitelline reservoir is distinguishable.

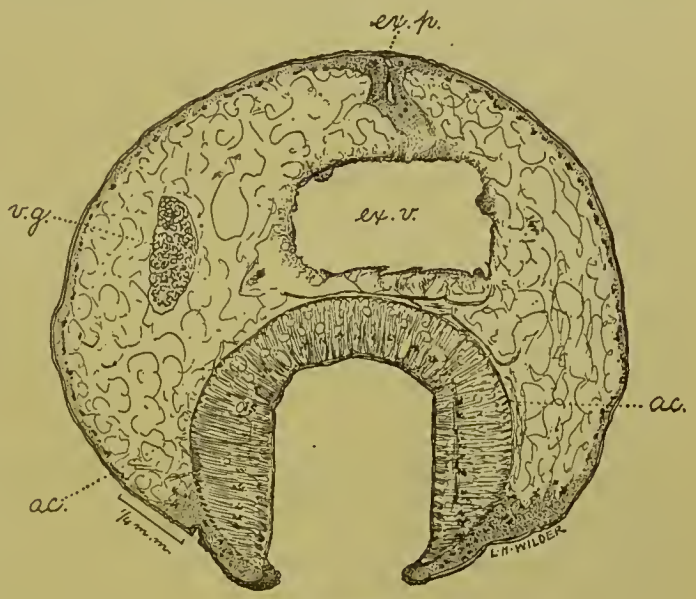

FIG. 130.

EXCRETORY SYSTEM.—A well-developed excretory vesicle is placed dorsally of the acetabulum between the latter and the dorsum. The dome of the vesicle reaches cephalad to a plane only a little caudad of that of the superior margin of the acetabulum. Caudad the vesicle extends to about the level of the caudal margin of the acetabular aperture. From the dorso-caudal aspect of the vesicle a duct

takes origin; this duct passes dorso-cephalad to open in about the median sagittal line of the dorsum (fig. 130) at a point in a transverse plane passing through about the middle of the acetabular aperture and about one-ninth the body length caudad of the opening of Laurer's canal. There is no crossing of Laurer's canal and vesicle, the former lying altogether dorsally of the dome of the latter. The excretory duct is thick walled and lined with a cuticular layer in anatomical continuity with that of the surface.

RELATION TO OTHER SPECIES.

P. shipleyi appears most closely related to *P. parvipapillatum* and *P. scoliocœlium*, from both of which it differs in the somewhat greater complexity of its copulatory apparatus, which is characterized by the presence of a relatively thick ring-like partition separating the ventral chamber of the genital atrium from the dorsal chamber, the two chambers being connected by a short, narrow duct. In *P. parvipapillatum* there is no partition between ventral and dorsal chambers, the line of demarcation being a fold or groove which may be (with a certain degree of evagination of the genital papilla) almost obliterated. Besides this, however, the genital atrium and base of the genital papilla of *P. parvipapillatum* are beset by minute papillæ. In *P. scoliocœlium* the genital atrium forms one undivided chamber.

ILLUSTRATIONS.

FIG. 123.—Diagrammatic sagittal projection.[a] *ac.*, acetabulum; *es.*, esophagus; *c. g.*, esophageal ganglion; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *g. a.*, dorsal chamber; *g. a. c.*, ventral chamber of genital atrium; *i.*, intestines; *L. c.*, Laurer's canal; *o. s.*, oral sucker; *ov.*, ovary; *p. m.*, pars musculosa; *p. p.*, pars prostatica; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. s.*, vesicula seminalis; *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, planes of section. Enlarged. Original.

FIG. 124.—Transverse section at *a–a*, fig. 123. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and mesenterium-like strands (*m. b.*). Enlarged. Original.

FIG. 125.—Transverse section at *b–b*, fig. 123. Shows esophagus (*es.*), esophageal bulb (*es. b.*), intestinal ceca (*i.*), vitellogene follicles (*v. g.*). Enlarged. Original.

FIG. 126.—Transverse section at *c–c*, Fig. 123. Shows terminal portion of pars musculosa (*p. m.*), the pars prostatica (*p. p.*), terminal copulatory apparatus, intestinal ceca (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

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[a] The vertical measurements are not in accurate proportion to the dorso-ventral diameters and the dorsal line is hypothetical. It is based on a series of transverse sections, the thickness of which was not known and could not be determined accurately.

FIG. 127.—Transverse section at *d–d*, fig. 123. Shows uterus (*ut.*), coils of pars musculosa (*p. m.*), the vesicula seminalis (*v. s.*), intestinal ceca (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 128.—Transverse section at *e–e*, fig. 123, through overlapping portions of the testes; *t. d.*, cephalic testis; *t. s.*, caudal testis; *v. e. s.*, left vas efferens from caudal testis; *i.*, intestines; *ut.*, uterus; *v. g.*, vitellaria. Enlarged. Original.

FIG. 129.—Transverse section at *f–f*, fig. 123. To show pore of Laurer's canal (*L. c.*), ovary (*ov.*), shell gland (*s. g.*), uterus (*ut.*), excretory vesicle (*ex. v.*), caudal testis (*t. s.*), right and left transverse vitello-ducts (*t. vd.*), intestinal ceca (*i.*), common vittello-duct (*c. vd.*), acetabulum (*ac.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 130.—Transverse section at *g–g*, fig. 123 (level of excretory pore). *Ex. p.*, excretory pore; *ex. v.*, excretory vesicle; *v. g.*, vitellogene gland (right); *ac.*, acetabulum. Enlarged. Original.

PARAMPHISTOMUM SIAMENSE, new species.

[Figs. 131 to 136.]

SPECIFIC DIAGNOSIS.—*Paramphistomum* (p. 73): Body 6 to 9 mm. long by 4 mm. broad; rather cornucopia-like in form, greatest transverse diameter just caudad of equator; greatest dorso-ventral diameter about at cephalic margin of aperture of acetabulum; tapers at first moderately then more rapidly to a bluntly pointed oral extremity; caudal extremity bluntly rounded; longitudinal outline of lateral margins decidedly convex; anterior half of body, especially, somewhat compressed dorso-ventrally, venter somewhat concave (to some extent, at least, artifact), dorsum arched (convex) in both axes. Surface smooth, except for slight transverse ridge-like striations and a few scattered, small ventral papillæ. Genital pore ventro-median, about one-sixth of length of body from oral end and at zone of intestinal bifurcation. Acetabulum very large, 3.5 to 5 mm., in press preparation 2.6 mm. in vertical diameter, in sagittal section anatomically terminal, but because of curving of body appears to open ventro-caudad subterminally; aperture 1.2 to 1.3 mm. in longitudinal and 1.3 to 1.4 mm. in transverse diameter, directed ventro-caudad, sunken slightly below surface of worm. Mouth terminal, leads directly into globular oral sucker the lumen of which is without papillæ; esophagus somewhat shorter than sucker; intestinal ceca long, extending about to equator of acetabulum. Excretory pore dorso-median, cephalad of pore of Laurer's canal, 2.35 mm. cephalad of caudal extremity in a sagittal section, and about on plane of cephalic margin of acetabulum; excretory vesicle dorsal of acetabulum, long, extending from near cephalic margin of acetabulum to near caudal end of body.

Male organs: Testes situated in axial region of equatorial third of body, one dorso-caudad of the other; vasa efferentia arise on cephalic aspect of testes, vas deferens with much coiled vesicula, continued as musculosa to near base of genital papilla, where it changes to pars prostatica; short ductus ejaculatorius in papilla, joins with metraterm to form ductus hermaphroditicus, which opens at vertex of papilla, the latter projecting into a shallow atrium.

Female organs: Ovary somewhat pyriform, slightly lateral of median line, dorsal of equator of acetabulum; shell gland somewhat globular, about on same transverse plane but a little median of ovary; vitellaria with closely aggregated follicles, in lateral region, extending caudad from base of sucker to slightly beyond intestinal ceca; uterus extends cephalad from shell gland, coils ventrally of shell gland and ovary,

passes cephalad dorsally of testes, beneath arch of vasa efferentia, then cephalo-ventrad to genital papilla; it is very well developed and nearly fills space between ceca; Laurer's canal skirts right side of excretory vesicle and opens slightly dextral of dorso-median line, caudad of excretory pore.

Eggs: Rather numerous, 120μ in length as measured in sections of uterus.

Type.—U.S.P.H. & M.-H.S. 9970.

Habitat.—Bile ducts of a calf (*Bos indicus* var.) in Phrapatoom, Siam.

Source of material.—This parasite was sent from Phrapatoom, Siam, by Dr. P. G. Wooley, who obtained it from the common bile ducts of a "calf" (variety of *Bos indicus*).

EXTERNAL CHARACTERS.

Size.—One specimen measured in glycerin alcohol was about 6 mm. long by about 4 mm. in greatest width; another measured on the slide as a press preparation was 9 mm. long.

Fig. 131.

Form.—In form (fig. 131) the worm resembles a Sicilian fisherman's cap or a cornucopia. The caudal extremity is large, formed by the acetabulum, the aperture of which is directed ventro-caudad. The body tapers toward the cephalic extremity which is bluntly pointed and pierced by the mouth; the latter may be directed slightly forward (ventrad). The body of the animal appears somewhat compressed dorso-ventrally. The venter appears slightly excavated, due perhaps to the contraction incident to fixing. The dorsal surface is arched from side to side, and the longitudinal axis of the body forms a curve with convexity dorsad.

Surface.—The surface cuticle is smooth, except for a few slight transverse striations and a few small scattered ventral papillæ near the region of the genital pore.

Genital pore.—In the ventro-median line, about one-sixth the length of the body from the oral extremity, is a slight circumscribed bulging, in the center of which is the genital pore.

Acetabulum.—The acetabulum is large and occupies the caudal portion of the body. In three press preparations it measured 3.5, 4, and 5 mm. in diameter respectively; in a sagittal section it measured 2.6 mm. in vertical diameter, with an aperture 1.23 mm. in the same diameter. In three alcohol specimens the aperture, which is directed downward and forward (ventro-caudad), measured from 1.2 to 2 mm. in longitudinal diameter and 1.3 to 1.4 mm. in transverse diameter.

Digestive tract.—The mouth, which pierces the bluntly pointed cephalic extremity, leads directly into the sucker. The latter is muscular and globular in form (figs. 132, 133, 135) and is inclosed in a well-defined space, being held in place by its attachments at its oral and basal poles and by mesenterium-like strands. Its lumen, somewhat spindle-shaped and without papillæ, leads into a short esophagus. Close to the dorso-caudal aspect of the sucker there is a transverse ganglionic cord. The esophagus, passing from its origin, appears to describe a U-shaped curve, with the base of the U ventrad, and then divides into two intestinal ceca. The intestinal ceca pass latero-ventrad from their point of origin and after approaching the lateral margin, from which they are separated by the vitelline glands, they change their course caudad. They terminate by blind extremities at about the level of the equator of the acetabulum. The cecal end of the right intestine extends a little farther caudad than that of the left. In transverse section they are of irregular, variable outline, and of considerable and variable caliber in the same specimen. The lumen of the sucker and esophagus is lined by a thin layer of cuticle which ceases abruptly at the esophageal fork. The intestinal ceca are lined by a layer of epithelium.

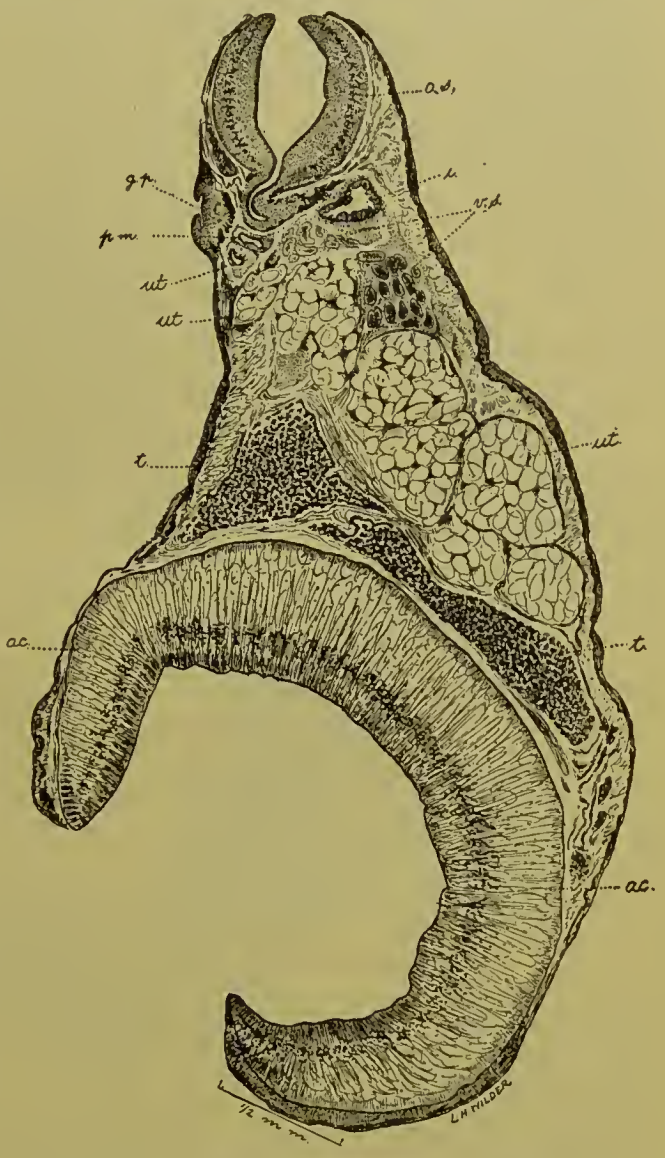

Fig. 132.

Genital system.—*Male organs.*—The testes (fig. 132) are placed one dorso-caudad or latero-caudad of the other in the axial region of

the equatorial third of the body. They appear crowded together, so that the contiguous portions may overlap. In one of the specimens the degree of this overlapping was very great, whereas in another there was none at all, the testicular zones being separate, though contiguous.

The form of the testes is irregular and varies in the different specimens; this variation is probably due partly to a difference in the degree to which the uterus is filled with eggs and partly to the degree of general contraction in the fixing and hardening processes. As seen in sections, their surface is more or less indented. There appears also to be considerable variation in their position in relation to the acetabulum. In some specimens the posterior testis is above (cephalad of) the upper margin of the acetabulum; in others (figs. 132, 136) it extends to the equator of the acetabulum, the caudal aspect of the anterior testis appearing to rest on the upper margin of the acetabulum.

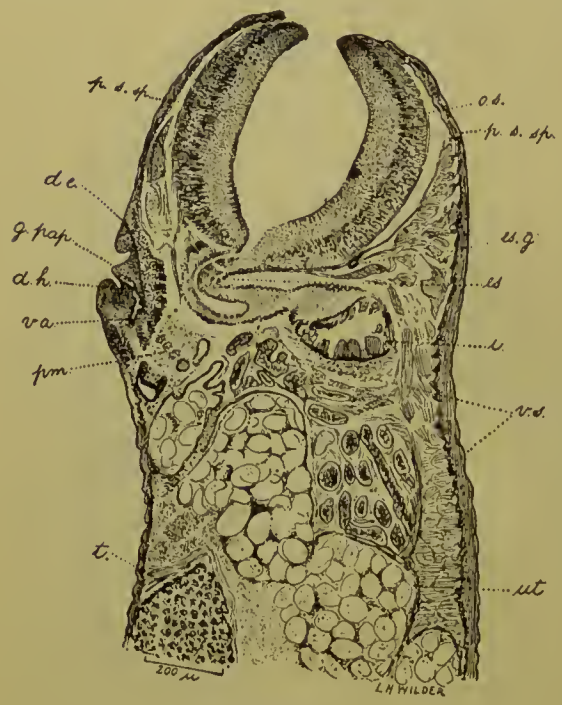

FIG. 133.

In neither of two series of transverse sections could the two vasa efferentia be followed for quite their entire extent, although in one of them only a very small portion of their course was not observed. Completing this portion from the other series, the following results were obtained:

A vas efferens rises from each testis; that from the right (or caudal) testis springs from the superior (cephalic) margin of the right lateral aspect and passes cephalad close to the right lateral aspect of the superior (or left) testis.

The vas efferens of the left (or superior) testis springs from the cephalic aspect of the latter and passes mediad and slightly caudad to unite with the right vas efferens to form the vas deferens. The latter is directed dorsad and almost at once dilates to form the much-coiled thin-walled vesicula. The latter passes ventrad, its wall becomes thick and its lumen becomes contracted (pars musculosa); as this latter approaches the base of the genital papilla it becomes surrounded by a large mass of cells (pars prostatica) which disappear as the duct enters the papilla. The exceedingly short terminal portion or ductus ejaculatorius joins with the metraterm in a common canal, the ductus hermaphroditicus, which opens at the vertex of the genital papilla (fig. 132).

Female organs.—The ovary (fig. 136) lies a little to the left of the median line in the caudal portion of the body, dorsally of and in a plane passing through about the equator of the acetabulum. It is somewhat pear-shaped, with its larger pole to the right. From this extremity the oviduct arises and passes to the shell gland. The shell gland is close to and a little to the right of the ovary and in about the same transverse plane. It is somewhat globular, with a diameter about equal to the ventro-dorsal diameter of the broader end of the ovary. It is pierced on its left aspect by the oviduct and on its caudal aspect by the vitello-duct which joins the former; the

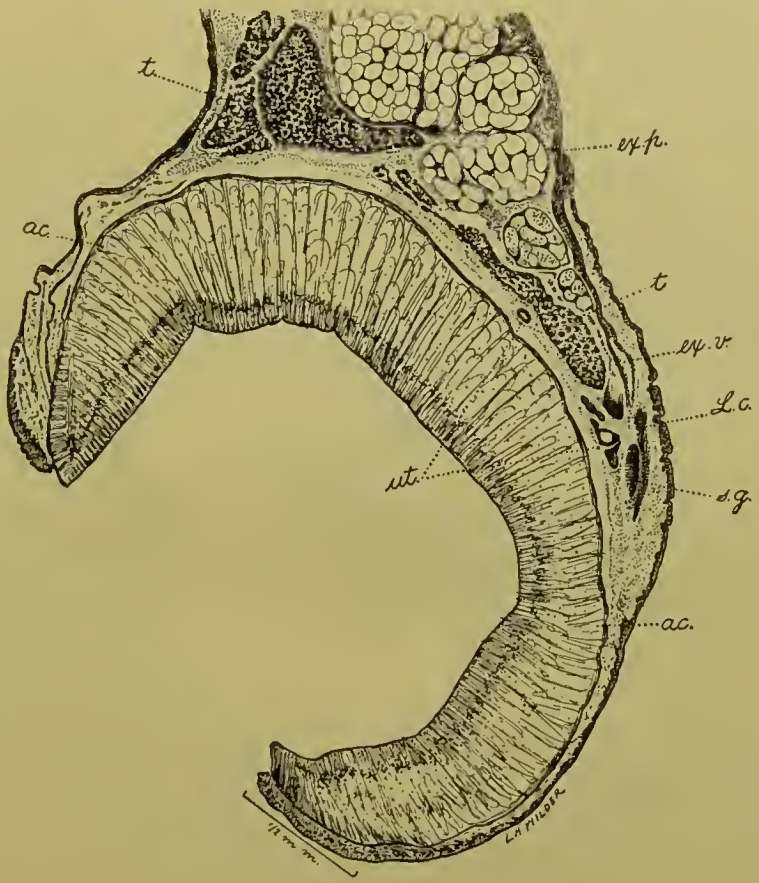

FIG. 134.

duct formed by their union is directed obliquely cephalad and to the right dilating to form the ootype, beyond which it is continued as the uterus. The uterus emerges from the cephalic or ventro-cephalic aspect of the shell gland and proceeds cephalad, first forming some coils ventrally of the shell gland and ovary. In its course cephalad it passes dorsally of the testes, and its coils, with lumen distended with eggs, fill the space between the intestinal ceca. Above the level of the anterior testis it forms coils beneath the vas deferens and passes ventrad toward the genital papilla, and opening, as already mentioned, into a short duct common with it and the male canal. The genital pore opens on the ventral surface at the level or slightly

cephalad of the esophageal fork. It leads into a shallow atrium, the dorsal wall of which is formed by a low conical papilla at the vertex of which is the opening (porus hermaphroditicus) of the short duct (ductus hermaphroditicus) into which, as has been noted, the male and female canals open.

The vitellogene glands consist of well-developed follicles (of the type of *P. cervi*), more or less closely aggregated close underneath the lateral body walls. They are found not only laterally, but also dorsally and ventrally of the ceca. They begin about at the level of the base of the sucker and extend into the caudal portion of the body to a point a little beyond the termination of the intestinal ceca. A duct leaves each gland a little below the level of the upper margin of the acetabulum and passes ventrad of the corresponding intestine toward the shell gland, near the ventro-caudal aspect of which they unite to form a dilated reservoir (fig. 136). From this reservoir a slender duct arises and pierces the caudal aspect of the shell gland to join the oviduct. Laurer's canal springs from the oviduct just as the latter is about to enter the shell gland. It describes a slight curve to the right around the corresponding margin of the excretory vesicle, to open on the dorsal surface a little below the excretory pore, slightly to the right of the median line.

FIG. 135.

EXCRETORY SYSTEM.—Only the excretory vesicle, terminal canal, and excretory pore could be satisfactorily traced. The vesicle lies in the caudal portion of the body dorsally of the acetabulum. Its fundus extends to near the caudal extremity of the worm, and its body extends cephalad close under the dorsum to the level of the upper margin of the acetabulum, at which it terminates by a short duct which opens in the dorso-median line (fig. 134) at the excretory pore, and about 2.35 mm. from caudal extremity, measured in sagittal section.

RELATIONS TO OTHER SPECIES.

This species resembles *Paramphist. cervi* and *P. fraternum*. It differs from *P. cervi* in the form of the body, that of *P. cervi* being more slender and more elongate; in the size of acetabulum, that of *P. cervi* being definitely smaller; in the position of the genital pore, that

of *P. cervi* being relatively farther caudad, about one-third of the body length from the oral margin and at or caudad of the esophageal fork, whereas in this species the genital pore is only about one-sixth the body length from the oral margin at or cephalad of the esophageal fork—that is, relatively much nearer the level of the base of the sucker than is the genital pore of *P. cervi*.

From *P. fraternum* also it differs in the form of the body, that of *P. fraternum* being markedly less flattened and its cephalic third decidedly more slender and more nearly conical; in the size of the acetabulum, that of *P. fraternum* being relatively smaller; in the posi-

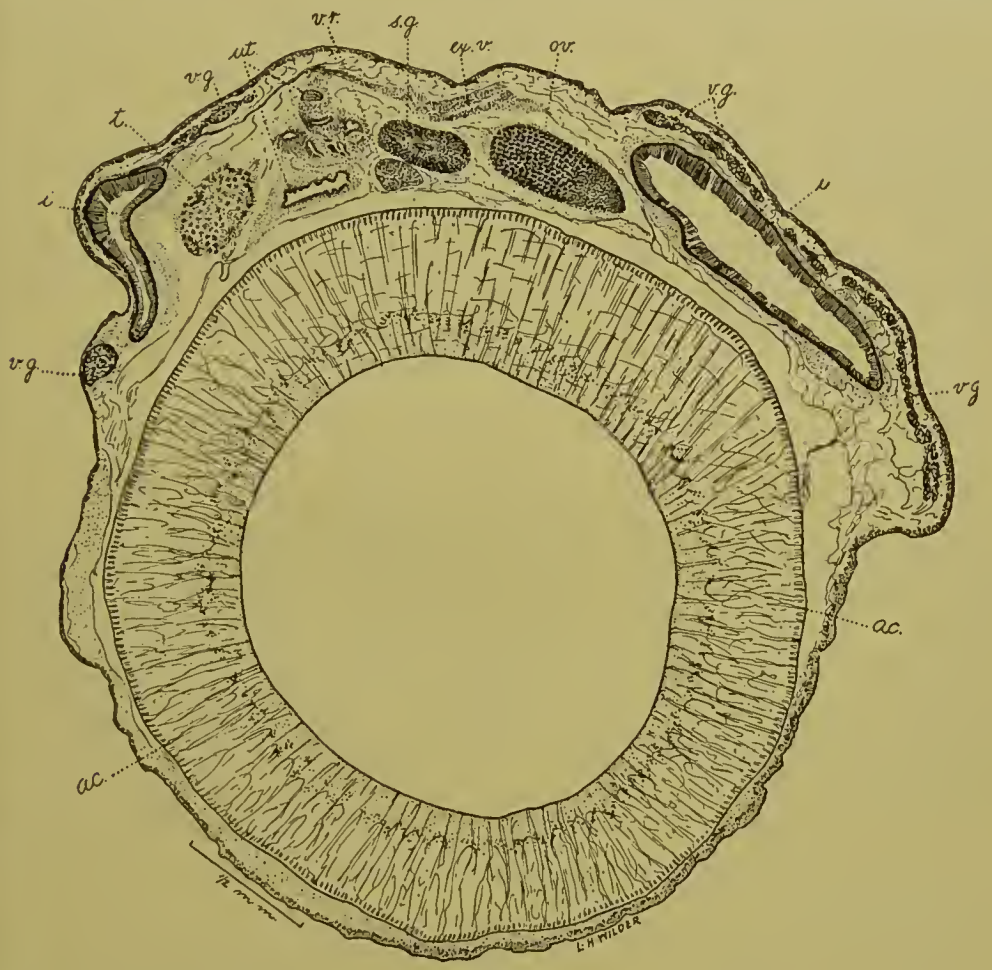

Fig. 136.

tion of the genital pore, that of *P. fraternum* being proportionately nearer the oral extremity, namely, about one-eighth the body length from this extremity and at or slightly cephalad of the level of the base of the sucker.

ILLUSTRATIONS.

Fig. 131.—Ventral aspect. Enlarged. Original.

Fig. 132.—Sagittal section. Shows oral sucker (*o. s.*), section of right intestinal cecum (*i.*), the two testes (*t.*), the vesicula seminalis (*v. s.*), the pars musculosa (*p. m.*), the genital pore (*g. p.*), the uterus (*ut.*), and the acetabulum (*ac.*). Enlarged. Original.

FIG. 133.—Sagittal section of oral extremity. Shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), esophagus (*es.*), section of right intestinal cecum (*i.*), the vesicula seminalis (*v. s.*), pars musculosa (*p. m.*), ductus ejaculatorius (*d. e.*), ductus hermaphroditicus (*d. h.*), genital papilla (*g. pap.*), the metraterm (*va.*), uterus distended with eggs (*ut.*), and cephalic portion of superior testis (*t.*). Enlarged. Original.

FIG. 134.—Sagittal section of caudal extremity. Shows acetabulum (*ac.*), the testes (*t.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), Laurer's canal (*L. c.*), shell gland (*s. g.*), and uterus (*ut.*). Enlarged. Original.

FIG. 135.—Transverse section, shows oral sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and follicles of right vitellogene gland (*v. g.*). Enlarged. Original.

FIG. 136.—Transverse section through caudal extremity of right (caudal) testis (*t.*). Shows position and relations of ovary (*ov.*), shell gland (*s. g.*), vitelline reservoir (*v. r.*), uterus (*ut.*), vitellaria (*v. g.*), intestinal ceca (*i.*), and acetabulum (*ac.*). Enlarged. Original.

STEPHANOPHARYNGINÆ, new subfamily.

SUBFAMILY DIAGNOSIS.—(*Paramphistomidæ*, p. 60): Oral sucker with circular evagination.

TYPE GENUS.—*Stephanopharynx* Fischœder, 1901.

The circular evagination of the oral sucker appears to be an important character. At first thought it seems more important than the sexual characters, still, when one recalls that the intestinal characters of the distomes are not of such great value as one is tempted to accord to them, it is not absolutely excluded that subfamily value is higher than this character justifies. Accordingly, this subfamily is proposed with some reserve.

The one genus (*Stephanopharynx*) known for this group, presents also the following important characters: Genital sucker and cirrus pouch absent, body not divided.

Fischœder classified *Stephanopharynx* in *Paramphistominæ*. With this view it is difficult to concur, and if *Stephanopharynx* were classified with the *Cladorchiinæ*, there should be a distinct tribe erected for it.

Genus STEPHANOPHARYNX Fischœder, 1901.

GENERIC DIAGNOSIS.[a]—*Stephanophayrnginæ* (p. 168): Body compressed, slightly concave ventrad, convex dorsad, but slightly flattened dorso-ventrally, cephalic and caudal ends rounded, sides excurvate longitudinally. Ventral pouch absent. Acetabulum ventro-subterminal, large, not sunken, margin not raised, aperture large. Genital pore with considerable musculature which is not sharply defined in form of a sucker, atrium divided into large ventral and small dorsal chamber, ductus hermaph-

[a] Based on Fischœder, 1903h.

roditicus present. Excretory pore prevesicular in acetabular zone, caudad of Laurer's canal. Oral sucker with circular evagination, larger dorsally than ventrally; esophagus without muscular thickening; ceca very wavy, end postequatorial, posttesticular.

Male organs: Testes 2, smaller than acetabulum, with small lobes, fields nearly coincide, zones abut or separate, preovarial, not widely separated from acetabulum, in equatorial and caudal thirds; musculosa well developed, but not enormous; cirrus pouch absent.

Female organs: Ovary and shell gland posttesticular; vitellaria pre- and cecal, profuse; uterus intercecal; eggs many; Laurer's canal entirely preexcretory.

TYPE SPECIES.—*S. compactus* Fischœder, 1901.

Subfamily CLADORCHIINÆ Fischœder, 1901.

SUBFAMILY DIAGNOSIS.—*Paramphistomidæ* (p. 60): Oral sucker with a pair of evaginations.

TYPE GENUS.—*Cladorchis* Fischœder, 1901.

Fischœder included in this subfamily the genera *Cladorchis* (subg. *Cladorchis, Taxorchis,* and *Stichorchis*), *Chiorchis, Gastrodiscus, Homalogaster,* and (as doubtful) *Diplodiscus.*

We have separated out (see p. 249) *Gastrodiscus* and *Homalogaster,* thereby restricting the group in one sense, and by eliminating certain characters from the subfamily diagnosis we have widened the scope of the group in another sense. It is very possible that the group may undergo further changes on basis of the different kinds of evaginations.

Genus CLADORCHIS Fischœder, 1901.

GENERIC DIAGNOSIS.[a]—*Cladorchiinæ* (p. 169): Genital pore with sucker. Evaginations of oral sucker recognizable outside the wall of the sucker; esophagus without muscular thickening.

Male organs: Testes branched.

TYPE SPECIES.—*C. pyriformis* (Diesing, 1838) Fischœder, 1901.

Fischœder divides this genus into 3 subgenera, but it seems to us possible that his genus *Chiorchis* is perhaps of tribal value and his subgenera of generic value.

Subgenus CLADORCHIS Fischœder, 1901.

SUBGENERIC DIAGNOSIS.[a]—*Cladorchis* (p. 169): Body rather pyriform, venter flattened to convex, dorsum convex, cephalic end attenuate, caudal end rounded. Ventral pouch absent. Acetabulum caudal, ventral, rather large to large, apparently sunken or not sunken, margin apparently raised or not raised, aperture circular, apparently medium to large. Genital pore with sucker, ductus hermaphroditicus present. Excretory pore postvesicular, post- or acetabular, caudad of pore of Laurer's canal. Oral sucker with paired strongly developed evaginations, and with not sharply bounded sphincter; esophagus without muscular thickening; ceca very wavy, long, end postequatorial, posttesticular, post- or acetabular.

Male organs: Testes 2, smaller than acetabulum, branched, fields abut, zones nearly coincide, preovarial, near acetabulum, in equatorial third, near venter; cirrus pouch present.

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[a] Based on Fischœder, 1903h.

Female organs: Ovary and shell gland posttesticular; vitellaria in cecal zone, testicular and post-, may be pretesticular, stretching ventrally and dorsally; uterus intercecal; Laurer's canal entirely prevesicular.

TYPE.—*C. pyriformis* (Diesing, 1838).

HABITAT.—Cecum of South American *Tapirus*.

Subgenus STICHORCHIS Fischœder, 1901.

GENERIC DIAGNOSIS.[a]—*Cladorchis* (p. 169): Body straight, venter rather flat, dorsum convex, cephalic third notably attenuate, caudal end attenuate but rounded. Ventral pouch absent. Acetabulum caudal, ventral, slightly sunken, margin (?), aperture circular, large. Genital pore with sucker, latter with distinct sphincter. Excretory pore apparently postvesicular, in acetabular zone, caudad of pore of Laurer's canal. Oral sucker with sphincter and paired evaginations; esophagus without muscular thickening; ceca slightly wavy, long, end postequatorial, posttesticular, in acetabular zone.

Male organs: Testes 2, about as large as acetabulum, branched, fields and zones overlap, preovarial, somewhat separated from acetabulum, near venter, in equatorial third; cirrus pouch small.

Female glands: Ovary and shell gland almost entirely posttesticular; vitellaria from bifurcal to postcecal zones; uterus intercecal; eggs (?); Laurer's canal entirely prevesicular.

TYPE SPECIES.—*S. giganteus* (Diesing, 1835).

Genus TAXORCHIS (Fischœder, 1901).

GENERIC DIAGNOSIS.[a]—*Cladorchiinæ* (p. 169): Body elongate, flattened, venter flat, dorsum somewhat convex. Ventral pouch absent. Acetabulum terminal, rather large, aperture elongate. Genital pore with sucker, ductus hermaphroditicus present. Excretory pore (?). Oral sucker with sphincter and well-developed paired evaginations; esophagus without muscular thickening; ceca broad, slightly wavy, near dorsum, long, end postequatorial, posttesticular, in acetabular zone.

Male organs: Testes 2, nearly as large as acetabulum, branched, fields separate, zones coincide, preovarial, preequatorial, widely separated from acetabulum and ovary; cirrus pouch present.

Female organs: Ovary and shell gland posttesticular, near acetabulum; vitellaria in cecal zone, entirely posttesticular; uterus intercecal, chiefly posttesticular, unusually well developed, first runs near dorsum cephalad to testes, then diagonally caudad near venter, then near venter cephalad to pore; ova numerous. Laurer's canal (?).

TYPE.—*T. schistocotyle* Fischœder, 1901.

HABITAT.—Cecum of Brazilian *Dicotyles*.

Fischœder gives *Taxorchis* as a subgenus of *Cladorchis*, but the form and position of the testes and the position of the uterus seem to us to entitle it to generic rank.

Genus PSEUDODISCUS Sonsino, 1895.

1895: *Pseudodiscus* and *Amphist.* (*Pseudodiscus*) Sonsino, 1895, 5, 8 (for *hawkesi, collinsi, ornatum*); 1895, 184, 185, 186; 1896, 310.—Fischœder, 1903h, 489, 631-632.—Piana & Stazzi, 1900a, 523.

GENERIC DIAGNOSIS.—*Cladorchiinæ* (p. 169): Body oval, venter convex to concave, dorsum convex, cephalic end less blunt than bluntly rounded caudal end, transverse section elliptical. Ventral pouch absent. Acetabulum ventral relatively small, margins prominently projecting. Genital pore postbifurcal without sucker, ductus

[a] Based on Fischœder, 1903h.

hermaphroditicus present. Excretory pore postvesicular, in postacetabular zone, caudad of pore of Laurer's canal. Oral sucker prominently constricted at equator, with a pair of evaginated horns, each with a globular pouch; esophagus without muscular thickening; ceca wavy, long, end postequatorial, posttesticular, in acetabular zone.

Male organs: Testes 2, smaller than acetabulum, cauliflower-like, testicular fields separate, zones coincide, preovarial, considerably or slightly removed from acetabulum, chiefly or entirely in equatorial third, near venter; musculosa not enormously developed; cirrus pouch absent.

Female organs: Ovary and shell gland chiefly posttesticular; vitellaria extend extracecal about from buccal pouches to acetabulum; uterus intercecal, chiefly posttesticular; ? eggs; Laurer's canal cephalad and dorsal of excretory vesicle.

Eggs: Not observed.

Type species.—*Amphist. stanleyii* Cobbold, 1875, from *Equus caballus* in India, type by present designation.

Hosts.—Horses and elephants.

This genus is left provisionally in the subfamily *Cladorchiinæ*, although indications are not entirely absent that it may eventually be eliminated from this group.

Sonsino (1895, anno 6, 5, 8) proposed this genus as a member of the *Amphistomidæ* and gave to it the following generic diagnosis:

Corpo allungato, convesso pianeggiante, sensa manico anteriore distinto. Ventosa posteriore subterminale piccola.

He included in the genus the species: *Amphist. hawkesi* [*stanleyii*] *collinsi*, and *ornatum*.

Piana & Stazzi (1900, 523) accept Sonsino's genus, adding to its diagnosis the phrase: "La faringe coi due diverticoli e il bulbo esofageo musculosa."

Fischœder (1902a, 48–49) gives the species *Amphist. hawkesi*, *collinsi*, *stanleyi*, and *ornatum* as species inquirendæ.

Fischœder (1903h, 489, 631–632) mentions the genus *Pseudodiscus*, but in view of the slight anatomical details then known for its species he lists them all as species inquirendæ of *Amphistomum*.

In reference to the species which come into consideration as members of this genus, Cobbold (1879b, 357–359, 398) states:

More importance attaches itself to the study of the amphistomatoid flukes [in equines]. These parasites, though in a scientific sense only recently discovered in equine bearers, have been long known to the natives of India. They appear to be capable of producing serious intestinal irritation. I have described two forms (*Amphistoma collinsii* and *A. coll.* var. *stanleyi*, which infests the colon. The specimens sent to Professor Simonds from India by Mr. Stanley, V. S., were much larger than those sent to me from Simla by Mr. Collins, V. S., some ten years later (1875). As in all other amphistomes obtained from the intestines of elephants and cattle the worms, when fresh, were of a bright brick-red color. By the natives of India these parasites are called *Masuri;* but no description of the worms had been published prior to the account which I gave of the contributions forwarded by Major-General Hawkes, Mr. Collins, and Mr. Stanley.

I shall have occasion to speak of the elephant's *Masuri* further on; but in the meantime I must remark that the generally received notion as to the parasitic cause of the

earth-eating propensities of various animals seems to have some foundation in fact. Not alone from Major-General Hawkes in Madras, from Mr. Folkard in Ceylon, and from various other trustworthy sources, have I been informed of this habit on the part of Indian horses; but Doctor Rowe told me that Australian horses, and even sheep, infested with stomach worms, are in the constant habit of consuming large quantities of sand. From all the facts that have come before me, I am inclined to think that gastric or intestinal irritation, however brought about, may induce the habit in question, parasites being only one of the many sources of irritation giving rise to symptoms of colic in solipeds and pachyderms alike. At all events the African elephants at the London Zoological Society's menagerie, as repeatedly witnessed by myself, are in the habit of swallowing large quantities of soft mud during the summer months, but no traces of *masuri* have as yet been detected in their fæces.

When by letter I informed Major-General Hawkes of an interesting find by Mr. Collins of *about a thousand* Amphistomes in the colon of a horse that had died at Simla, the announcement called forth a reply which is sufficiently instructive to be quoted. Writing from Secunderabad, in July, 1875, he says respecting this "find:" "Your statement has incidentally thrown light upon a subject which has puzzled many of us in this country. It occasionally happens that a horse, on being opened after death, is found to have accumulated in his intestines large quantities of sand and gravel. In a recent case this accumulation amounted to 14½ pounds. Until recently it was always held that this gravel or sand could only be introduced with the animal's food. All grain in this country is trodden out by bullocks on an earthen floor, and the grain undoubtedly contains a proportion of sand and gravel derived from this source. Although this ought to be carefully washed out before it is given to the horse, still, owing to the carelessness of the native horse keepers, this cleaning is, I expect, often omitted. In the daily 'feed' of 8 or 10 pounds of grain given to each horse the utmost quantity of sand or gravel that could be found admixed therewith would not probably exceed 2 or 3 ounces. Consequently it would take from seventy-seven to one hundred and sixteen days to accumulate so large a quantity as 14½ pounds. Now, the advocates of the theory of the gradual accumulation of sand in this way have never been able to explain why the grain, grass, hay, and other ingesta should pass in the ordinary way through the intestines whilst this sand or gravel remains behind. One can understand the possibility of such substances as wool, hair, or similar matters concreting in the alimentary canal, though I believe they are usually found in the stomach and not in the intestines; but how a most incohesive substance, like sand, can possibly accumulate in the gradual way required by their theory I have never heard even plausibly explained. On the other hand, the fact that horses are often excessively addicted to eating earth is well known; and if my memory serves me correctly, it was found necessary, about twenty years ago, to remove the mud walls of the pickets surrounding some of the horses of a mounted corps in this presidency in consequence of this habit. Now, given the fact that the amphistoma has been found in the horse (as your specimens prove), may we not fairly suppose it possible that the animal resorts to the same mode of ridding himself of this parasite as does the elephant; and, also, would it not in a much more natural manner account for the large quantity of gravel or sand found in the intestines than does the theory of gradual accumulation? Reasoning from analogy, as in the case of the elephant, this eating of earth in the horse would be an instinctive effort on the part of the 'host' to rid himself of the parasite. This self-taken remedy is doubtless in many cases quite effectual, though unnoticed. The fatal cases are probably those in which the horse has either overdone the remedy or where the system was too debilitated to carry off a quantity of sand or gravel that would otherwise have safely passed through the intestines of a horse in more robust health. The actual fact must, of course, be verified by careful investigation."

When describing the parasites of the horse (p. 358), I spoke of Collins's amphistome from that animal; but in the letter addressed to me from Simla, March 22, 1875, Mr. Collins made no allusion to the earth-eating habit. He wrote: "I forward you by this mail parasites found in the colon of a horse that died, a subject of fever peculiar to this country. There were about a thousand of the parasites, and nearly the whole of them were situated close to the cæcum and were loose in the gut. Not having seen parasites at all similar to these, I have forwarded them for identification. They were of a brick-red color when first obtained." These explicit statements by Mr. Collins are interesting from many points of view. One has only to place his specimens side by side with those from the elephant in order to satisfy one's self that the two forms are distinct. For the reasons already stated, I provisionally called the worm *Amphistoma collinsii*. It is probable that other veterinary surgeons have encountered this entozoon in India; but unless they can point to some published account of the fact Mr. Collins is entitled to be considered as its discoverer. Doubtless many other European residents in India, Ceylon, and Burmah must, like Doctor Gilchrist, be well acquainted with the *masuri* as such, though unaware of their zoological position.

The known species[a] of *Pseudodiscus* may be distinguished by the following key:

a^1. Testicular zones nearly or quite coincide, fields separate; esophagus without muscular thickening.....subg. *Pseudodiscus*, p. 173.

b^1. Testes more than half as large as acetabulum; intertesticular field less than half as broad as testicular field; body 8.6 to 9 mm. long; type host *Equus caballus*, India.....*Ps. stanleyii*, p. 173.

b^2. Testes less than half as large as acetabulum; intertesticular field much broader than testicular field; body 5 to 5.7 mm. long; type host *Equus caballus*, India.....*Ps. collinsii*, p. 187.

a^2. Testicular zones separate, nearly abut, fields nearly or quite coincide; esophageal muscular thickening present; tpye *hawkesii*.....subg. *Hawkesius*, p. 200.

b^3. Body 3.5 to 5 mm. long; type host *Elephas indicus*, India...*Ps. hawkesii*, p. 200.

Subgenus PSEUDODISCUS.

Subgeneric diagnosis.—*Pseudodiscus* (p. 170): Esophageal muscular thickening absent. Testicular zones nearly or quite coincide, fields separate.

Type species.—*Ps. stanleyii*.

PSEUDODISCUS STANLEYII (Cobbold, 1875) Stiles & Goldberger, 1910.

[Figs. 137 to 151.]

1875: *Amphist. stanleyii* Cobbold, 1875n, 818, 819 as possible syn. of *Amphist. collinsii* [in *Equus caballus*, India].

1879: *Amphist. collinsii* var. *stanleyi* Cobbold, 1879b, 357 for *stanleyii* 1875 (in *Equus*).—Piana & Stazzi, 1900a, 519, as syn. of *hawkesi*.—Sons., 1895, 182.

1895: *Amphist. collinsi* var. *stanleyi* Cobbold.—Sons., 1895, 4 syn. of *Amphist. hawkesi*.—Fischœder, 1902a, 48; 1903h, 631, 632.

1895: *Amphist. stanleyi* Cobbold.—Ward, 1895, 338 as syn. of *A. collinsi* (in *Equus caballus*).—Fischœder, 1902, 48.

Specific diagnosis.—*Pseudodiscus* (p. 170): Body 8.6 to 9 mm. long by 5.5 to 5.6 mm. broad, by 3.5 to 4 mm. thick; flesh color (alcohol specimen); oval, somewhat flattened dorso-ventrally, cephalic extremity bluntly pointed, caudal extremity very

[a] Except *ornatus*, for which definite data are lacking.

bluntly rounded; lateral margins convex, greatest diameter (both transverse and sagittal) about at caudal end of equatorial third of body; cephalic extremity bears bluntly pointed slender papillæ. Genital pore ventro-median in cephalic portion of equatorial third, about midway between oral extremity and anterior margin of acetabulum, postbifurcal. Acetabulum ventro-subterminal, 1.7 mm. in diameter, aperture circular, 1 to 1.25 mm. in diameter, surrounded by a distinctly raised margin; cavity rather shallow. Mouth terminal; oral sucker constricted at equator into globular oral and bibulbous esophageal portions; each lateral bulb connects with a globular pouch; the bibulbous portion of sucker and the pouches lie on each side in a cavity, but are bound dorsally and ventrally to the parenchyma by mesenterium-like bands; esophagus arises from base between bulbs and extends (at first in the ventral mesenterium-like band) nearly to border between cephalic and equatorial thirds of body; ceca long, extend caudad slightly beyond equator of acetabulum, each forming in its course 2 strongly convex lines latero-dorsad, which come together near caudal margin of testis. Excretory pore dorso-median, caudad of acetabulum; excretory vesicle well developed, dorsal of acetabulum.

Male organs: Testes large, somewhat lobulated or cauliflower-like, ventral, equatorial, postbifurcal, preacetabular, their center slightly nearer caudal than cephalic margin; vasa efferentia spring from dorsal aspect, run cephalo-mediad, then mediad, unite about in median line slightly caudad of equator of body to form vas deferens; vesicula seminalis intricately coiled, moderately dilated; pars musculosa dilated, moderately coiled, extends slightly cephalad of genital pore; pars prostatica relatively short, vesicular, dorsal of pore, with short narrow muscular canal (ductus ejaculatorius) to the short ductus hermaphroditicus which leads to the pore; cirrus pouch absent.

Female organs: Ovary and shell gland submedian, posttesticular, preacetabular, nearer acetabulum than testes, ovary cephalad of shell gland; vitellaria, with well-developed follicles, lateral of ceca, extend about from base of esophageal pouches to or slightly caudad of intestinal ceca; vitello-ducts arise about at plane of shell gland; uterus forms coils dorso-mediad of ovary, then passes cephalo-ventrad in suctorial field between testes, crossing ventrally of vasa efferentia, and runs in but slight coils ventrad of vas deferens to enter ductus hermaphroditicus dorsal of pore; Laurer's canal runs from its origin (between dorsal margin of ovary and shell gland) caudo-dorsad to dorso-median line slightly caudad of cephalic margin of acetabulum.

Eggs: Not observed.

Type.—U.S.N.M. (Coll. Stiles) 5274; cotype U.S.N.M. (Coll. Hassall) 5779, sectioned and used as basis for present anatomical discussion.

Habitat.—Colon of the horse (*Equus caballus*), India.

Source of material.—The material used as basis of this discussion represents some of Cobbold's original specimens which he gave to Hassall; the latter brought them to this country. Cobbold was not in the habit of designating any particular specimen as type, but Hassall has designated 5274 as such on the label.

Historical review.—In the first mention of the name *Amphistoma stanleyii* Cobbold (1875n, 818, 819) states that the parasites were collected by Edward Stanley, jr., from the colon of the horse in India; in size they appear nearer to *A. hawkesii* than they do to *A. collinsii*, still "this is apparently nothing more than a large variety of the above [*collinsii*] (?)."

Ward (1895, 338) merely mentions this form as a synonym of *Amphist. collinsi*, in a list of parasites of the horse.

Sonsino (1895, 4), quoting Cobbold, mentions the worm as a synonym of *Amphist. hawkesi*.

Fischœder (1902a, 48; 1903h, 631, 632) quotes the measurements as 10 mm. long by 6 mm. broad, states that this form occurs in the colon of *Equus caballus* in India, and marks the parasite as a species inquirenda.

FIG. 137.

EXTERNAL CHARACTERS.

SIZE.—The specimens, preserved in alcohol, measure 9 mm. and 8.6 mm., respectively, in length; 5.5 and 5.6 mm. in greatest width, and 3.5 and 4 mm., respectively, in greatest dorso-ventral diameter.

COLOR.—The worms are of a flesh tint.

FORM.—The worms are ventro-dorsally somewhat flattened oval objects, with a bluntly pointed oral and a broad rounded caudal extremity (figs. 137, 138). The greatest transverse and ventro-dorsal diameters are about in the region of junction of the middle with the caudal third of the body. In transverse sections the form of the body is somewhat that of an ellipse.

SURFACE.—The surface of the oral pole is beset by small, more or less bluntly pointed, quite slender papillæ. They presented much the appearance of spines, but any doubt as to interpretation was dissipated on studying the sectioned specimen.

FIG. 138.

Genital pore.—On the ventral surface in the median longitudinal line, about midway between the oral extremity and the anterior margin of the acetabular aperture, is the genital pore. This pore is situated in about the center of a broad shallow depression of the ventral surface. In sections it is seen that what appears to be the genital pore is a fairly large circular aperture that leads into a circular slit-like atrium, on the dorsal wall of which appears a minute pore which leads into another, somewhat better defined, chamber. On the dorsal wall of the latter is the opening of the ductus hermaphroditicus. These atria and the ductus hermaphroditicus are surrounded by a globular mesh of muscular fibers (fig. 146).

Acetabulum.—The acetabulum is in the caudal portion of the body, with its aperture ventro-subterminal. In one specimen it measured (in sections) about 1.7 mm. in diameter; the aperture of the acetab-

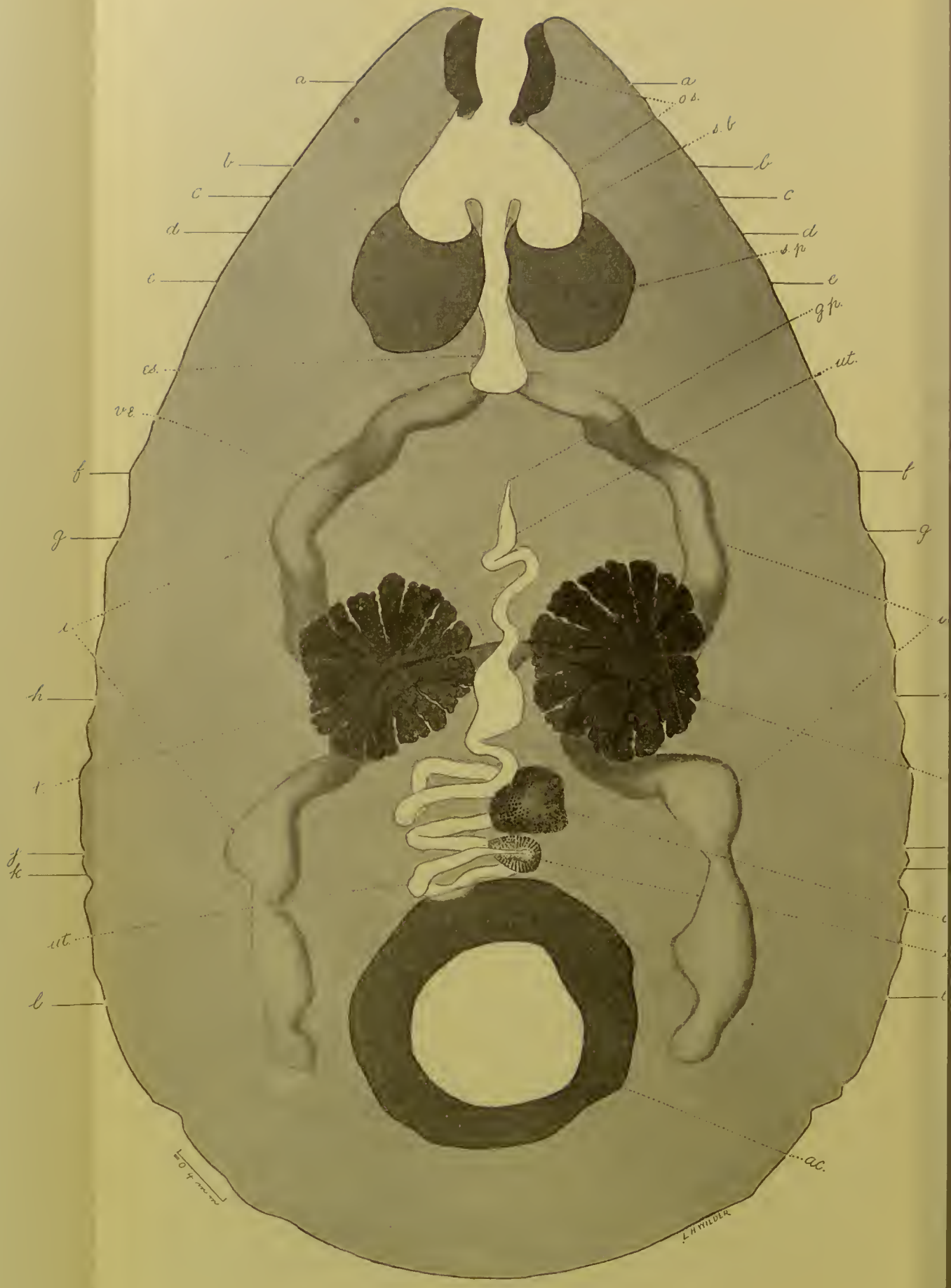

FIG. 139.

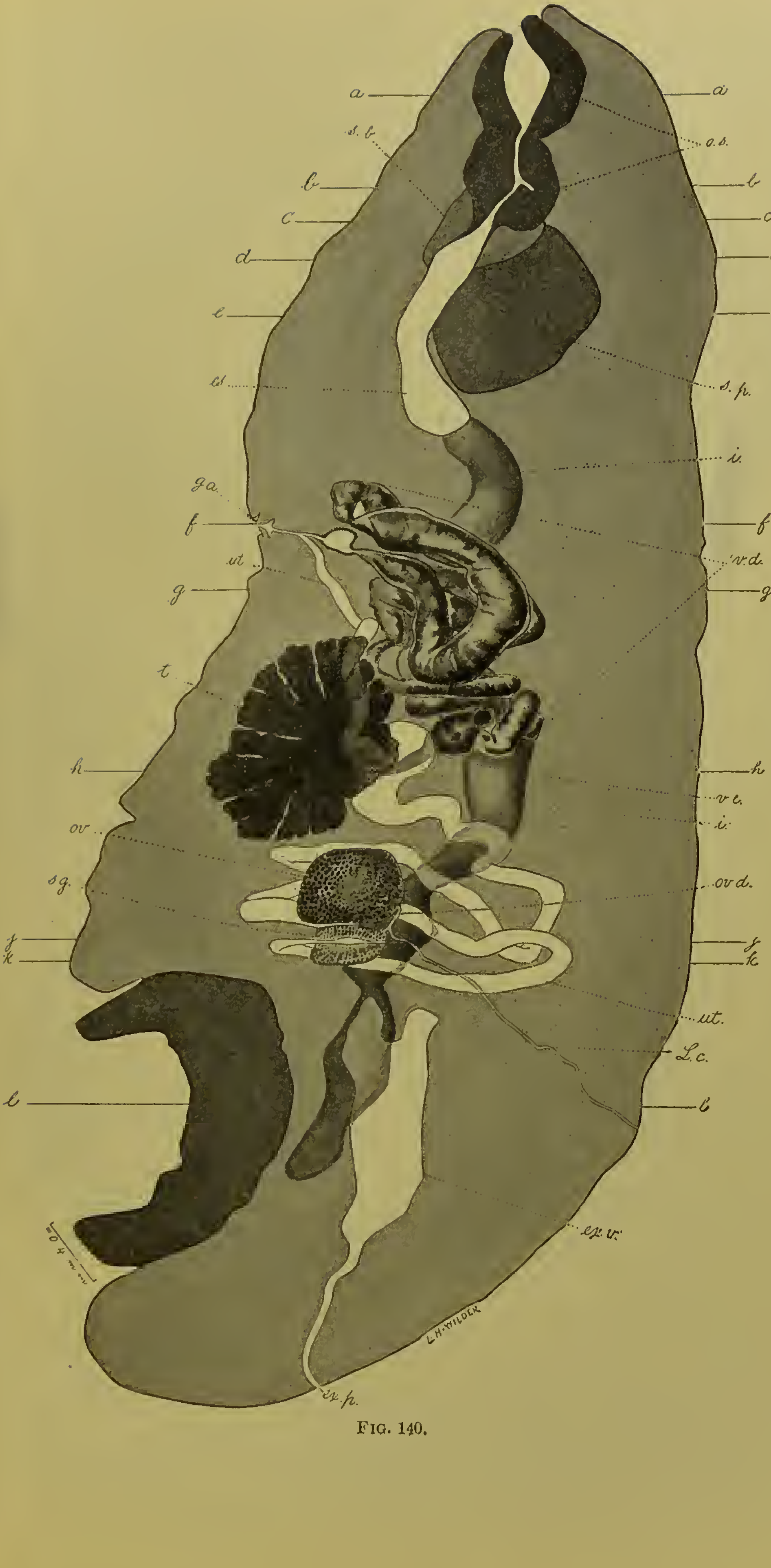

FIG. 140.

ulum in the 2 worms measured 1 mm. and 1.25 mm., respectively, in diameter. This aperture is surrounded by a narrow ring which is marked off from the general surface by a deep and more or less narrow circular groove. This ring is seen in sections to be part of the acetabulum (fig. 151). The cavity of the acetabulum is relatively shallow.

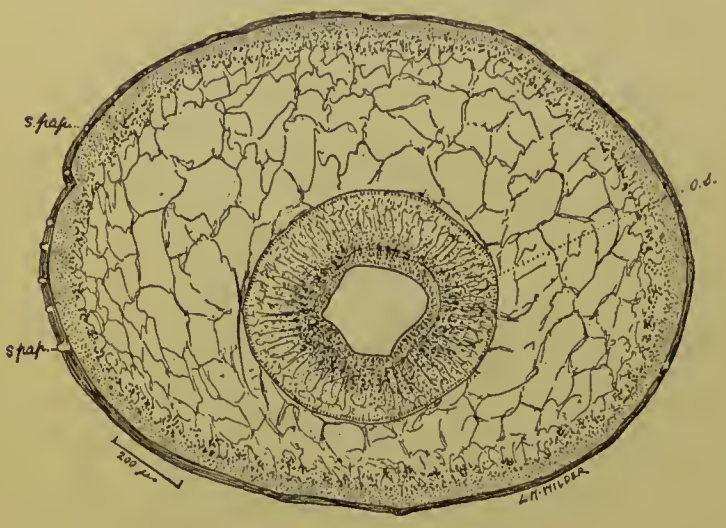

FIG. 141.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The oral aperture, which pierces the cephalic extremity of the worm and is unprovided with a sphincter, leads directly into a muscular sucker. The latter shows a well-marked constriction or isthmus at about its equator, which divides it transversely into two portions almost equal in length—the anterior, which may be designated as the oral, and the posterior, as the esophageal (or bulbous) portion. The oral portion of the sucker is somewhat globular in form, measuring (in sections) about 0.64 mm. in longitudinal axis, 0.64 mm. in transverse, and 0.58 mm. in ventro-dorsal diameter. The esophageal or bulbous portion differs in form quite markedly from the oral portion (figs. 139, 140, 141, 142, 143). It measures (in sections) about 0.50 mm. in longitudinal axis and 0.48 mm. in greatest ventro-dorsal diameter. In transverse diameter this part of the sucker is narrowest at the constriction marking its anterior limit, where it measures 0.40 mm., but it increases rapidly to a maximum width of 1.10 mm. at its base, namely, at the level at which the esophagus takes its departure. In sections it is seen that this increase in width is due to the formation of lateral bulbs which extend caudad on either side of and in line with the esophagus for a distance (measured in the long axis of the bulb) of about 0.40 mm. beyond

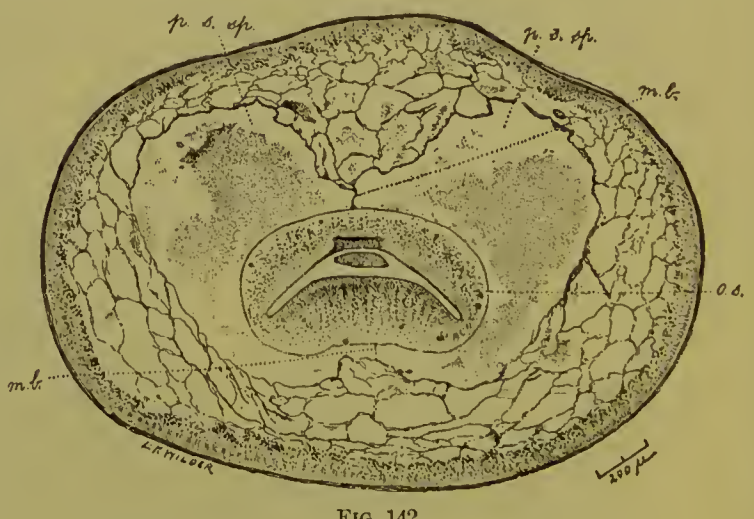

FIG. 142.

the level or plane of origin of the esophagus (figs. 139, 140). Attached to the dorso-caudal aspect of these bulbs there is on each side a globular pouch.

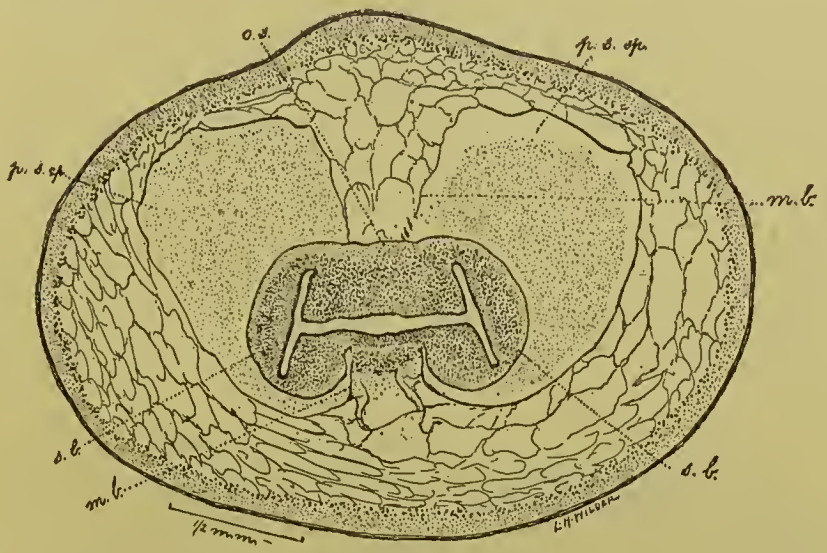

FIG. 143.

In consequence of this relation between the pouches and the corresponding bulbs, the former are found close to, on either side, and slightly dorsad of the esophagus. The suctorial bulbs, which are an integral part of the sucker, are, like the latter, muscular in structure. The portion of these bulbs which on surface inspection is seen to

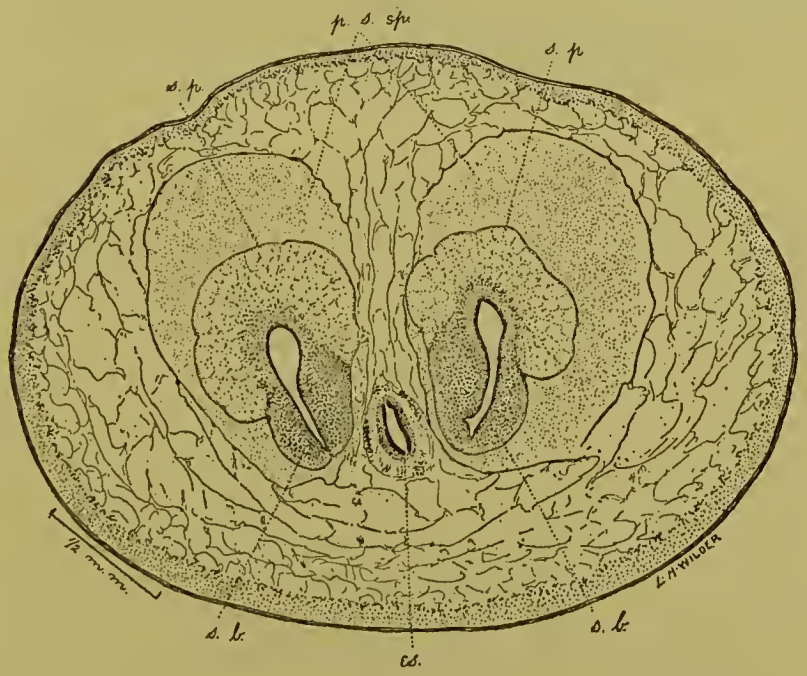

FIG. 144.

extend beyond the base of the sucker, that is, caudad of the level of origin of the esophagus, measures about 0.40 mm. in its longitudinal axis, about 0.56 mm. in its greatest dorso-ventral diameter, and about

0.40 mm. in its greatest transverse diameter. The suctorial "pouches" (wl ich are here distinguished from the "bulbs") are in a general way globular in form. Their long axes have about the same direction as the long axis of the worm itself and exceed their transverse diameter by about 0.20 mm., the latter measuring about 0.80 mm. In structure the pouches are entirely different from the bulbs. The walls of each pouch, which measure about 0.30 mm., are made up of parenchyma-like cells and some muscular fibers. These parenchyma-like cells, though large, are much smaller than those of the body parenchyma, from which they are sharply separated by a thin membranous layer which at the same time forms the outer covering of the wall of the pouch. Beneath the lining cuticle is a layer of structures which are very irregular in size and which at first sight are not very easy to interpret; they have something of the appearance of poorly preserved nuclei; some seem to be solid, others appear to be hollow, with a peripheral row of dots; in some fields they remind the observer very strongly of cross-sections of longitudinal muscles, and it seems probable that they are such, for the terminal sections of the pouch show distinct fibers apparently corresponding to these structures. Immediately external to this layer is found a thin layer of circular muscles.

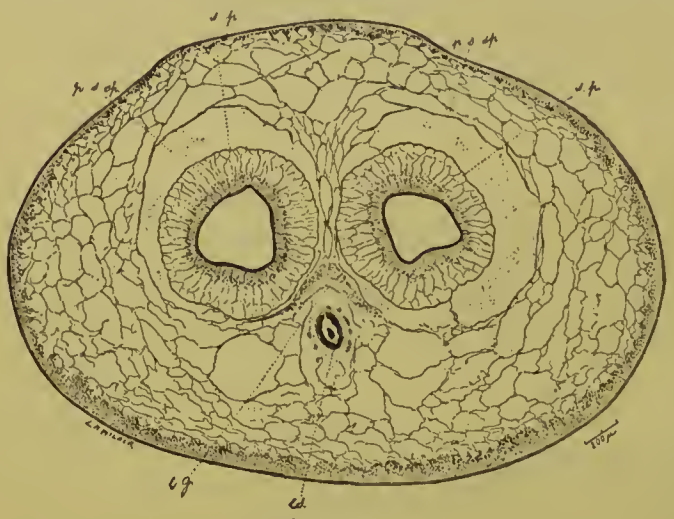

FIG. 145.

The portion of the sucker caudad of the isthmus, together with the two pouches, lies in a cavity which reminds the observer strongly of a rudimentary body cavity. From the dorsal and the ventral surfaces of the sucker a line of tissue, reminding the observer of a mesenterium, extends dorsad and ventrad to the body parenchyma, thus holding these structures in place; similar mesenterium-like bands connect the pouches with the somatic parenchyma (figs. 142–145); at their insertion, these bands spread around the sucker and pouches like a peritoneum; the esophagus runs in the ventral mesentery band, which also contains the esophageal ganglion.

Whether the cavities in question actually represent a rudimentary body cavity is a question which may be left open, but such an interpretation is rather tempting. Similar cavities are found or at least strongly indicated in *Homologaster philippinensis* (see Stiles and Goldberger, 1908a, figs. 34–36) *Watsonius watsoni*, and in other Paramphis-

tomidæ. The lumen of the sucker differs in form in the different portions of the suctorial tract; that of the oral portion is somewhat spindle-shaped, while that of the esophageal portion is a transverse slit, slightly crescentic in both transverse and sagittal sections with the convexity directed dorsad. In about the equatorial plane of this portion of the sucker a shallow, transverse, slit-like diverticulum of the suctorial lumen is formed in the dorsal muscular wall, so that the lumen of the sucker in sagittal plane at this point presents a triradiate form (fig. 140); in transverse section at this point the impression obtained is that of a transverse tongue-like ridge or partition projecting upward into the lumen of the sucker (fig. 142). Caudad of this level the horns of the crescentic lumen seen in transverse section rapidly shift and assume a more or less direct dorso-

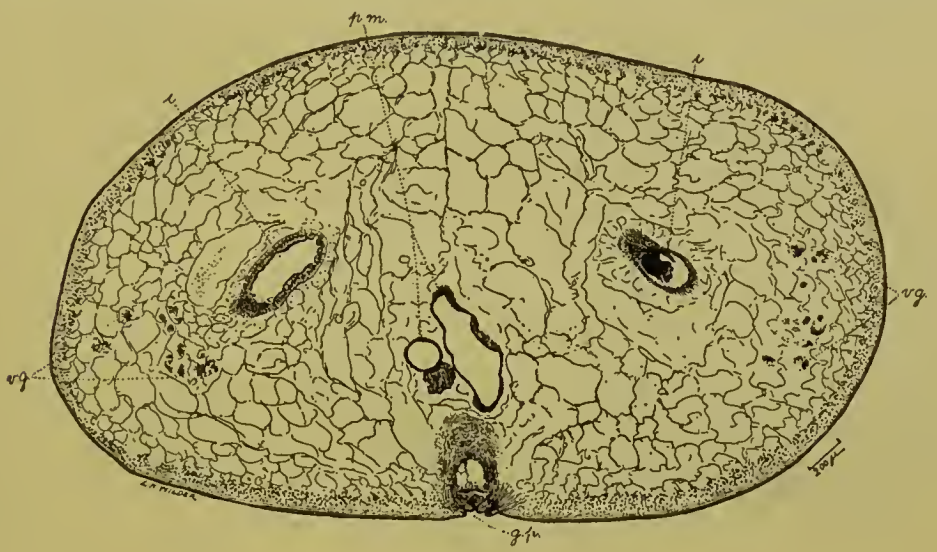

FIG. 146.

ventral direction and form the dorso-ventral slit-like lumen of the bulbs so that in a section, say, at the level of origin of the esophagus, the lumen of the sucker and bulbs combined has a broad H-shape (fig. 143). The caudo-dorsal extremity of the slit-like lumen of the bulbs leads into the irregular lumen of the pouches (fig. 144). The sucker, bulbs, and pouches are lined throughout with a cuticle in anatomical continuation with that of the body surface. That of the second portion of the sucker and of its bulbs is provided with minute irregularly scattered conical papillæ. The esophagus (figs. 139, 140, 143, 145) springs from the base of the sucker in the space between the downward projections of the bulbs.

From this point it passes caudad, describing a slight curve ventrad, to a point but very little less than one-third of the body length from the oral extremity, slightly nearer the venter than the dorsum and about equidistant from the lateral margins, where it terminates, giving origin to the intestinal ceca. This terminal portion is some-

what expanded, and its musculature distinctly though not very greatly increased in thickness. The musculature of the esophagus consists of 2 layers, an internal of circular and an external of longitudinal fibers. The increase in thickness of the muscle wall of the caudal portion of the esophagus takes place gradually, and is due mainly to an increase in thickness of the internal circular layer. The intestinal tubes leave the latero-dorso-caudal aspect of the slightly-expanded caudal extremity of the esophagus and curve downward (caudad) and outward (laterad) and slightly dorsad, forming a transverse arch in the first part of their course. They terminate by blind extremities in the caudal portion of the body, the left at a very slightly higher level than the right, and both slightly caudad of a transverse plane through the equator of the acetabulum and about midway between the latero-dorsal aspect of the latter and the corresponding aspect of the body surface of the worm (figs. 139, 140, 151). In their course caudad the intestinal ceca describe an undulating path. The undulations are of moderate amplitude, directed from front (venter) to back (dorsum) and maintain about an equal distance from the latero-dorsal, curved surface of the worm.

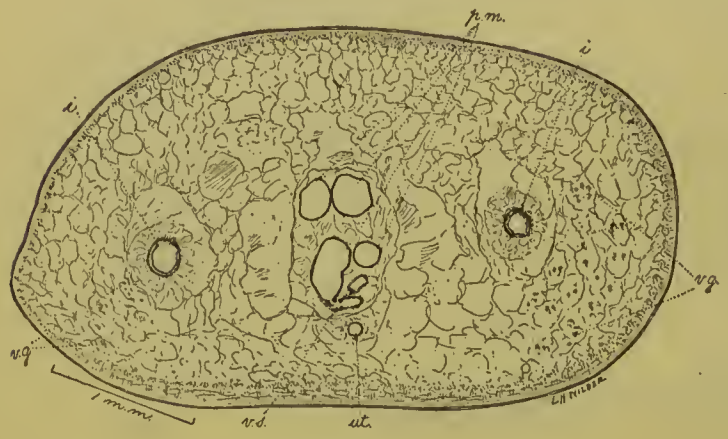

FIG. 147.

The ceca approach nearest the dorso-median longitudinal line in the testicular zone, and reach a position dorsad of the caudal portions of the corresponding testis. The diameter of the intestines varies somewhat in different portions, and although they are, in a general way, cylindrical tubes, yet they are compressed here and there in one diameter or another, so that in transverse sections they present quite a variable outline. The lumen of the esophagus is lined with a cuticular layer in anatomical continuation with that of the sucker, but apparently somewhat thicker than that of the latter. This lining ceases abruptly at the beginning of the intestinal ceca, which are lined throughout with an epitheial cell layer.

GENITAL SYSTEM.—The male and the female genital organs, with the exception of the vitellogene glands, are disposed in the median field bounded laterally by the intestinal ceca.

Male organs.—This worm is provided with 2 fairly large lobulated (cauliflower-like) testes (fig. 148). They are placed one on each side of and close to the median sagittal plane in the same zone, slightly

nearer the caudal than the oral extremity and decidedly nearer the venter than the dorsum. There is but slight if any difference in the size of the two organs. Such difference as may exist is in favor of the left.

From the dorsal aspect of each testis there emerges a vas efferens (fig. 148), which is directed at first slightly cephalo-mediad, then more directly mediad to unite with its fellow at a point in about the median sagittal plane, slightly nearer the caudal than the oral extremity, and considerably nearer the dorsum than the venter, to form the vas deferens. The first portion of the vas is an intricately coiled thin walled moderately-dilated duct or vesicula seminalis. At a point which may be clearly distinguished (fig. 147) the thin walled vesicula gives place to a relatively thick (15μ) muscular walled canal (pars musculosa) of considerable caliber (150μ), which is much less

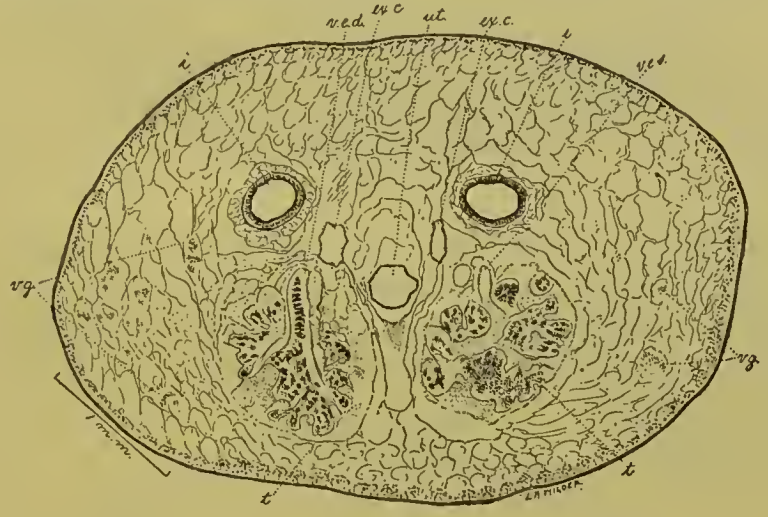

FIG. 148.

intricately coiled, so that its longitudinal windings may be followed in transverse sections. A valve-like constriction of the lumen marks the change from vesicula to pars musculosa. The windings of these two portions of the vas deferens form a fairly compact mass, which lies in the axial region of the body between and cephalo-dorsad of the testes, and longitudinally between the equatorial plane and a transverse plane slightly cephalad of the genital pore. The terminal portion of the vas deferens is relatively quite short, and, like that of the pars musculosa, its beginning is clearly and sharply marked by a change in the character of the wall, which becomes thin and surrounded by glandular cells, which are relatively few in number, and by a valve-like constriction of the lumen. This portion of the vas deferens, which by analogy may be called the pars prostatica, is in the form of a small vesicle dorsal of the genital pore. From its ventral aspect there passes ventrad a short muscular duct (ductus ejaculatorius), which unites with the metraterm to form a ductus her-

maphroditicus. The latter, a short delicate canal, opens into a small chamber, which in its turn opens into a slit-like genital atrium (fig. 140).

Female organs.—In the axial region of the body, a little to the left of the median line, between two transverse planes, one of which is

FIG. 149.

just caudad of the caudal plane of the testes and the other just cephalad of the upper margin of the acetabulum, are the ovary and shell gland, the former just above (cephalad) and slightly to the left of the latter. From the dorso-caudal aspect of the ovary there

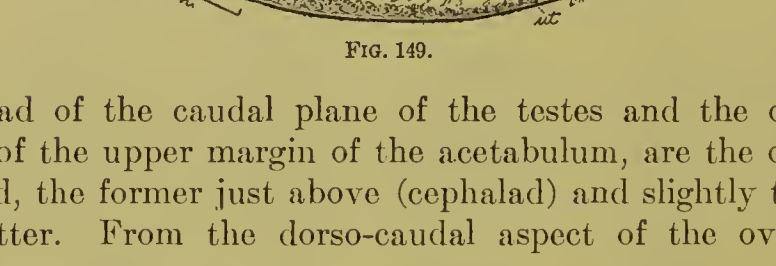

FIG. 150.

springs the oviduct, which turns caudad as it passes to the dorsal aspect of the shell gland at the superior margin of which it divides into two branches, one of which curves slightly to the right to penetrate the dorsal aspect of the shell gland, in the substance of which it is joined by the vitello-duct to form the ootype. The shell gland is con-

siderably smaller than the ovary, immediately caudad of which it lies. It is penetrated by the vitello-duct and, as just described, by the oviduct on its caudo-dorsal aspect. These two ducts unite to form a fusiform ootype (fig. 149), which is directed dorso-ventrally and is continued as the uterus, the latter emerging from the ventral aspect of the gland. The uterus, after emerging from the shell gland, curves to the right, then dorsad, and describes some coils in the axial region of the body to the right and dorsad of the shell gland and ovary, as it winds its way cephalad. At about the level of the superior aspect of the ovary it passes obliquely cephalo-ventrad to reach the ventral aspect of the coiled vas deferens. From this point onward its course is but slightly wavy, maintaining throughout its relation to the vas deferens as it passes at first directly cephalad, then gradually tilts ventrad, uniting with the ductus ejaculatorius at about the level and a short distance dorsad of the genital pore. The second of the two ducts into which the oviduct has been described as branching at the level of the superior margin of the shell gland is Laurer's canal (fig. 140). This canal passes caudo-dorsad to open in the middle line of the dorsal surface, a little caudad of the level of the upper margin of the acetabulum. The vitellogene glands, consisting of well-developed follicles, occupy the lateral regions of the body, external to the intestinal ceca, and extend from about the level of the plane of the base of the esophageal pouches to or slightly caudad of the plane of the cecal extremities of the intestines. At about the level of the shell gland a duct leaves each of the vitellogene glands and passes transversely inward ventrally of the ceca, the two uniting at the level of and close to the ventro-caudal margin of the shell gland (fig. 150). From their point of junction a duct passes dorsad, skirting the caudo-mesial margin of the shell gland and penetrating the latter at its caudo-dorsal aspect.

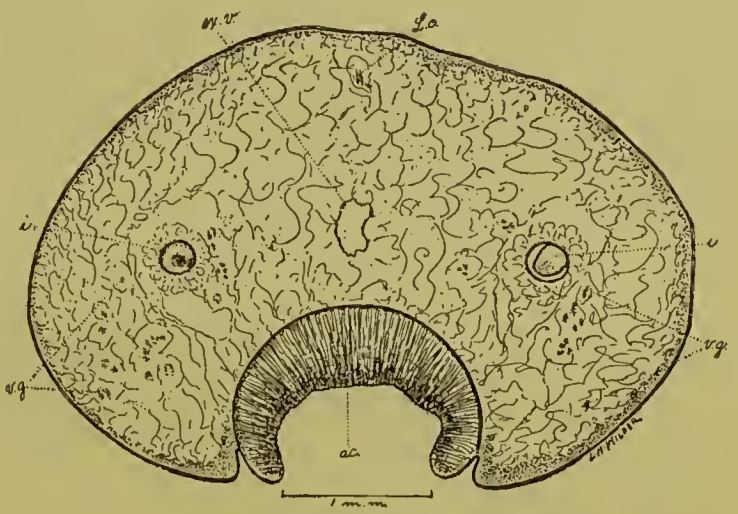

FIG. 151.

EXCRETORY SYSTEM.—This is highly developed. Two large and several small excretory canals enter the cephalic aspect of the excretory vesicle, which lies in the caudal portion of the axial region of the body dorsad of the acetabulum (figs. 140, 151). The vesicle is

an elongate sack, the lumen of which as it extends caudad gradually becomes reduced in caliber, finally becoming a narrow canal, the terminal portion of which is lined with a cuticle in anatomical continuation with that of the surface. This terminal portion or excretory duct opens in the middle line of the dorsal surface only a little above the caudal margin of the worm and at a considerable distance caudad of the opening of Laurer's canal.

ILLUSTRATIONS.

FIG. 137.—Ventral view of *Ps. stanleyii*. Enlarged. Original.

FIG. 138.—Profile view of same. Enlarged. Original.

FIG. 139.—Frontal projection. Shows oral sucker (*o. s.*), suctorial bulbs (*s. b.*), suctorial pouches (*s. p.*), esophagus (*es.*), intestines (*i.*), testes (*t.*), vasa efferentia (*v. e.*), ovary (*ov.*), shell gland (*s. g.*), uterus (*ut.*), position of genital pore (*g. p.*), and acetabulum (*ac.*). *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, *h–h*, *j–j*, *k–k*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 140.—Profile projection. Shows oral sucker (*o. s.*), suctorial bulb (*s. b.*), suctorial pouches (*s. p.*), esophagus (*es.*), intestines (*i.*), right testis (*t*), right vas efferens (*v. e.*), vas deferens (*v. d.*), ovary (*ov.*), shell gland (*s. g.*), uterus (*ut.*), oviduct (*ov. d.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), and genital atrium (*g. a.*). *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, *g–g*, *h–h*, *j–j*, *k–k*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 141.—Transverse section at *a–a* figs. 139 and 140. Shows form of body, surface papillæ (*s. pap.*) and oral sucker (*o. s.*). Enlarged. Original.

FIG. 142.—Transverse section at *b–b* figs. 139 and 140. Shows form of body, form of esophageal portion of sucker (*o. s.*), perisuctorial space (*p. s. sp.*), and dorsal and ventral mesenterium-like bands (*m. b.*). Enlarged. Original.

FIG. 143.—Transverse section at beginning of esophagus through plane at *c–c* figs. 139 and 140. Shows form of body, form of oral sucker (*o. s.*), H-shaped form of suctorial lumen, perisuctorial space (*p. s. sp.*), and dorsal and ventral bands (*m. b.*). Enlarged. Original.

FIG. 144.—Transverse section through plane *d–d* figs. 139 and 140. Shows form of body, esophagus (*es.*), extension of lumen of suctorial bulb (*s. b.*) into suctorial pouch (*s. p.*), and caudal extension of perisuctorial space (*p. s. sp.*), which is filled with a granular coagulum. Enlarged. Original.

FIG. 145.—Transverse section through plane *e–e* figs. 139 and 140. Shows position and relations of suctorial pouches (*s. p.*) to esophagus (*es.*), the esophageal ganglion (*e. g.*), and the caudal extensions of the perisuctorial space (*p. s. sp.*), which contains some granular coagulum. Enlarged. Original.

Fig. 146.—Transverse section through plane at *f–f* figs. 139 and 140. Shows genital pore (*g. p.*), pars musculosa (*p. m.*), the intestinal ceca (*i.*), and the vitellaria (*v. g.*). Enlarged. Original.

Fig. 147.—Transverse section through plane *g–g* figs. 139 and 140. Shows position and relations of intestines (*i.*), pars musculosa (*p. m.*), the valve-like junction of the vesicula seminalis (*v. s.*) with the pars musculosa, the uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

Fig. 148.—Transverse section through plane *h–h* figs. 139 and 140. Shows position and relations of the testes (*t.*), the point of origin of the right (*v. e. d.*) and the left (*v. e. s.*) vas efferens, uterus (*ut.*), intestinal ceca (*i.*), vitellaria (*v. g.*), and excretory canals (*ex. c.*). Enlarged. Original.

Fig. 149.—Transverse section through plane *i–i* figs. 139 and 140. Shows position and relations of shell gland (*s. g.*), Laurer's canal (*L. c.*), uterus (*ut.*), intestines (*i.*), vitellaria (*v. g.*), and excretory canals (*ex. c.*). Enlarged. Original.

Fig. 150.—Transverse section through plane *k–k* figs. 139 and 140. Shows position and relations of transverse vitello-ducts (*t. vd.*), the common vitello-duct (*c. vd.*), base of shell gland (*s. g.*), Laurer's canal (*L. c.*), the uterus (*ut.*), vitellaria (*v. g.*), intestinal ceca (*i.*), and excretory canals (*ex. c.*). Enlarged. Original.

Fig. 151.—Transverse section at plane *l–l* figs. 139 and 140. Shows position and relations of Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), vitellaria (*v. g.*), intestines (*i.*), and acetabulum (*ac.*), with its projecting rim. Enlarged. Original.

PSEUDODISCUS COLLINSII (Cobbold, 1875) Stiles & Goldberger, 1910.

[Figs. 152 to 162.]

1875: *Amphist. collinsii* Cobbold, 1875l, 741 (in *Equus caballus;* Simla, India); 1875n, 818, 819; 1879b, 357, 359; 1883x, 515.—Fischœder., 1903h, 489 to *Pseudodiscus* by Sonsino.—Huber, 1896a, 580 (India).—Sonsino, 1895, 182, fig. 2; 1895, 4–5, fig. 2.—Theobold, 1900, 51.

1895: *Amphist.* (*Pseudodiscus*) *collinsi* (Cobbold, 1875) Sonsino, 1895, 182, 187; fig. 2; 1895, 9, fig. 2.

1895: *Amphist. collinsi* Ward, 1895, 338 (in *Equus caballus*).—Fischœder, 1902a, 48 (*E. c.*; India); 1903h, 631, 632.

Specific diagnosis.—*Pseudodiscus* (p. 170): Body 5 to 5.76 mm. long by 3.5 to 4 mm. broad; brick red (fresh) or flesh tint (alcohol specimens); oval, cephalic extremity somewhat blunted, caudal extremity very broadly rounded, nearly semicircular, lateral margins convex, greatest diameter slightly caudad of equator, about in testicular zone; cephalic extremity bears minute, slender, conical papillæ. Genital pore ventro-median about nine twenty-thirds of length from anterior end, in cephalic portion of equatorial third, postbifureal, halfway between oral margin and cephalic margin of acetabulum. Acetabulum ventro-subterminal, 1.58 mm. broad, 1.1 mm. long, aperture 0.5 to 0.7 mm. in diameter, surrounded by very prominently raised margin; cavity relatively deep. Mouth terminal; oral sucker constricted at equator into a globular oral and a bibulbous esophageal portion; each

lateral bulb connects with a large globular pouch; these pouches and a portion of the sucker lie in cavities strongly suggestive of a rudimentary body cavity, but they are connected with the body wall by dorso-ventral mesenterium-like bands; esophagus arises from base between bulbs and extends about to border between cephalic and equatorial thirds of body; ceca long, extend about to equator of acetabulum, each forming in its course two strongly convex lines latero-dorsad, which come together near caudal margin of testis. Excretory pore medio-terminal, caudal of acetabulum; excretory vesicle well developed, dorsal of acetabulum.

Male organs: Testes rather small, somewhat globular and cauliflower like, ventral, equatorial, slightly nearer median line than corresponding lateral margins; zones nearly coincide, fields separate; vasa efferentia spring from dorso-median aspect, run dorso-mediad, unite about in equator in median line to form vas deferens; vesicula seminalis and pars musculosa compactly coiled in median field, extending very slightly cephalad of genital pore; pars prostatica short; ductus ejaculatorius very short, opens above metraterm into an atrium; the latter appears to communicate with a slit-like atrium from which a slender ductus hermaphroditicus extends ventrad to open on vertex of the small genital papilla; cirrus pouch absent.

Female organs: Ovary and shell gland submedian, posttesticular, preacetabular, nearer acetabulum than testes, ovary cephalad of shell gland; vitellaria, with sparsely scattered follicles, lateral of ceca, extending from equatorial plane of esophagus to plane of caudal end of ceca; vitello-ducts pass ventrally of ceca; uterus forms coils dorso-medio-lateral of ovary, and from a point about on the cephalic plane of the ovary it passes ventro-cephalad in a somewhat wavy course, crossing ventrally of the vasa efferentia, and eventually the metraterm opens into a slit-like atrium into which the ductus ejaculatorius also discharges; Laurer's canal from its origin (dorsally of shell gland) runs dorsally of excretory vesicle caudo-dorsad to dorso-median line, over equator of acetabulum, its pore being some distance cephalad of excretory pore.

Eggs: Not observed.

Type.—U.S.N.M. (Coll. Hassall) 5778 (C in sections); cotypes U.S.N.M. (Coll. Stiles) 5266, and U.S.B.A.I. 1720; all from Cobbold's original material.

Host.—The horse (*Equus caballus;* India).

Source of material.—The material, consisting of six specimens in all, was obtained from bottles as follows: U.S.N.M. (Coll. Stiles) No. 5266, containing 1 specimen; U.S.N.M. (Coll. Hassall) No. 5778, containing 4 specimens; U.S.B.A.I. No. 1720, containing 1 specimen.

These specimens represent part of Cobbold's original material, presented by him to Hassall in 1882. The worms were collected from *Equus caballus* in India.

Historical review.—Cobbold (1875l, 741) quotes from a letter from Collins, dated Simla, as follows:

> I forward you by this mail parasites found in the colon of a horse that died a subject of fever peculiar to this country. There were about a thousand of the parasites, and nearly the whole of them were situated close to the cœcum, and were loose in the gut. Not having seen parasites at all similar to these, I have taken the liberty to forward them for identification.

Cobbold states that the worms are considerably smaller than are *Amphist. hawkesii* from the elephant, and he names the worm *A. collinsii.* In a later paper (1875n, 818, 819) he refers to them again very briefly and gives the colon as the habitat.

Ward (1895, 338) merely mentions the worm, with *Amphist. stanleyi* as synonym, in a list of the parasites of the horse.

Sonsino (1895, 4–5, fig. 2) gives the size as 7 mm. long by 5 mm. broad, figures the worm, and, referring to its similarity to *Amphist. hawkesii*, places it in his new genus *Pseudodiscus*.

Huber (1896a, 580) simply states that this species "which occurs in horses, is also said to give rise to fatal disease in India."

FIG. 152.

Fischœder (1901a, 48) merely cites this form as a species inquirenda, gives the measurements as 7 mm. long by 3 mm. broad, and states that it occurs in the colon of *Equus caballus* in India.

EXTERNAL CHARACTERS.

SIZE.—The 6 specimens preserved in alcohol-glycerine varied from 5 to 5.76 mm. in extreme length and from 3.5 to 4 mm. in greatest width.

COLOR.—The worms are of a flesh tint.

FORM.—The specimens are not in very good state of preservation and are contracted in various ways, so that all specimens are not uniform; on this account it is somewhat difficult to give an accurate description of the outline. In general, however, it may be said to be oval, with a somewhat blunted oral and a broadly rounded caudal extremity; it bears quite a resemblance to *Ps. stanleyii*, but the sides appear more uniformly convex, the cephalic end seems to have less tendency to be pointed, and the caudal extremity seems to be relatively more blunt (figs. 152, 153).

FIG. 153.

SURFACE.—At the oral pole the surface is beset by minute, slender, conical papillæ. They resemble those on *Ps. stanleyii* but are more minute. Around the oral aperture and concentric with it are a number of circular shallow grooves; the one nearest the oral margin appears rather prominent and marks off a narrow circular zone about the mouth. In some of the specimens there were noted fine transverse lines on the ventral surface. The dorsal surface is irregularly grooved, probably the result in part of irregular contraction of the body, and in part, perhaps, the result of the action of the fixative and preservative.

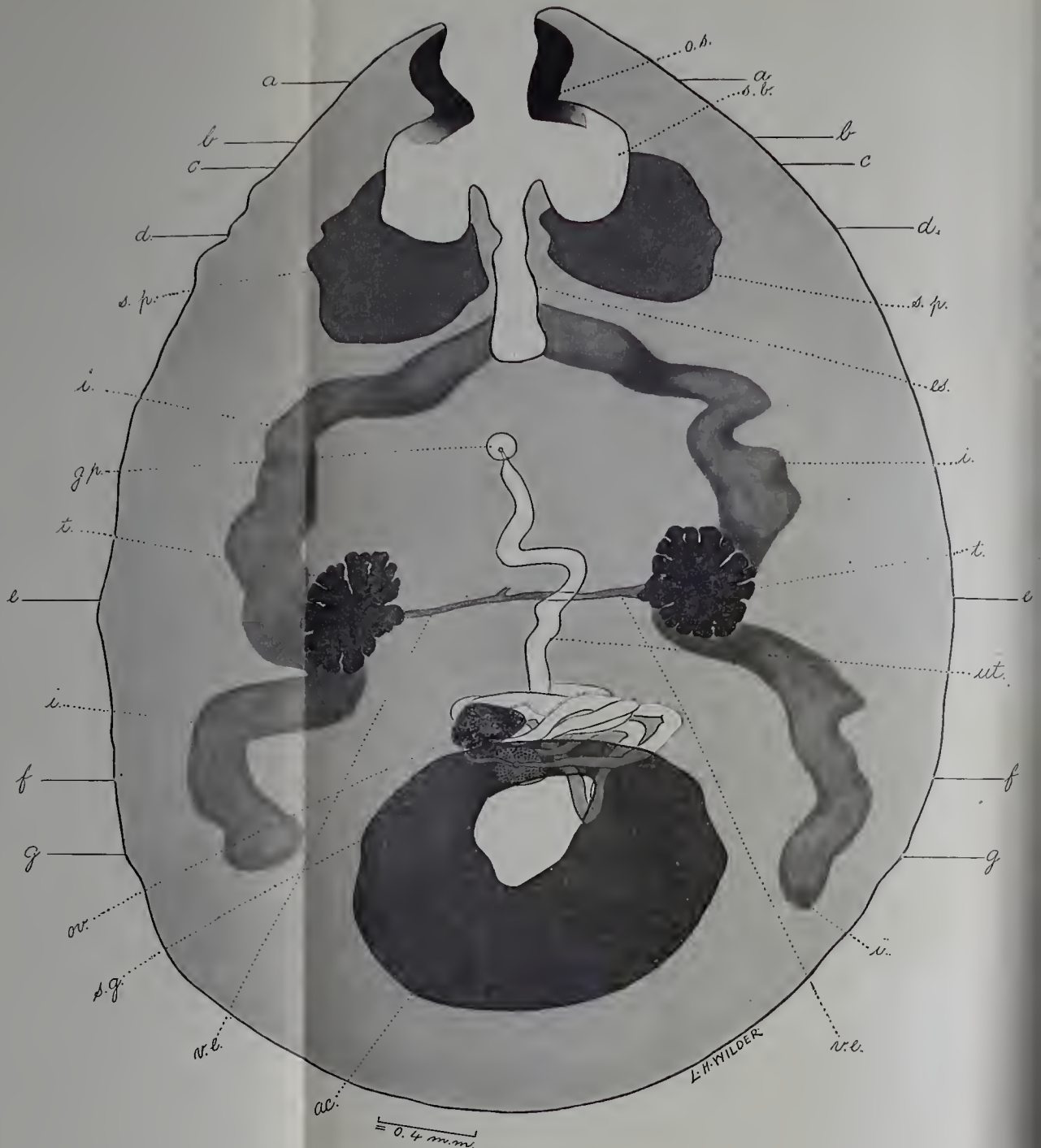

FIG. 154.

FIG. 155.

Genital pore.—On the ventral surface in the median longitudinal line and about midway between the oral margin and the anterior margin of the acetabular aperture is the genital pore. In one specimen this was at the vertex of a small circular bulging of the venter and, with the genital papillæ (apparently) filling it, suggested the form of an umbillicated smallpox vesicle.

Acetabulum.—The acetabulum, measuring 1.58 mm. in transverse and 1.1 mm. in longitudinal diameter, is in the caudal portion of the body, its aperture being ventro-subterminal and measuring 0.5 to 0.73 mm. in diameter. Encircling the aperture there is a prominent ring marked off from the general surface by a deep circular groove (figs. 152, 153, 161, 162). This projecting ring is seen in sections to be a portion of the acetabulum. The acetabulum is relatively much larger in this than in *Ps. stanleyii*, and its cavity is deeper.

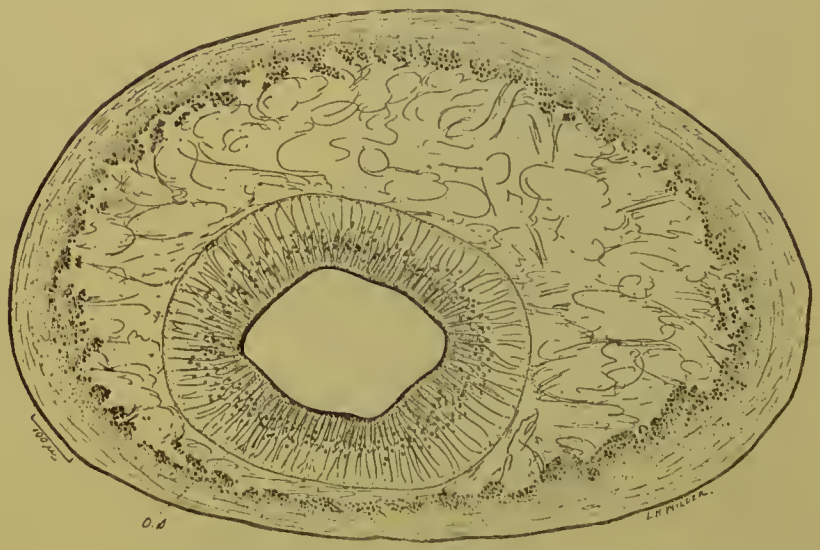

Fig. 156.

INTERNAL ANATOMY.

Digestive tract.—The cephalic extremity is pierced by a more or less circular aperture which measured 0.41 mm. and 0.36 mm., respectively, in 2 specimens. This oral aperture leads directly into a muscular sucker. As in the case of *Ps. stanleyii* the sucker may be divided for purposes of description into 2 portions, which are marked off by a constriction (or isthmus) at about its equator. The first or oral portion is of a somewhat globular form and measures 0.64 mm. in transverse and 0.52 mm. in dorso-ventral diameter; its lumen is of relatively considerable diameter, both transversely and ventro-dorsally (fig. 156). Corresponding to the region of constriction referred to as the dividing line between the two portions of the sucker the lumen becomes a transverse slit and leads into the second, esophageal (or bulbous), portion of the sucker. This portion broadens

out and, on each side of the origin of the esophagus, it extends caudad for a short distance of about 0.24 mm. in the form of a muscular bulb (figs. 154, 155). This portion of the sucker measures about 0.52 mm. in greatest dorso-ventral diameter, which is at about the equator of this portion of the sucker, and about 1 mm. in transverse diameter measured at the level of origin of the esophagus. Compared with the corresponding portion of the sucker of *Ps. stanleyii* this is relatively much larger in *Ps. collinsii*. From the ventral and from the dorsal wall of this portion of the sucker a transverse muscular ridge projects into the lumen of the sucker (figs. 155, 157) in a manner which strongly suggests the relation between the pharynx and oral sucker in *Fasciola hepatica*. The lateral projecting edges of these ridges serve as inner (median) boundaries of the dorso-ventrally-running slit-like lumen of the suctorial bulbs (fig. 158). In transverse section just above the level of origin of the esophagus the relation of the

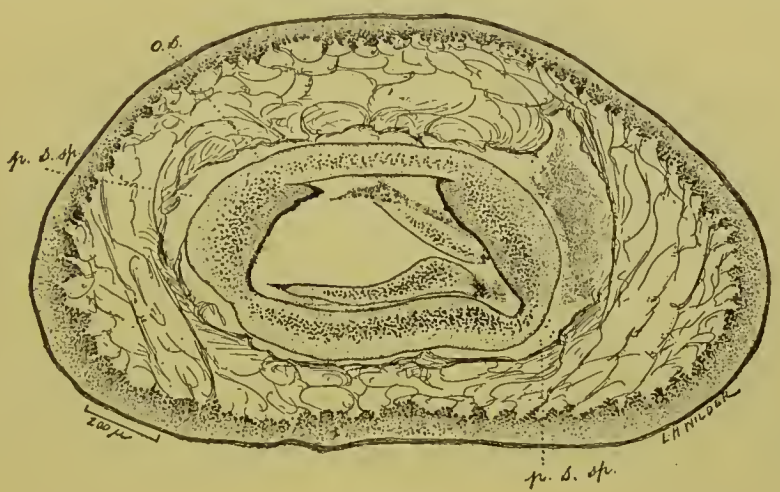

Fig. 157.

lumen of the sucker to that of its bulbs is such that combined they form a broad letter H (fig. 158).

From the dorso-caudal aspect of the lateral suctorial prolongations or bulbs there springs on each side a pouch. These pouches are roughly globular in form, of relatively considerable dimensions. The right is a little larger than the left. They are in relation to the latero-dorsal aspects of the esophagus (fig. 159) and extend caudad to about the level at which the latter gives origin to the intestinal ceca. The pouches are sharply delimited by a cavity from the surrounding body parenchyma. Their walls consist of cells which, though large and resembling those of the body parenchyma, are much smaller than those of the latter. A considerable portion of the sucker, together with the bulbs, lies in a cavity strongly suggestive of a rudimentary body cavity and similar to the condition described for *Ps. stanleyii;* mesenterium-like bands are found dor-

sally and ventrally extending from the body wall to the digestive apparatus in question. The upper limit of this cavity is as in *Ps. stanleyii* at the level of the suctorial isthmus. At or slightly above the level of origin of the esophagus this cavity becomes definitely divided into two (fig. 158), which inclose the bulbs and extend caudad to a point slightly below (caudad of) the corresponding caudal margin of the pouch. The cavity contains a granular mass (fig. 158) resembling if not identical with the granular material encountered here and there in the excretory canals. The lumen of the second portion of the sucker is transversely elongate, more or less contracted ventro-dorsally, and extends laterally into the lateral suctorial prolongations; in these the lumen, though still slit-like, is directed ventro-dorsally. In its turn this dorso-ventral slit-like lumen is continued from its dorsal extremity into the lateral pouches. The

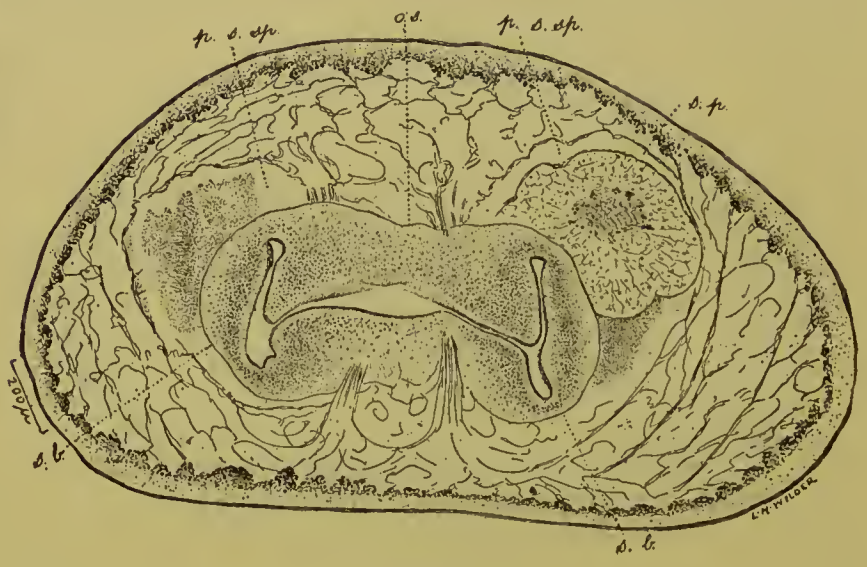

FIG. 158.

lumina of the latter are irregular in form and variable in the degree of distention, both in different specimens and at different levels in the same specimen. The esophagus leaving the sucker, as already described, passes caudad, describing in its course a slight curve, with convexity ventrad, and at about the junction of the first with the middle third of the body length it terminates, giving origin laterally to the intestinal ceca. The intestines, as simple tubes, pass at first dorso-laterad and at the same time slightly caudad to a point about one-fourth the width from the lateral margins, where they bend almost directly caudad, describing a wavy course both transversely and ventro-dorsally, similar to that in *Ps. stanleyii*, and terminate by cecal extremities laterally of the acetabulum at about the level of the lower margin of the aperture of the latter. In their course caudad they markedly approach the median line at one point, namely, dorsad of the corresponding testis.

The lumen of the digestive tract from the oral margin to the intestinal ceca is lined by a cuticle-like layer in anatomical continuation with that of the body surface. It is thickest in the esophagus. In the region of the mouth in the esophageal portion of the sucker and in that part lining the lumen of the lateral suctorial prolongations or bulbs it is beset by numerous small conical papillæ. These papillæ were not observed in any other portion of the sucker or in the suctorial pouches. The intestinal lumen is lined by an epithelial cell layer.

Genital system.—As in *Ps. stanleyii*, the male and the female genital organs, except the vitellogene glands, are disposed in the median field, namely, between the intestinal ceca.

Male organs.—This worm is provided with two roughly globular, cauliflower-like (fig. 160) testes. They are disposed in one of the

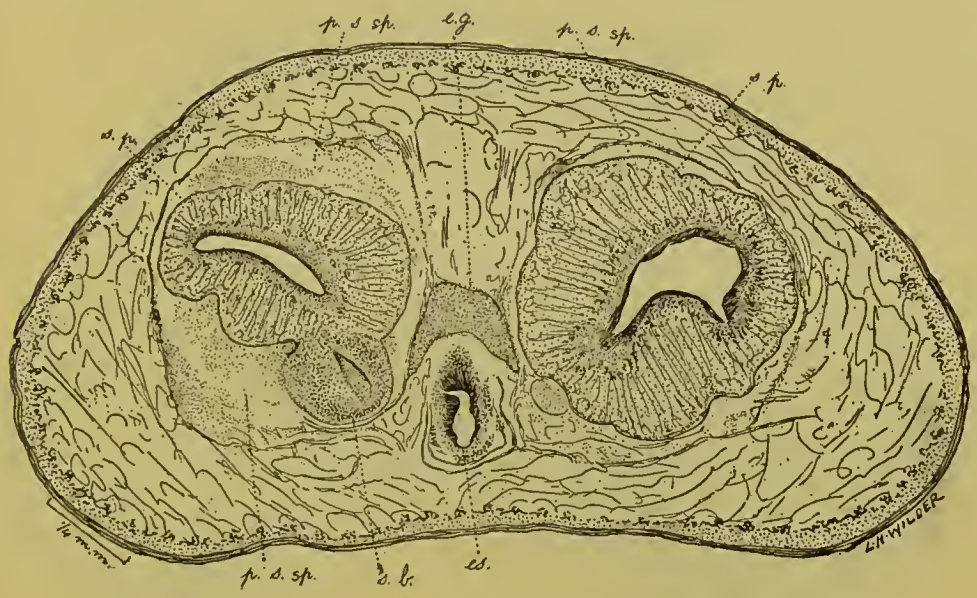

Fig. 159.

transverse diameters, (very) slightly (if at all) caudad of the equator of the worm. Each testis is a little nearer the median-sagittal plane than the corresponding lateral margin and much nearer the venter than the dorsum (figs. 154, 155, 160). From the dorso-median aspect of each testis there springs a duct, vas efferens, which passes more or less horizontally dorso-mediad, uniting with its fellow to form the vas deferens. The vas deferens is clearly differentiated into three portions, the first and second, vesicula and pars musculosa, being compactly coiled in the axial region of the body of the worm.

The vesicula is thin walled, but is not notably dilated; the musculosa, measuring about 112 μ in diameter, is provided with a relatively thick (37 μ) muscular wall; its terminal portion passes ventrocephalad, and its wall becomes somewhat reduced in thickness as it passes into the third division (pars prostatica) of the vas deferens.

The latter is distinguished, as in other forms of this group, by being inclosed in a mass of nucleated cells; the prostatica is short and maintains the direction assumed by the distal portion of the pars musculosa, coming into close relation to the dorsal aspect of the terminal portion of the uterus; the prostatic cells cease a little before the male duct ends; this terminal portion appears to be very short and corresponds to the ductus ejaculatorius of the other forms. The ductus ejaculatorius appears to open just above the metraterm on the vertex of what may be regarded as a papilla forming the dorsal wall of a curved slit-like atrium. This atrium appears to communicate (?) with a smaller slit-like space immediately ventrad of it, from which there passes a slender duct, interpreted as the ductus hermaphroditicus, that opens on the vertex of a small genital papilla. The ductus hermaphroditicus, the two slit-like atria, the ductus ejactulatorius,

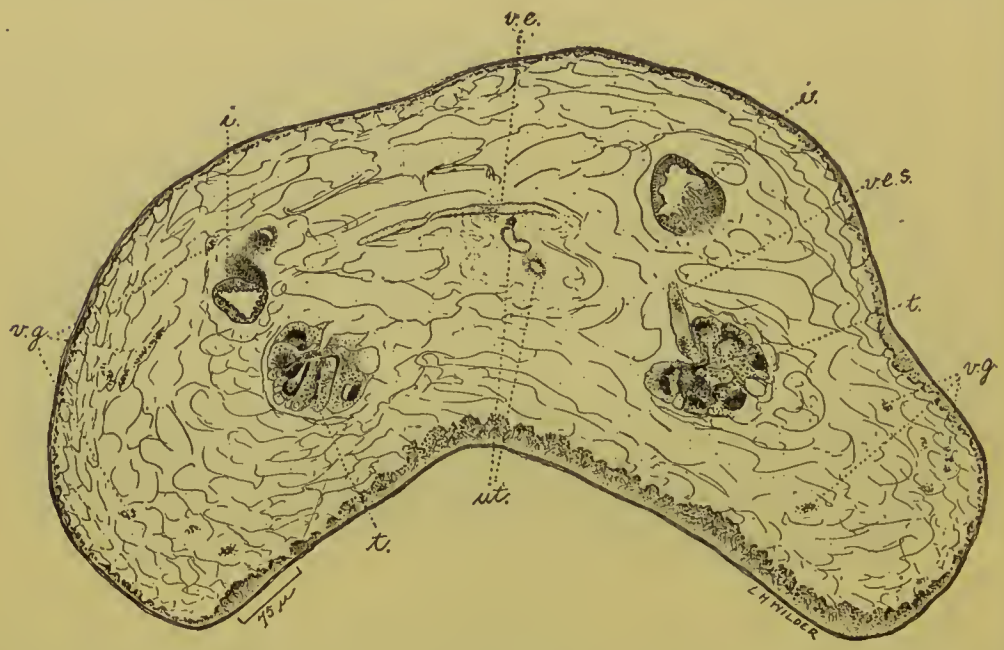

FIG. 160.

and metraterm are inclosed in a somewhat globular mass of muscular fibers.

This description of the termination of the male and female canals and of the ductus hermaphroditicus is tentative, as it is based only on transverse sections of poorly preserved material, which are of difficult and doubtful interpretation.

Female organs.—In the posttesticular axial region of the body, but a little to the right of the median line and just above the upper margin of the acetabulum, is the ovary. Close to the caudo-mesial aspect of the latter is the slightly smaller shell gland (figs. 154, 155). The oviduct springs from the caudal aspect of the ovary and passes at first directly caudad for a very short distance, then it passes dorso-mediad and skirts the dorso-caudal aspect of the shell gland which it pene-

trates. Laurer's canal leaves the oviduct at a point just before the latter begins to skirt the shell gland; it passes caudo-dorsad, cephalad of the excretory vesicle, the dorsal aspect of which it gains, and ultimately it reaches the middle line of the dorsal surface at a point in a plane slightly cephalad of the equator of the acetabulum, and relatively some distance above the excretory pore. The vitellogene glands consist of sparsely scattered follicles in the lateral regions of the body (external to the intestinal ceca), appearing also ventrally and dorsally of the ceca. They extend longitudinally from the level of the middle of the esophagus to the level at which the intestinal tubes terminate. From each gland a duct passes transversely mediad in front of the corresponding intestine to unite with its fellow close to the ventro-caudal aspect of the shell gland. From their point of union

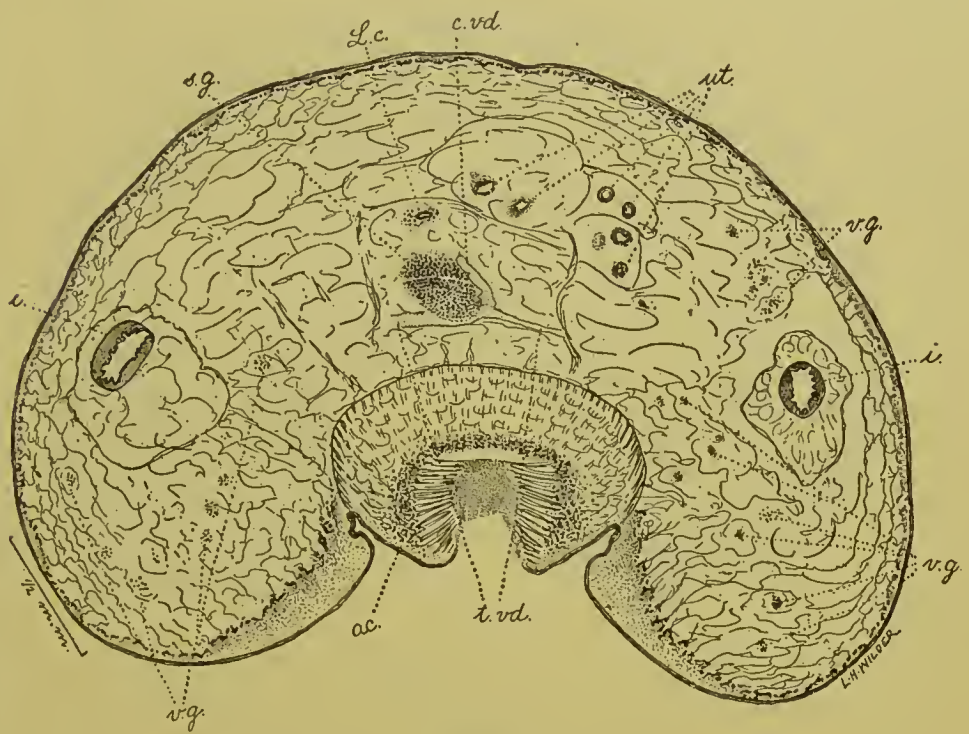

FIG. 161.

(fig. 161) a smaller duct originates and passes dorsad and a little to the right, skirting the corresponding aspect of the shell gland which it penetrates at its caudo-dorsal aspect a little to the left of the point of penetration of the oviduct. Within the gland the vitello-duct unites with the oviduct, the duct resulting from their union forming the ootype and continuing beyond as the uterus.

The uterus emerges from the ventral aspect of the shell gland, winds its way to the left, and then forms a number of coils in the axial body region to the left and dorsad of the ovary as it winds its way cephalad. Its windings cease at about the level of the cephalic aspect of the ovary; beyond this point the uterus pursues a direct, though slightly wavy, course ventro-cephalad to gain the ventral aspect of the coiled

vas deferens, passing beneath and ventrad of the arch of union of the vasa efferentia. In the remainder of its course the uterus retains this relation to the ventral aspect of the male duct and, as has been described, appears to open immediately below the latter into the slit-like atrium (fig. 155.)

Excretory system.—The excretory system appears well developed. The excretory vesicle is in the caudal portion of the body dorsally of the acetabulum (figs. 155, 162). It extends caudad to about the level of the caudal margin of the acetabulum. At this point its lumen becomes reduced to a duct, with a narrow lumen but strong wall, which passes directly caudad and opens in the median line of the dorsum almost if not quite at the caudal extremity of the worm.

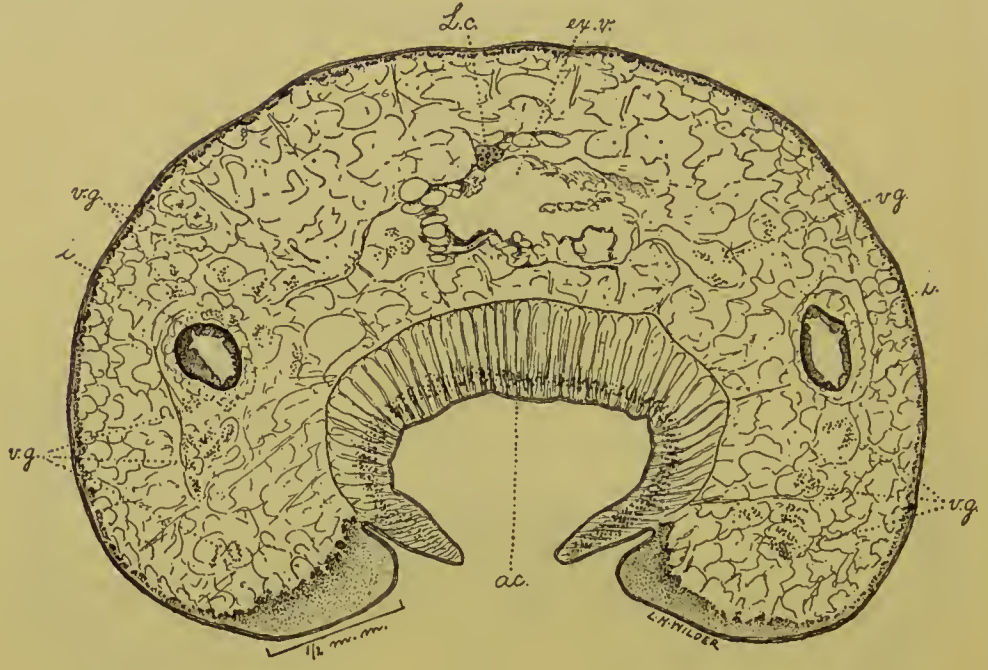

Fig. 162.

Relation to *Pseudodiscus stanleyii*.

Except for the difference in size, the two species are much alike in external appearance. A study of their internal anatomy brings out several points of difference. The esophageal portion of the sucker in *Ps. collinsii* is relatively much broader than that of *Ps. stanleyii*, and presents both a dorsal and a ventral transverse projecting ridge in its lumen; *Ps. stanleyii* presents a dorsal ridge only. The testes are actually and relatively much smaller in *Ps. collinsii* than in *Ps. stanleyii*, and furthermore they are more widely separated in *Ps. collinsii* than in *Ps. stanleyii*. The anatomy of the terminal portions of the genital canals appears to differ markedly in the two forms, though too much emphasis should not be placed on this because of the difficulty of interpretation of sections and of the limited and unsatisfactory nature of the material. The opening of Laurer's canal is much

farther caudad in *Ps. collinsii* than in *Ps. stanleyii;* in the former it is a little above the caudal margin of the acetabulum, whereas in the latter it is only a little below the upper margin of the acetabulum. The acetabulum of *Ps. collinsii* is relatively much larger than of *Ps. stanleyii,* and its cavity is deeper. The ovary and the shell gland are at about the level of the upper margin of the acetabulum in *Ps. collinsii,* but distinctly above this level and nearer the level of the caudal aspects of the testes in *Ps. stanleyii.*

ILLUSTRATIONS.

FIG. 152–153.—Ventral aspect showing some of the variations in outline.

FIG. 154.—Frontal projection from transverse sections of specimen shown in fig. 152. Shows oral sucker (*o. s.*), suctorial bulbs (*s. b.*), suctorial pouches (*s. p.*), esophagus (*es.*), intestines (*i.*), genital pore (*g. p.*), testes (*t.*), vasa efferentia (*v. e.*), uterus (*ut.*), ovary (*ov.*), shell gland (*s. g.*) and acetabulum (*ac.*). *a–a, b–b, c–c, d–d, e–e, f–f, g–g,* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 155.—Profile projection of specimen shown in fig.152. Shows oral sucker (*o. s.*), left suctorial bulb (*s. b.*), suctorial pouch (*s. p.*), esophagus (*es.*), vas deferens (*v. d.*), uterus (*ut.*), ovary (*ov.*), shell gland (*s. g.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore(*ex. p.*), and genital pore (*g. p.*). *a–a, b–b, c–c, d–d, e–e, f–f, g–g,* planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 156.—Transverse section through plane *a–a* figs. 154 and 155. Shows form of body and form of oral sucker (*o. s.*). Enlarged. Original.

FIG. 157.—Transverse section through plane *b–b* figs. 154 and 155. Shows oral sucker (*o. s.*) with ventral and dorsal ridges projecting into its lumen, and perisuctorial space (*p. s. sp.*) containing some granular coagulum. Enlarged. Original.

FIG. 158.—Transverse section through plane *c–c* figs. 154 and 155. Shows H-shaped lumen of oral sucker (*o. s.*) and suctorial bulbs (*s. b.*), the superior margin of the left suctorial pouch (*s. p.*) and the perisuctorial space (*p. s. sp.*) containing some granular coagulum. Enlarged. Original.

FIG. 159.—Transverse section through plane *d–d* figs. 154 and 155. Shows esophagus (*es.*), esophageal ganglion (*e. g.*), caudal portion of right suctorial bulb (*s. b.*), suctorial pouches (*s. p.*), and caudal prolongations of perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 160.—Transverse section at plane *e–e* figs. 154 and 155. Shows position and relation of the testes (*t.*), intestinal ceca (*i.*), arch of union of vasa efferentia (*v. e.*), origin of left vas efferens (*v. e. s.*), the uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 161.—Transverse section at plane *f–f* figs. 154 and 155. Shows position and relation of caudal margin of shell gland (*s. g.*), union of transverse vitello-duct (*t. vd.*), the common vitello-duct (*c. vd.*), Laurer's canal (*L. c.*), uterus (*ut.*), vitellaria (*v. g.*), intestines (*i.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 162.—Transverse section at plane *g–g* figs. 154 and 155. Shows position and relation of intestines (*i.*), excretory vesicle (*ex. v.*), Laurer's canal (*L. c.*), vitellaria (*v. g.*), and acetabulum (*ac.*) with its projecting rim. Enlarged. Original.

HAWKESIUS, new subgenus.

SUBGENERIC DIAGNOSIS.—*Pseudodiscus* (p. 170): Esophageal wall with pronounced muscular thickening in caudal half. Testicular zones separate, nearly or quite abut, fields coincide.

TYPE SPECIES.—*Pseudodiscus* (*Hawkesius*) *hawkesii*.

PSEUDODISCUS HAWKESII (Cobbold, 1875) Stiles & Goldberger, 1910.

[Figs. 163 to 174.]

1875: *Amphist. hawkesii* Cobbold, 1875n, 818, 819 (in *Elephas indicus;* India); 1877e, 234; 1879b, 393, 396, 399; 1882, 238–240, fig. 8; 1883x, 515.—Braun, 1893a, 874, 905; 1893d, 466 (*hawkesi*).—Fischder., 1902a, 48 (*hawkesi*) (in *E. indicus;* India); 1903h, 489 (to *Pseudodiscus* by Sons., 1895).—Galli-Valerio, 1901c, 364 (in elephant).—Huber, 1896a, 579–580 (in elephant).—Looss, 1902m, 439 (*hawkesi*).—Mégnin, 1882v, 455.—Piana & Stazzi, 1900a, 511, 519–525, 529, figs. 12–14 (*hawkesi*); 1901, 416.

1893: *Amphist. hawkesi* Braun, 1893d, 466 for *hawkesii*.

1895: *Amphist. hawkesi* Sonsino, 1895, 182 for *hawkesii;* 1895, 187, fig. to *Pseudodiscus;* 1896, 310.

1895: *Amphist.* (*Pseudodiscus*) *hawkesi* (Cobbold, 1875) Sonsino, 1895, 187 (9), fig. 1.

1895: *Amphist.* (*Pseudodiscus*) *hawkesi* Sonsino, 1895, 9, fig. 1.

1896: *Pseudodiscus hawkesi* (Cobbold, 1875) Sonsino, 1896, 310.—Piana & Stazzi, 1900, 519 to *Amphist.*

SPECIFIC DIAGNOSIS.—*Pseudodiscus* (p. 170): Body 3.5 to 5 mm. long by 2 to 3 mm. broad; light buff in color (alcohol material); oval, oral pole bluntly rounded, tilted slightly ventrad, caudal pole very bluntly rounded, almost semicircular; lateral margins convex in transverse section, straight to convex longitudinally, dorsum convex, venter flat to slightly concave longitudinally and transversely; oral pole with slender digitate papillæ. Genital pore ventro-median, postbifurcal, two-fifths of body length from oral margin with subhemispherical bulging. Acetabulum ventral at caudal end, oval to circular, 1.2 mm. in sagittal diameter, aperture 0.58 mm., dome 0.30 mm. thick; its margin projects and is separated from the body by circular groove; cavity rather shallow. Mouth subterminal; oral sucker constricted at equator into globular oral and a shorter broader esophageal portion; well-defined bulbs absent, but there are 2 large pouches which extend caudad about to equator of esophagus; esophageal portion of sucker and the pouches lie in a perisuctorial cavity; esophagus arises from base of sucker, extends to caudal margin of oral third of body; the anterior half of esophagus about 90μ thick, with wall 22μ thick, its caudal half increased enormously (up to 330μ) in diameter by increase of muscular tissue; ceca long, extend in wavy course to or slightly beyond equator of acetabulum; their course is wavy and at equator of animal they approach toward median line. Excretory pore at caudal extremity;

excretory vesicle dorsal of acetabulum, extends from near shell gland to postacetabular zone.

Male organs: Testes preacetabular in same longitudinal median field, with separate or slightly overlapping zones, deeply lobate but not of cauliflower type, noticed in *Ps. stanleyii;* vasa efferentia arise from dorsal aspect, extend cephalo-dorso-laterad, then cephalad, uniting about 120μ cephalad of cephalic testis to form vas deferens; vesicula much coiled, musculosa coiled and well developed, prostatica and ejaculatorius short, the latter uniting with metraterm to form wide ductus hermaphroditicus, which discharges at genital pore; cirrus pouch absent.

Female organs: Ovary posttesticular, in testicular fields, in pre- and acetabular zone; shell gland postovarial; vitellaria, with small follicles, chiefly in extracecal area, apparently confined to cecal zone; uterus emerges ventrally from shell gland, passes in coils dorsad, caudad, then cephalad dorsally of ovary and testes, ventrocephalad under arch of vasa efferentia, to ductus hermaphroditicus; Laurer's canal long, extends from oviduct caudo-dorsad, dorsally of excretory vesicle to dorso-median line, opening slightly cephalad of caudal margin of acetabulum, cephalad of excretory pore.

Eggs: Not observed.

Type.—Unknown.

Habitat.—Colon of elephant (*Elephas indicus*), India.

Source of material.—The material at our disposal, consisting of 11 specimens, was kindly sent to us by Prof. Pietro Stazzi, of Milan, Italy. The specimens are presumed to be some of those collected by Piana and Stazzi (1900) from the colon of an elephant.

Historical review.—Cobbold (1875l, 736) originally named this species without giving any anatomical details, but discussing its possible effects upon the host. The worms were collected from the elephant and sent to him from Secunderabad, India. They were named in honor of the sender. In his second paper (1875n, 818, 819) no details were added. Later Cobbold (1877e, 234) refers to having noticed some papillæ in the acetabulum of this species (but the question arises as to whether he did not perhaps have before him specimens of *Amphist. papillatum* from the same host). Still later (1879a, 393, 396, 399) Cobbold refers to the worms in connection with the habit of dirt-eating among elephants, and states that he had also found *hawkesii* in an elephant which died in England.

Mégnin (1882v, 455) states that Cobbold had admitted in a letter that *Amphist. hawkesii* and *A. ornatum* represent two varieties of the same species.

Cobbold (1882a, 224, 238–240, 241, fig. 8) gives *Amphist. collinsii* var. *stanleyi* as synonym of *hawkesii*, but states that he thinks that *stanleyi* will eventually prove to be a good species. He publishes the following specific diagnosis of *hawkesii*, which really represents the first attempt at a detailed zoological description:

Body of a pink color, smooth, plano-convex, finely wrinkled transversely, bluntly pointed and contracted in front, broadly rounded behind. Head surrounded by a few regular but not well-pronounced folds, armed with numerous small and extremely minute warty papillæ. Mouth terminal, circular. Ventral surface often slightly

depressed near the center, forming slight prominences on either side. Caudal sucker placed well forward, rather large, circular, with a broad lip and smooth concavity. Reproductive papilla small, situated nearly midway between the mouth and upper margin of the caudal sucker. Length, on the average, three-eighths of an inch; the longest specimen seven-sixteenths of an inch. Breadth one-fourth of an inch. Hab., large intestines of *Elephas indicus*.

Cobbold's figure 8 does not add any essential details.

Cobbold (1883x, 515) again refers to this species incidentally, but gives no further details. Neither are any additional data given by Braun (1893a, 874, 905; 1893d, 466), Huber (1896a, 579–580), Fischœder (1902a, 48; 1903h, 631), or Looss (1902m, 439), none of whom examined this species.

Sonsino (1895, 4) considers *hawkesii* as identical with *collinsii*, transfers the species to *Pseudodiscus*, and gives the following specific characters:

Color rosso carnicino come generalmente tutti gli Amfistomidi di mammiferi. 10 mm. by 6 mm. Corpo allungato, convesso pianeggiante, senza peduncolo distinto, con leggière striscie trasverse e coll' estremo anteriore ristretto, ma ottuso e l' estremo posteriore arrontondato. Bocca terminale e circolare. Superficie ventrale spesso alquanto depresse verso il centro, dando così apparenza di superficiale escavazione, con due leggière prominenze laterali corrispondenti probabilmente alle due masse testicolari. Ventosa posteriore subterminale, larga, circolare con margine grosso e con cavità liscia. Papilla genitale piccola a mezza distanza tra la bocca e il margine superiore della ventosa posteriore.

Later, Sonsino (1896, 310) merely mentions the worm.

Piana and Stazzi (1900, 520–525) described specimens of worms determined as *Amphistomum hawkesi* found in the colon of an elephant autopsied in Milan. Their diagnosis reads:

Corpo di color rosso carnicino, oblungo, convesso nel superficie dorsale ed escavato a doccia in quella ventrale. Estremità arrotondate, quella posteriore piu larga della anteriore. Lunghezza del corpo, in tutti gli individui esaminati, no superiore a 6 mm.; larghezza corrispondentemente al terzo anteriore del corpo 2.70 mm., corrispondentemente al terzo posteriore 3.70 mm. La superficie cuticolare, guardata con lente, appare irregolarmente striata nel senso trasversale. Sul margine della parte anteriore del corpo, alquanto verso la superficie ventrale, si trova la bocca oblunga in senso verticale circondata da una piccola ventosa del diametro di 0.18 mm., la quale è limita da un orlo della larghezza di 0.10 mm. Sulla superficie ventrale a livello del limite tra il terzo anteriore e il terzo mediano delle larghezza del corpo, si trova il poro genitale, in forma di un orifizio oblungo in senso trasversale, lungo 0.25 mm. e largo 0.15 mm. Sempre sulla superficie ventrale, alla distanza di 4.80 mm. della ventosa boccale, e quindi nella parte posteriore del corpo, si trova la ventosa posteriore, la quale è circondata da un orlo largo circa 0.17 mm. ed ha un orifizio del diametro di 0.40 mm.

Of the internal anatomy they recognized the "pharynx" (oral sucker), with a diverticulum each side, an esophagus 0.7 mm. long with posterior muscular thickening, and 2 long wavy ceca which end in the suctorial zone; the ovary and "vitellogene gland" [=shell gland] are located near the acetabulum; the uterus is flexuous and extends cephalad to the genital pore; dextral of the "female pore" there are seen structures indicative of the cirrus, vas deferens, and the 2 testes,

but they figure (fig. 14) 2 pairs of testes, 1 pair cephalad of the other, zones separate, fields coincide.

Piana and Stazzi point out that their specimens are smaller than Cobbold's, but explain this fact by assuming that they are dealing with young worms.

We accept the specific determination of their worms as *Amphist. hawkesii* on the principle that when an author claims to have identified a species his identification is to be assumed to be correct until proved to be incorrect. At the same time we may be permitted to recall the fact that recent work on trematodes has caused a great many surprises and it is not by any means excluded that if Cobbold's original specimens can be found, the material here accepted as *hawkesii* may eventually prove to be a distinct species.

FIG. 163.

In order to avoid a troublesome nomenclatural difficulty which frequently arises, and in regard to which authors are at present divided in opinion, we would state that should the original material of *hawkesii* prove to be distinct from the material here described, the subgenus *Hawkesius* is based upon the material now on hand, without any reference to characters which may or may not be present in the type of *hawkesii*. In other words, the species represented by U.S.P.H. & M. H.S. no. 10545 is the type of *Hawkesius*.

EXTERNAL CHARACTERS.

SIZE.—The alcohol-preserved specimens varied in length between 3.5 and 5 mm., and in greatest width between 2 and 3 mm.

COLOR.—The worms are of a light buff tint.

FIG. 164.

FORM.—The bottle in which the specimens were sent to us was found on arrival to be broken and the specimens dried out. They were put into 70 per cent. alcohol in which they regained to a considerable extent their original form, but they are still shrunken and deformed to a considerable degree (figs. 163, 164). They suggest *Ps. collinsii* in form, but appear more elongate and with the oral pole relatively more acutely pointed.

The dorsum is convex both longitudinally and from side to side; the venter is flat or slightly excavate in both the longitudinal and transverse directions, the concavity being best defined in the caudal half of the venter. The oral pole is bluntly rounded, presents a slightly bulbous appearance and is tilted to a variable degree ventrad. The caudal pole is broad and rounded from side to side. The lateral margins are convex in transverse section and straight or but slightly curved longitudinally.

Surface.—The cuticle is marked on its ventral surface by fine transverse sulci. These sulci are most clearly defined in the region between the genital pore and acetabulum. Around the oral pole there are slender digitate papillæ (fig. 172), some of which measure 90μ in length when measured in sagittal sections.

Genital pore.—In about the median line of the ventral surface, about two-fifths of the body length from the oral margin, is a distinct subhemispherical ventral bulging (figs. 163, 169) of variable extent, measuring in sections of one specimen 0.375 mm. in longitudinal diameter. At the vertex of this bulging is the genital pore. This pore measured 150μ in longitudinal diameter in one sectioned specimen. It leads into an irregularly cylindrical chamber into the lumen of which there arises from its dorsal wall the genital papilla (fig. 165).

Fig. 165.

There was observed in several of the specimens still another ventral bulging. This is elongate, in the median longitudinal line (fig. 163) and extends from a little below the bulbous oral extremity to almost the genital bulging. This elongate bulging is found in sections to correspond to the esophageal bulb (fig. 168). In the median line of the caudal portion of the venter the aperture of the acetabulum presents itself. It is irregularly oval or circular in form encircled, as in *Ps. collinsii* and *Ps. stanleyii*, by a rim which is marked off from the general surface by a deep narrow groove. On each side of this aperture the venter of the worm bulges out so that it appears to be in a more or less well-marked fairly broad vertical groove (fig. 163).

Acetabulum.—The acetabulum is in the caudal portion of the body, and, as already stated, its aperture is on the ventral aspect of the caudal extremity. Measured in sagittal sections of one specimen the vertical diameter was 1.20 mm., with an aperture of 0.58 mm. in the same diameter, with a thickness of dome of 0.30 mm. As in *Ps. collinsii* and in *Ps. stanleyii* the acetabular aperture is encircled by a projecting ring (figs. 163, 165) marked off from the general body surface by a deep narrow groove. This ring is formed by part of the acetabulum itself.

Digestive tract.—The cephalic extremity is pierced by the mouth which is somewhat elliptical in form and directed dorso-ventrally. The aperture of the mouth leads directly into the oral sucker; this appears to be divided into two portions by a circular constriction at about its equator. The first or oral portion appears somewhat globular in form. The form of the second or esophageal portion can not be made out accurately from the material at our disposal. In a general way, however, it is shorter but broader than the oral portion. The increase in the transverse diameter is preparatory to the formation of lateral suctorial pouches which project caudad and laterad of the point of origin of the esophagus. They are irregularly globular in form and extend caudad on each side and dorsally of the esophagus (figs. 165, 167, 168) to about the equator of the latter. A well-defined suctorial bulb, such as was described for *Ps. collinsii* and *Ps. stanleyii*, is not present. The suctorial walls are muscular (figs. 166, 172), but the arrangement of the muscular bundles is less compact than in *Ps. collinsii*. The structure of the pouch wall (figs. 167, 168) is distinctly less muscular than that of that portion of the sucker from which the pouches project and the transition in structure from one to the other can readily be made out. The cell structure of the pouch walls is loose but the cells are decidedly smaller than those of *Ps. collinsii*. The lumen of the sucker and pouches is lined by a thin cuticle-like layer. That of the second portion of the sucker is closely beset by small conical papillæ. A space around the caudal portion of the sucker and the pouches similar to that in *Ps. collinsii* is present (figs. 166, 167, 168). The esophagus springs from the ventral aspect of the base of the sucker. For about one-third its length it passes in a slightly wavy course caudad, then turns rather abruptly and passes directly dorso-caudad to a point in a transverse plane at about the junction of the first with the equatorial third of the body and about midway between venter and dorsum, where it gives off the intestinal ceca. The walls of the first portion of the esophagus measured in transverse sections of one specimen were about 22μ in thickness, the diameter of the esophagus at the same point being about 90μ. In the second portion of the esophagus the walls become greatly thickened

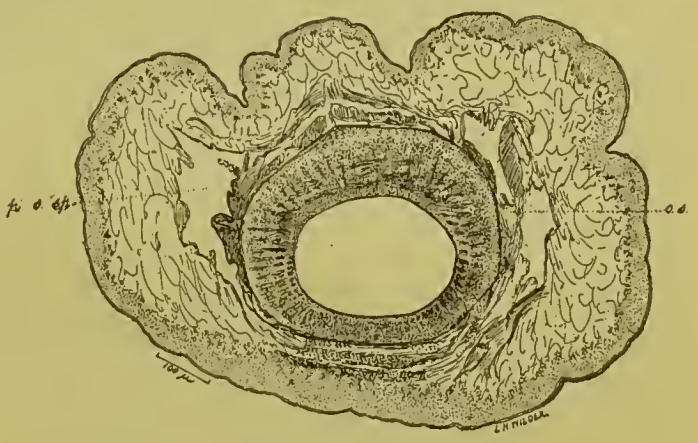

Fig. 166.

by the development of its muscular layers. In this portion three layers can readily be made out, an internal and an external of longitudinal, and a middle, very thick layer, of circular fibers (figs. 172, 173). This portion of the esophagus measured, in a sagittal section of one specimen, was 750μ long with a maximum dorso-ventral diameter of

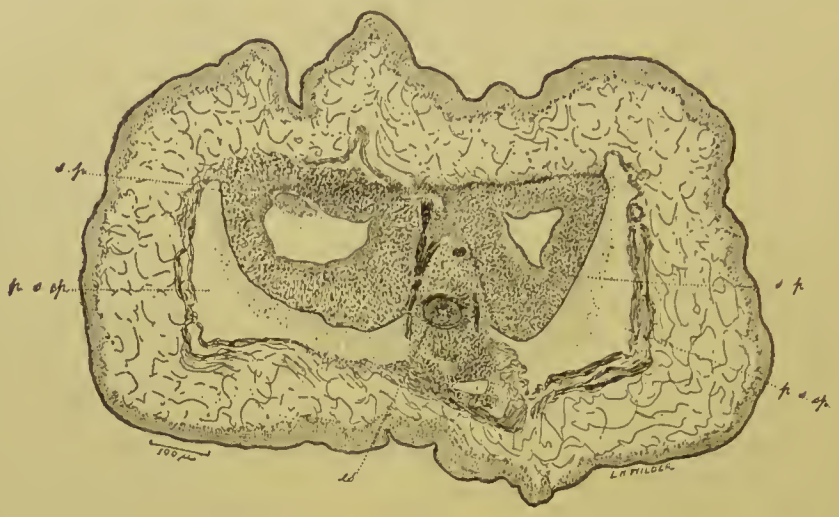

FIG. 167.

330μ and with a thickness of wall of between 90μ and 105μ. The esophagus is lined by a fairly thick cuticle-like layer.

The intestinal ceca pass laterad, at first almost at right angles with the esophagus, then describing a gentle curve they pass caudad

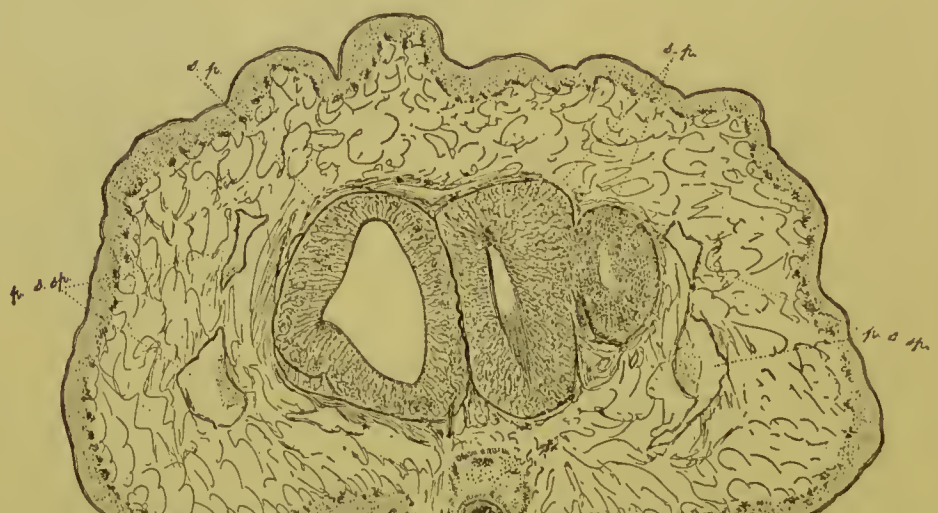

FIG. 168.

in a ventro-dorsal wavy course apparently similar to that in *Ps. collinsii* (fig. 174). At about the level of the equator of the animal the ceca approach close to the corresponding dorso-lateral aspect of the superior testis. This is also the point where in their course the intes-

tines come nearest together. A similar peculiarity has been noted in *Ps. collinsii* and *Ps. stanleyii*. The intestines extend caudad to or slightly beyond the equator of the acetabulum. In transverse sec-

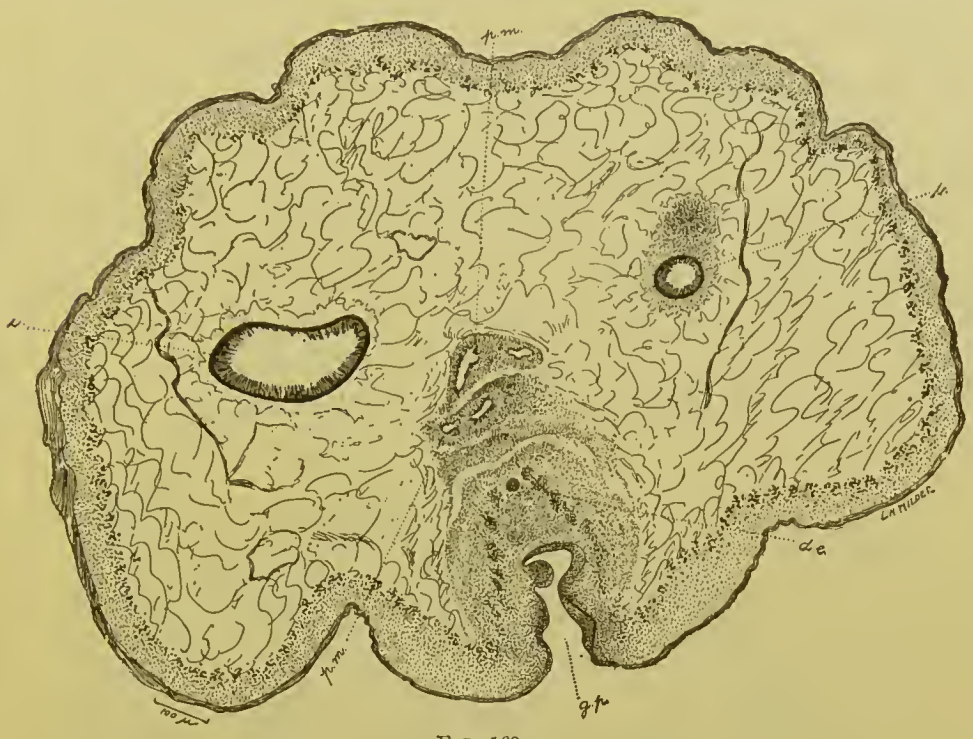

FIG. 169.

tions the ceca are irregularly circular in outline and are more or less constricted at irregular intervals, causing considerable variation in diameter. The lumen is lined by an epithelial cell layer.

GENITAL SYSTEM.—With the exception of the vitellogene glands the genital organs are disposed in the intercecal space.

Male organs.—The two testes are in the axial region of the body, somewhat nearer the venter than the dorsum. They occupy about two-ninths of the body length in the zone immediately cephalad of the acetabulum. They are placed one directly caudad of the other, their zones either overlapping very slightly or separated by a very narrow interspace. The two testes are of about the same size; measured

FIG. 170.

from a series of transverse sections of one specimen the superior testis was 420μ long by 365μ wide by 210μ thick, while the caudal testis was 400μ long by 390μ wide by 180μ thick. Each testis is divided into numerous lobes by deep infoldings of its inclosing membrane. The testes are not quite of the cauliflower-type, such as those of *Ps. collinsii* and *Ps. stanleyii*. From the dorsal aspect of each testis there emerges a vas efferens (figs. 170, 171). After emerging from the testes the vasa efferentia tend cephalo-dorsad and away from the median line, the vas from the superior testis going to the left and that from the inferior (or caudal) to the right. After reaching a point near the mesial aspect of the corresponding intestine the vasa pass directly cephalad until they reach a plane slightly (about 120μ) cephalad of the superior aspect of the superior testis, when each curves inward to unite with its fellow to form the vas deferens. In

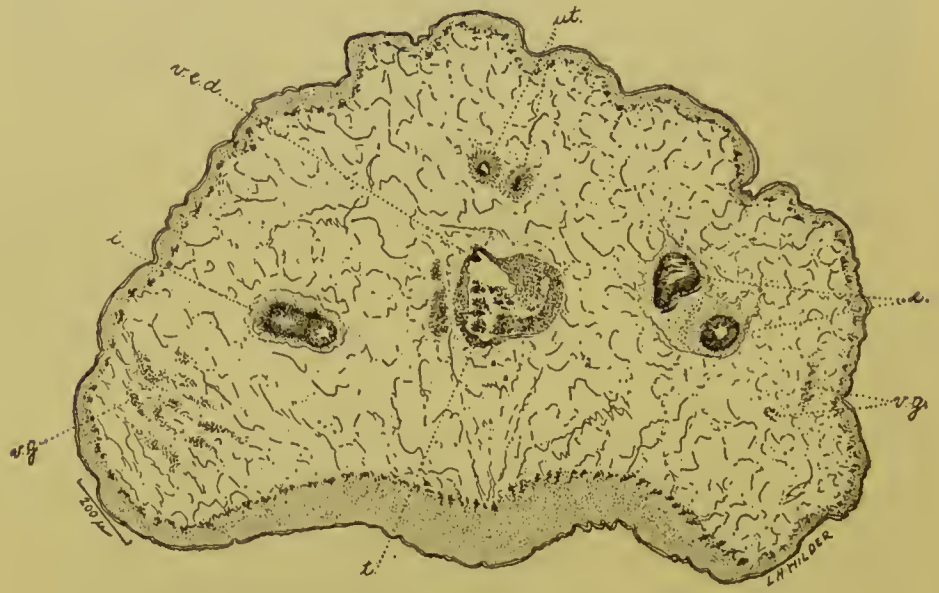

FIG. 171.

so doing the vasa efferentia form a transverse arch, beneath which the uterus passes as it ascends cephalo-ventrad. The vas deferens presents in the first part of its course a much coiled vesicula, which is succeeded in the second part by a coiled, well-developed musculosa. The latter gives place to a short prostatica. The terminal portion of the vas deferens is a short narrow duct, the ductus ejaculatorius, which unites at the base of the genital papilla with the terminal portion of the uterus to form the ductus hermaphroditicus (fig. 165, *d. h.*). The latter is a wide duct which pierces the genital papilla to open on the vertex of the latter at the porus hermaphroditicus.

Female organs.—The ovary lies posttesticular, a little to the left of the median sagittal plane, close to the acetabulum, and in or immediately caudad of the transverse plane of its superior margin. The oviduct springs from the dorsal aspect of the ovary and passes caudo-

dorsad, skirting the dorsal aspect of the shell gland and giving off Laurer's canal close to the dorso-caudal aspect of the latter. The main duct then penetrates this aspect of the shell gland. The shell gland, apparently somewhat larger than the ovary, lies immediately caudo-dorsad of the latter. It is, as just described, penetrated on its caudo-dorsal aspect by the oviduct; on its caudal aspect it is penetrated by a duct which is interpreted as the vitello-duct. The union between these ducts is not satisfactorily made out in our preparations, but no doubt it takes place to form a fairly distinct ootype, the continuation of which emerges from the ventro-cephalic aspect

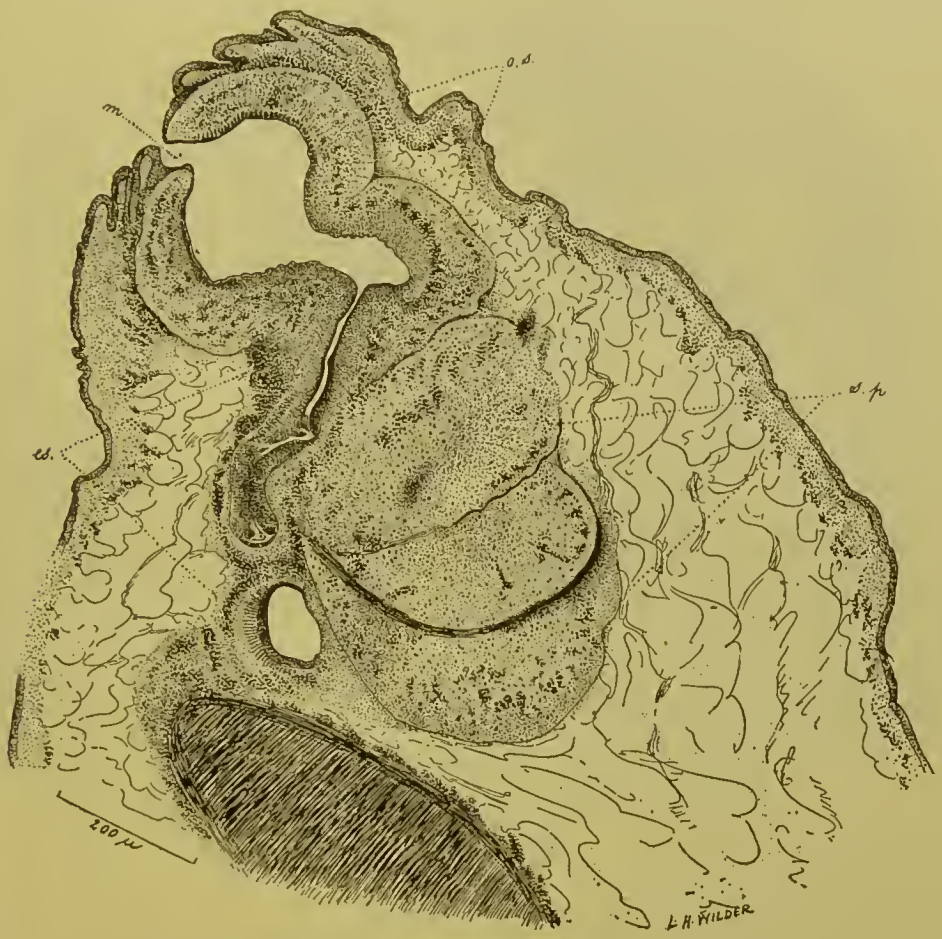

FIG. 172.

of the gland as the uterus (fig. 165). After emerging, the uterus turns to the right and dorsad, then dips caudad dorsally of the shell gland and in the axial region of the worm, forming some coils, then turns cephalad describing coils as it ascends between the dorsum and the testes. It passes ventro-cephalad over the superior testis and beneath the arch of union of the vasa efferentia to gain the ventral aspect of the coiled vas deferens. It retains this relation in the remainder of its course to the base of the genital papilla, where it

unites with the ductus ejaculatorius in the formation of the ductus hermaphroditicus.

Laurer's canal passes caudo-dorsad dorsally of the excretory vesicle to open in about the median line of the dorsum, cephalad of the excretory pore and slightly cephalad of the level of the caudal margin of the acetabulum.

The vitellogene glands, consisting of small insignificant follicles, are longitudinally disposed in the extracecal area, their caudal portions extending, however, into the cecal and to a slight extent into the intercecal area. Longitudinally they do not appear to extend

FIG. 173.

outside of the cecal zone, but this point can not be made out from our preparations as satisfactorily as is desirable.

EXCRETORY SYSTEM.—The excretory vesicle lies close to the dorsal aspect (the dome) of the acetabulum (fig. 165, *ex. v.*). It begins close to the ventro-caudal aspect of the shell gland and extends to slightly above the caudal margin of the acetabulum, beyond which point it is continued as a relatively thick duct to open in about the median line of the caudal extremity. This duct is inclosed in a well-marked layer of nuclei, probably of cells, the bodies of which, however, are not satisfactorily discernible. The excretory canals can not be satisfactorily followed in our preparations.

FIG. 163.—Ventral aspect. Enlarged. Original.

FIG. 164.—Profile view of same. Enlarged. Original.

FIG. 165.—Diagrammatic sagittal section, showing oral sucker (*o. s.*), suctorial pouch (*s. p.*), esophagus (*es.*), testes (*t.*), vas deferens (*v. d.*), uterus (*ut.*), ovary (*ov.*), oviduct (*ov. d.*), shell gland (*s. g.*), Laurer's canal (*L. c.*), excretory vesicle (*ex. v.*), excretory pore (*ex. p.*), genital papilla (*g. pap.*), ductus hermaphroditicus (*d. h.*), and acetabulum (*ac.*). Enlarged. Original.

FIG. 166.—Transverse section (about through equator of oral portion of sucker, *o. s.*) to show its form and the perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 167.—Transverse section (at level of origin of esophagus) to show position and relations of suctorial pouches (*s. p.*) and beginning of esophagus (*es.*); also shows extension of perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 168.—Transverse section at beginning of bulbous portion of esophagus to show position and relation of fundi of suctorial pouches (*s. p.*) to this portion of the esophagus (*es.*). Shows also extension of perisuctorial space (*p. s. sp.*) and molding of venter over the esophagus. Enlarged. Original.

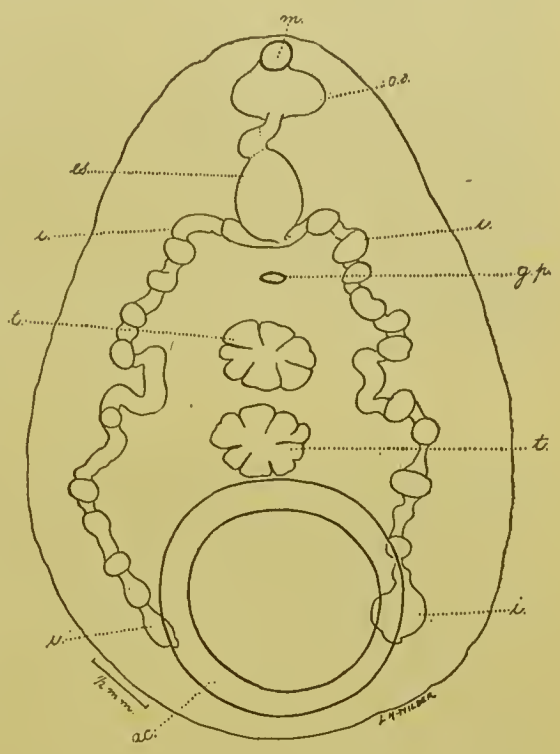

FIG. 174.

FIG. 169.—Transverse section at level of genital pore, showing subhemispherical genital bulging, genital pore (*g. p.*), pars musculosa (*p. m.*), ductus ejaculatorius (*d. e.*), and intestinal ceca (*i.*). Enlarged. Original.

FIG. 170.—Transverse section at level of origin of left vas efferens (*v. e. s.*) from superior testis (*t.*). Shows also position and relations of intestinal ceca (*i.*), uterus (*ut.*), right vas efferens (*v. e. d.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 171.—Transverse section at level of origin of right vas efferens (*v. e. d.*) from caudal testis (*t.*). Shows also position and relations of intestinal ceca (*i.*), uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 172.—Sagittal section through oral extremity. Shows mouth (*m.*), oral sucker (*o. s.*), and first portion of esophagus (*es.*); also shows mesial wall of suctorial pouch (*s. p.*). Enlarged. Original.

FIG. 173.—Sagittal section through second portion of esophagus (*es.*); shows also portion of suctorial pouch (*s. p.*). Enlarged. Original.

FIG. 174.—Diagram to show topography of digestive tract. *ac.*, acetabulum; *g. p.*, position of genital pore; *es.*, esophagus; *i.*, intestinal ceca (showing constrictions and dilatations); *m.*, mouth; *o. s.*, oral sucker (and pouches); *t.*, testes; Enlarged. Original.

WATSONIUS, new genus.

GENERIC DIAGNOSIS.—*Cladorchiinæ* (p. 169): Body pyriform. Ventral pouch absent. Acetabulum ventral or ? ventro-subterminal; very large, margins projecting; aperture small. Genital pore prebifurcal, without sucker; ductus hermaphroditicus apparently absent. Excretory pore caudad of vesicle, in acetabular zone, caudad of pore of Laurér's canal. Oral sucker with a pair of latero-caudal irregularly globular suctorial pouches; esophagus with distal thickening of muscular layer (esophageal thickening); ceca long, not wavy, end postequatorial, posttesticular, in acetabular zone.

Male organs: Testes 2, lobulate, smaller than acetabulum, fields nearly or quite coincide, zones abut to slightly overlap, preovarial, not far removed from acetabulum, in equatorial and caudal thirds; musculosa not enormously developed; cirrus pouch absent.

Female organs: Ovary and shell gland immediately posttesticular; vitellaria extend about from bifurcal zone to slightly postcecal, into acetabular zone; uterus intercecal, in part posttesticular; Laurer's canal cephalad of excretory vesicle.

TYPE SPECIES.—*Watsonius watsoni* (Conyngham, 1904).

WATSONIUS WATSONI (Conyngham, 1904) Stiles & Goldberger, 1910.

[Figs. 175 to 189.]

1904: *Amphist. watsoni* Conyngham, 1904, Aug. 13, 464; Aug. 27, 355; 1905, Sept. 8; 1902, Sept. 17, 663, figs. 1–2 (in *Homo*, Africa); 1905, Sept. 29, 1480; 1905, Oct. 8, 710.—Shipley, 1905, 8 to *Cladorchis*.

1905: *Cladorchis watsoni* (Conyngham, 1904) Shipley, 1905, 129–135, pl. 4, figs. 1–10 (in *Homo*, Africa); 1905, 1–9, pl. 4, figs. 1–10; 1905, Apr., 205; 1905, Apr. 8, 950; 1905, Nov. 2, 1298; 1905, 9 pp., 10 figs.—Braun, 1908, 4 ed., 175–176, figs. 125–126.

SPECIFIC DIAGNOSIS.—*Watsonius* (p. 212): Body 8 to 10 mm. long, by 4 to 5 mm. in maximum breadth, by 4 mm. thick; fresh specimens reddish-yellow, translucent, gelatinous; preserved specimens dark slate to dirty brown in color; pyriform, greatest diameter about at border of equatorial and caudal thirds; tapers cephalad to about 2.5 mm.; tapers more rapidly caudad so that the caudal extremity is very bluntly rounded; lateral margins convex on ventral view; venter somewhat flattened and slightly indented posteriorly at margin of acetabulum; venter surrounded by an elevated ridge and bulges posteriorly [transverse sections are too irregularly contracted from preservation to permit of safe interpretation]. Surface with transverse ridges, coarser, and better defined ventrally. Genital pore ventro-median, "about 2 mm. from the oral sucker," or rather prominent, about one-fourth of body length from anterior end; about at equator of esophageal zone and in zone of suctorial pouches. Acetabulum ventro-subterminal (or ventral?), very large, over 1 mm. in diameter; its free margin projects considerably; aperture small. Mouth ventro-subterminal in a dorso-ventral groove (contraction?), with digitate papillæ; oral sucker sunken in body, very large, about one-fifth as long as body, attains 1.2 mm. in transverse and 1.1 mm. in dorso-ventral diameter; with a pair of latero-caudal irregularly globular suctorial pouches, which extend about halfway to bifurcal zone; esophagus slightly longer than oral

sucker, distinctly bent, its convexity ventrad, its muscular wall thicker in its caudal half; ceca extend into fifth zone, ending in anterior half of acetabular zone, their lumina compressed laterally so that their dorso-ventral diameter is about 5 times as great as their transverse diameter. Excretory pore dorsal, apparently slightly sinistrad of median line, in zone of aperture of acetabulum; excretory duct thick-walled; excretory vesicle relatively small, dorsal of acetabulum, extends about from plane of transverse vitello-ducts to equator of acetabulum.

Male organs: Testes large, deeply notched (lobulated), each about one-seventh as long as body, one caudad of the other, in median line, fields coincide, zones overlap very slightly; each vas efferens springs from dorso-cephalic aspect [point of union not definitely traced]; vas deferens consists of vesicula seminalis intricately coiled and dilated, pars musculosa relatively short and not coiled, a dilated portion (corresponding to pars prostatica), in which no prostatic cells were found, a relatively long, narrow ductus ejaculatorius which opens on genital papilla, cephalad of metraterm, into papillated genital atrium; terminal portion is surrounded by a muscular mesh which forms a genital bulging; true cirrus pouch absent.

Female organs: Ovary slightly sinistrad (but apparently touches median line), dorso-caudad of posterior testis, dorso-cephalad of acetabulum; shell gland dorsad of ovary; vitellaria with moderate number of well-developed follicles, ventro-laterad of ceca, in extracecal and cecal area, extend from bifurcal zone into postcecal zone about to equator of acetabulum; uterus passes from shell gland ventro-dextrad into acetabular zone not quite to end of ceca, bends cephalad, runs in coils dorsally of testes, then in rather straight to sinuous course ventrally of vas deferens to its opening caudad of male opening; apparently no ductus hermaphroditicus present; Laurer's canal opens apparently in dorso-median line, very slightly caudad of cephalic limit of acetabular zone.

Eggs: Eggs oval, 122 to 130μ long by 75 to 80μ broad.

Type.—(?). Cotype U.S.P.H.&M.H.S. 10720.

Habitat.—Jejunum and duodenum of man (*Homo*); German West Africa.

Source of material.—We are indebted to the kind courtesy of Dr. A. E. Shipley, to whom we desire to express our sincerest thanks, for the loan of a series of transverse sections of this worm.

Historical review.—At a meeting of the Section of Tropical Diseases of the British Medical Association, on July 27, 1904, Dr. H. C. Conyngham, demonstrator at the London School of Tropical Medicine, presented a paper entitled "A new trematode of man (*Amphistoma watsoni*)." This paper was abstracted in the Lancet, 1904, August 13, page 464, and Journal of Tropical Medicine, 1904, August 15, page 252. The full paper, which appeared in the British Medical Journal, September 17, page 663, reads as follows:

A new trematode of man (*Amphistoma watsoni*).

Last February Doctor Watson, of Northern Nigeria, sent six curious trematodes from the small intestine of a negro, who had died of starvation and diarrhea, to the London School of Tropical Medicine. These proved to be a species of *amphistome*, totally unlike the *Gastrodiscus hominis* of Lewis—so far the only one of that genus found in man—and also unlike any hitherto described as occurring in animals. A specimen was sent to Professor Blanchard, of Paris, who very kindly examined it and reported that he considered it a new species. Doctor Watson sent some clinical notes of the case; they are as follows;

The patient—one of a gang of freed slaves, all of whom were in a pitiable condition due to starvation—was brought from Adamawa, German West Africa, to Zola, Northern

Nigeria. He was found to be suffering from diarrhea, and was admitted to hospital, where he died the same night. His stools were numerous, watery, and of a bilious color, but containing no blood or mucus. In the stools were found many reddish-yellow, translucent, gelatinous, oval bodies (the trematodes). Necropsy revealed the spleen small, hard, and black. In the stomach some undigested milk was found. The duodenum and upper part of the jejunum were found full of these oval bodies, some of which were alive and adherent. The mucus membrane showed no hemorrhages, but appeared to be slightly red. The other parts of the bowel, as also the other organs, were normal. A few of the bodies were seen lying in the large intestine. The patient was extremely fond of eating raw meat.

The animals are pear shaped, flattened ventrally and slightly indented posteriorly at the margin of the posterior sucker, but owing to the preservative used they have shrunk considerably and are now of a dark slate color. The anterior sucker in most of the specimens is retracted and lies at the bottom of a sulcus, which is terminal and ventral; the posterior sucker is very large, its cavity measuring over 1 mm. across; it is subterminal and ventral. The genital pore lies about a quarter of the length of the parasite from the anterior end and is rather prominent. The cuticle of the body is marked with transverse ridges, these being coarser and better defined on the ventral surface; the latter is flattened, surrounded by an elevated ridge and bulges posteriorly.

The worms measure 8 mm. long, 5 mm. at point of greatest breadth, this tapering gently anteriorly to 2.5 mm.; their greatest thickness is about 4 mm.

The genital pore lies 2 mm. from the anterior sucker. The ova as seen in the uterus are oval and measure 130μ by 75μ. It was found impossible to clear the specimens sufficiently to make out definitely their internal anatomy, but the general arrangement seems to be like that of the *Amphistoma conicum* (Zeder).

That these parasites may have been the cause of death is not at all unlikely, when it is considered that the larger part of the small intestine contained a great number of them and that at least one other species of the same genus causes serious sickness in the higher animals, namely, the amphistome of Collins in India, causing *masuri*, a condition of severe intestinal irritation in horses; and another, the *Gastrodiscus* of Sonsino, is supposed to cause death in horses and mules in Egypt, Senegal, and Guadeloupe. Another trematode of a different genus, the *Fasciolopsis buski*, inhabitating the small intestine of man, has been credited with causing intestinal irritation and typhoid-like symptoms, and this is occasionally followed by death.

These worms are, therefore, a new parasite of man, probably causing serious intestinal disturbance, diarrhea, marasmus, and death. Whether their distribution is limited, which is likely, remains to be seen; but by a careful examination of feces for ova, or adults in cases of diarrhea, it may be found again in at least that part of Africa in which the patient resided.

It is not at all probable that the eating of raw meat, which Doctor Watson notes, has anything to do with their introduction into the body, as parasites of that genus are, as a rule, ingested in the larval or cercarial form, encysted on some vegetable substance.

I would suggest that the name *Amphistoma watsoni* be given to the interesting parasite.

Shipley (1905, 3–9, pl. 4, figs. 1–10) gave the history of this trematode, as furnished by Doctor Watson, as follows:

The patient was a Pagan who had come from Adamawa, German West Africa—one of a gang of freed slaves brought to the resident of Zola, Northern Nigeria, nearly all of whom were in a terrible condition, due to starvation.

He made a certain amount of progress at first, but did not improve as the others, and had constant diarrhea. The stools were watery and of a bilious color, no blood or mucus in the same. He was taken into the hospital, but died the same night, and on

inspecting the stools passed during the night numerous reddish-yellow, translucent, gelatinous, oval bodies were found.

Post-mortem.—The lungs and heart were normal. Liver normal. The spleen small, hard, and black. The stomach contained some food, and on opening the small intestine the duodenum and upper part of the jejunum were found full of the oval bodies, none of them adherent, although they were alive. The mucous membrane was reddish, but no hemorrhages or petechiæ were apparent. The rest of the bowel was normal, a few of the oval bodies found loose in the large intestine. The kidneys were normal. The oval bodies have shrunken considerably, and are only about a third of the normal size.

These Pagans appear to be extremely fond of raw meat, and eat fowls raw.

As Shipley made a careful anatomical study of this parasite, and as our results differ in some respects from his, Shipley's account is here reproduced for comparison:

II. Anatomy.

Alimentary canal.—There is no true sucker at the anterior end. The mouth is a simple aperture leading into a pharynx, the walls of which form an almost spherical bulb. The lumen is lined with chitin, and the bulb is separated from the general parenchyma of the body by a basement membrane. Between the basement membrane and the chitinous lining lies a loose tissue crossed by numerous muscle fibers, which mostly run in a radial direction, but a few run circularly.

At first the lumen of the pharynx is compressed from side to side, but after about 30–35 sections from the anterior end the lumen has become depressed from above downward, and just here are found two short dorsal and ventral valves projecting like tongues into the lumen, only directed backward. They are attached anteriorly and free posteriorly. Behind these valves the lumen becomes diamond-shaped, the long axis being the transverse one, and here the bulb is at its largest and occupies a good deal of the area within the body wall. Its wall is also now divided into an outer and inner layer by a well-marked layer of circular muscles. The inner layer consists largely of radiating muscle fibers. The whole bulb lies somewhat freely in the very loosely vacuolated parenchyma, which seems to form a space around it, transversed only by a few sparse threads of protoplasm.

As we pass into the posterior half of the bulb the diamond-shaped lumen becomes a slightly oval slit whose angles shortly afterwards are turned down, thus forming a crescentic-like space in cross section. At the hinder end of the bulb these turned-down corners are cut off from the central lumen and form two lateral diverticula, the pharyngeal pouches. The diverticula, although they have their origin in the turned-down corners of the lumen, soon come to lie dorso-lateral of the central channel, and this alteration in relative position is caused by the central channel passing toward the ventral surface of the body. The pharyngeal pouches consist of the same kind of loose vacuolated tissue as the bulb; they are very thick walled and with small lumina.

Behind the bulb the lumen of what may now be called the œsophagus deepens, and in the region of the anterior border of the genital pore the central portion of the alimentary canal is no longer surrounded by the characteristic tissue of the bulb, though the two dorso-lateral diverticula, which still persist, are. The lumina of these diverticula then become slightly coiled so as to appear twice in one section, and then each of them fades out and disappears altogether. At about the level where the anterior third of the body joins the posterior two-thirds, the œsophagus divides into the two lateral diverticula, and around the λ-shaped lumen at this point is a thick bulb or sheath of muscle fibers mostly circular in their arrangement, though some are radial. Around them is a layer of longitudinal muscles. The lateral diverticula now pass outward and begin to include between them the reproductive organs. Each diverticu-

lum is flattened sideways and has a considerable dorso-ventral axis. They give off no secondary diverticula, though they are wavy or wrinkled, especially posteriorly, and here also they diminish in size, pass dorsally, and come to an end just about the level of the anterior lip of the great posterior sucker.

It does not seem possible to make out any cells lining any part of the gut. No epithelium is recognizable. The lumen is lined by a deeply-stained layer which looks like mucus, very thin in the pharynx, but quite thick in the intestinal diverticula. At the outer surface of this deeply-staining layer, darkly-stained structures, which may be nuclei, are here and there to be seen. The whole rests on a very definite basement membrane, and outside this in the region of the diverticula is a single layer of longitudinal muscles, the whole recalling in appearance the structureless lamella and the muscle tails of the ectoderm cells lying on it, in a hydra.

The excretory system.—The excretory pore lies in the middle line above the posterior sucker. It opens into a tube lined with cuticle directly continuous with that which clothes the body. This canal is pushed a little way out of the median line and lies, in the single specimen reduced to sections, a little to the left. Its walls soon thicken, and numerous darkly stained structures appear in its periphery; there may be nuclei or possibly sections through minute muscle fibers. Passing forward the canal enlarges and forms a spacious vesicle, which still lies over the sucker, spreading over its anterior end; from this vesicle, secondary canals pass up into the surrounding tissue. These, however, can not be traced farther in sections. The bladder or vesicle narrows again as we pass forward, and by the time the anterior edge of the sucker is reached it comes to lie between the hindermost ends of the diverticula of the alimentary canal. In front of this the main trunk seemed to divide into two, but beyond this they could not be traced.

The parenchyma.—This packing or ground tissue consists of large cells usually diamond-shaped in section. They are evidently very soft, and have been pulled out into strand-like structures where the cuticle has been elevated. The cells contain a granular-looking protoplasm. The cells underlying the cuticle are much smaller than those of the parenchyma within; the details could not be made out, but amongst and between them are some obvious muscle fibers. Similar muscle fibers lie outside the gut-diverticula, and many such fibers surround the outer parts of the reproductive ducts.

The reproductive organs.—There is a genital papilla situated in the middle ventral line about the level where the anterior quarter joins the posterior three-quarters. On this open close together the canal of the cirrus and the metratrema, the vas deferens opening slightly in front of the latter. The whole papilla is but slightly projecting; its tissue is closer and firmer than the usual body tissue. The distal end of the cirrus canal is muscular for a short space, and seems to have glands opening into it, but it soon gives a bend and opens into a thin-walled vesicle on the ventral surface, the vesicula seminalis, which in the specimen that was cut into sections contained a mass of spermatozoa. The genital papilla is on a level with the lateral diverticula of the esophagus, but the vesicula seminalis lies beneath the muscular pharynx, just where the alimentary canal is beginning to split into two diverticula. Ventral to it lies the small vagina with muscular walls which, just behind the level of the opening of the cirrus canal into the vesicula seminalis, expands into the thin-walled uterus.

The vesicula seminalis opens into the vas deferens dorsally, and begins to pass backward as a slightly coiled, thick-walled duct. This is still packed with spermatozoa. The thick-walled duct suddenly passes into a thin-walled duct, which is closely coiled and still packed with spermatozoa. The junction of the two is at the level where the uterus begins to pass dorsally; it continues, however, to lie ventral to the coiled thin-walled portion of the vas deferens. The testes are double, and

lie side by side, though one projects farther back then the other. They are ventral to the uterus, which for a short space lies between the glands and their ducts. The testes are closely adpressed to one another, and it is just possible that they unite at one point. They open straight into the thin-walled vas deferens. Each testis is deeply lobulated. The glands are packed with sperm morulas in various stages of development, their darkly stained nuclei giving the tissue a very characteristic appearance.

The metratrema or distal and modified end of the uterus opens close behind the vas deferens: it is a thick, muscular duct which passes backward for a short distance in a straight line. Just in front of the anterior border of the testes it enlarges into the uterus, and this begins to twist and loop, lying between the dorsally placed vas deferens and the ventrally placed testes. The uterus contains ova, but not in very great quantities; the eggs are incased in a shell and contain many deeply staining yolk granules, but little more can be made out. My measurements for an ovum, which looked unusually large, were 122μ by 80μ, but Conyngham gives 130μ by 75μ. Undoubtedly the eggs vary in size to a certain extent. The uterus coils a good deal over the testes, and at the posterior end of these glands its lumen enlarges, and it becomes filled with a glairy looking coagulum in which the ova lie embedded.

The ovary or germarium lies close behind the testes, and rather to the right of the body; it contains minute ova with large nuclei, closely packed together in some places and loosely in others. The whole, like the testes, is ensheathed in a connecting tissue casing. The oviduct leads from the anterior end and curves back above the ovary, it becomes almost immediately surrounded by the shell gland, and may here be called the ootype. Close behind the shell gland the ootype receives the opening of the vitelline duct and the inner end of Laurer's canal. The shell gland and the ovary come to an end at about the same level as the anterior edge of the posterior sucker. There is a well-marked canal of Laurer which passes almost directly dorsalward and opens in the dorsal middle line just in front of the posterior sucker.

The yolk glands are conspicuous, follicular structures, which take no stain, but remain a somewhat dirty-brown color, somewhat glistening. They extend forward as far as the reproductive pores, and they lie near the edge of the body, ventral to the right and left branches of the alimentary canal. The glands increase in number posteriorly, and in the region of the great sucker are very numerous. Their minute ductules fuse together and gradually unite into right and left ducts that open into the ootype, which is surrounded by the shell gland, and in which the egg is made up. Into the same space opens the duct of the yolk reservoir, which is a coiled receptacle, full of yolk, lying to the left and opposite the ovary.

III. Systematic Position.

The trematode we have to do with has been described by Mr. H. F. Conyngham as a species of the genus *Amphistoma*, which he calls *Amphistoma watsoni*. Dr. F. Fischœder has recently pointed out that the name *Amphistoma* is in reality a synonym of the genus *Strigea*, but the original *Strigea* has since been described as *Holostomum macrocephalum*, and if *Strigea* is to be revived it must be for that form. Hence, Doctor Fischœder proposes to us the name *Paramphistomum* for what we have used to term *Amphistomum*, and the name *Paramphistomidæ* for the family to which they belong. Whether we follow the classification of Bronn's Thierreich or, as I propose to do, the later classification of Fischœder, it is impossible to class the new human parasite described above as an *Amphistomum*, because that species is characterized, amongst other things, by the absence of the lateral diverticula of the pharynx, which form so characteristic a feature of our species. This fact, however, could only be determined by cutting the animal into sections, and therefore escaped the notice of Mr. Conyngham.

Fischœder divides the *Paramphistomidæ* of the Mammalia into two subfamilies: (i) the *Paramphistominæ* with the genera *Paramphistomum*, *Stephanopharynx*, and *Gastrothylax*, all these being devoid of pharyngeal side pouches, and (ii) the *Cladorchinæ* with the genera *Cladorchis*, *Chiorchis*, *Gastrodiscus*, *Homalogaster*, and *Balanorchis*. Of these genera *Cladorchis* is characterized by having the body not divided into anterior and posterior portions, by having the lateral edges rounded, by having the ventral surface slightly hollowed, and in all these respects our genus agrees with *Cladorchis*, and differs from the other members of the subfamily. I therefore place it in this genus.

CLADORCHIS WATSONI (Conyngham).

Synonym.—*Amphistomum watsoni* (Conyngham).

Length, 8–10 mm.; greatest breadth, 4–5 mm., tapering toward the anterior end to about 2.5 mm.; and depth about 4 mm.; color, when fresh, reddish-yellow, when preserved, a dirty brown; when fresh, translucent and gelatinous; the ventral surface transversely wrinkled, the aperture to the posterior sucker small, but the sucker itself big; no distinct sucker anteriorly but a well-marked pharyngeal bulb; the two pharyngeal pouches project beyond the outer limit of the bulb; circular sphincter round the esophagus just where it forks; distinct genital papilla, testis lobed, divided into two, side by side, anterior to ovary; Laurer's canal straight, opening anteriorly to excretory vesicle in middle line above the posterior sucker; the latter is very large and vaulted; the ova measure from 122–130μ by 75–80μ.

Habitat.—*Homo sapiens*, a West African negro, jejunum and duodenum, very few in the large intestines.

So far as we are aware, all other reference to this species are based upon the foregoing papers.

EXTERNAL CHARACTERS.

Size.—Conyngham (1904) states that the worms measure 8 mm. in length and 5 mm. in greatest breadth, tapering gently cephalad to 2.5 mm. in breadth, and 4 mm. in greatest thickness.

Shipley (1905) gives the length as from 8 to 10 mm., greatest breadth 4 to 5 mm., tapering toward the oral extremity to about 2.5 mm., and 4 mm. in dorso-ventral diameter.

Color.—In Watson's clinical notes quoted by Conyngham (1904) the fresh specimens are described as reddish-yellow, translucent, gelatinous bodies. Conyngham states that after fixing and in the preserved state they become a dark slate color. Shipley (1905) gives the color as reddish-yellow, translucent, and gelatinous in the fresh state and a dirty brown when preserved.

Form.—Conyngham describes them as pear shaped (figs. 175, 176), flattened ventrally and slightly posteriorly at the margin of the posterior sucker, but very much shrunken from the action of the preservative.

Surface.—Conyngham states that the cuticle is marked by transverse ridges which are more coarse and better defined on the ventral surface. The anterior sucker is described as being retracted in most of the specimens and as lying at the bottom of a ventro-

terminal sulcus. The venter is described as flattened, surrounded by an elevated ridge and as bulging posteriorly.

Genital pore.—The genital pore is given as being 2 mm. from the anterior sucker, presumably in the ventro-median line, or about one-fourth of the length of the parasite from the anterior end and is stated to be rather prominent. Shipley (1905) states that there is no true oral sucker, and that the venter is transversely wrinkled. Shipley mentions a genital papilla as situated in the midventral line about the level where the anterior fourth joins the posterior three-fourths.

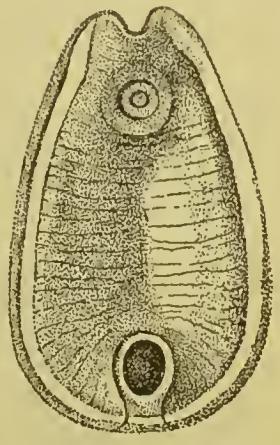

FIG. 175.

Acetabulum.—Conyngham states that the "posterior sucker is very large, its cavity measuring over 1 mm. across; it is subterminal and ventral." Shipley describes the posterior sucker as big, but with a small aperture.

We find that the rim of the acetabulum projects considerably beyond the embrace of the body parenchyma in a manner very similar to that which obtains in *Ps. stanleyii* and, as in the latter, it forms a ring around the aperture, being encircled by a deep, narrow groove (figs. 175, 189), which marks it from the general surface.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The oral extremity of the worm is marked by a dorso-ventrally directed groove-like depression which encroaches slightly on the ventral surface. By Conyngham this is described as a ventro-terminal sulcus and this is pictured, though not mentioned, by Shipley (fig. 175). The surface of this depression is beset by digitate papillæ. It leads by an irregularly circular aperture about 165μ in diameter directly into the oral sucker. The latter (figs. 178, 179) is a large organ; in length it equals about one-fifth of the total body length. Its maximum transverse and dorso-ventral diameters are at about its equator, and measured from sections are 1.2 mm. and 1.1 mm., respectively. These diameters decrease in the direction of both poles, but more particularly toward the oral pole, which is bluntly pointed. The decrease in these diameters, in the direction of the caudal pole or base, is progressive though slight. A little above the level of the base the decrease in the transverse diameter ceases; soon this diameter begins to expand, this expansion being due to

FIG. 176.

the extension at first laterad and then dorso-laterad in the form of pouches of the sucker from the region of its caudo-lateral aspect. The ventro-dorsal diameter, however, continues progressively to decrease, the base of the sucker viewed in sagittal plane being rounded, tilted somewhat ventrad and giving origin to the esophagus.

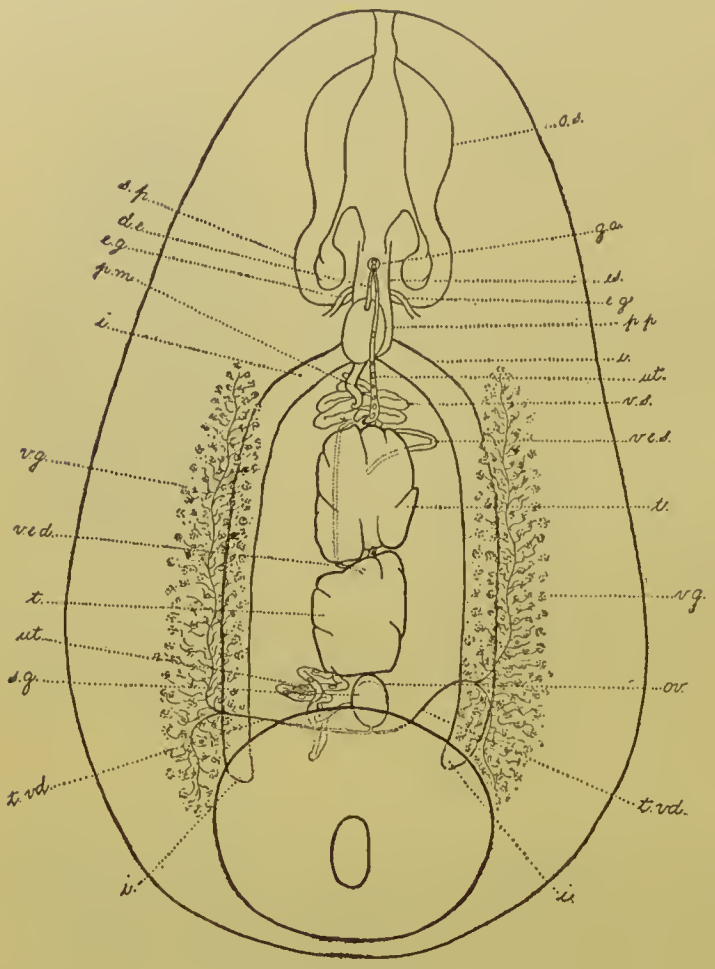

Fig. 177.

The pouches are irregularly globular in form and as they extend latero-caudad come to lie close to the dorso-lateral aspects of the first portion of the esophagus. The caudal third of the sucker and its pouch-like prolongations are in a well-marked perisuctorial space (fig. 181), in which they are retained in position by mesenterium-like strands extending from the parenchyma particularly to the dorsal and ventral aspects of the sucker. The structure of the suctorial wall differs somewhat at different levels. At the oral pole the suctorial wall consists of parenchyma-like cells with some radial, circular, and longitudinal muscular fibers arranged beneath the cuticular lining of the lumen. Farther caudad, however, these muscular fibers increase in number and except for the radial bundles are massed into a well-defined inner zone as contrasted to an outer zone of the parenchyma-like cell structure. Just above the level of origin of the pouches the inner muscular zone forms the greater portion of the thickness of the wall, the cell structure of the outer zone at the same time becoming greatly condensed. The structure of the pouch walls shows a similar inner relatively narrow muscular zone in which the circular fibers are most prominent, and an outer parenchyma-like zone.

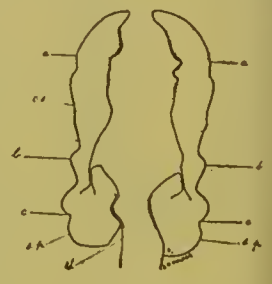

Fig. 178.

The lumen of the sucker, in a general way, is a dorso-ventrally narrow, but transversely a relatively broad space. Caudo-laterally it extends into the caudo-lateral prolongations or suctorial pouches of the sucker. Besides variations in the dorso-ventral diameter of the lumen at different levels, naturally to be expected from irregularities in the degree of contraction at the time of fixing, there are differences due to peculiarities in form of the suctorial wall itself. Beginning at the oral aperture of the sucker the lumen for some distance caudad maintains a fairly uniform dorso-ventral diameter, then rather abruptly this becomes decidedly increased. This increase is due to a retraction in the dorsal and in the ventral suctorial wall so as to form what Shipley describes as "dorsal and ventral valves projecting like tongues into the lumen, only directed backward" (fig. 179). These transverse projecting tongues or ridges are not continuous laterally; the interval thus left increases to a corresponding degree the dorso-ventral diameter of the lumen at its lateral angles; the form in transverse section of the lumen at the level where these ridges are formed suggests to a slight extent the letter H (fig. 180).

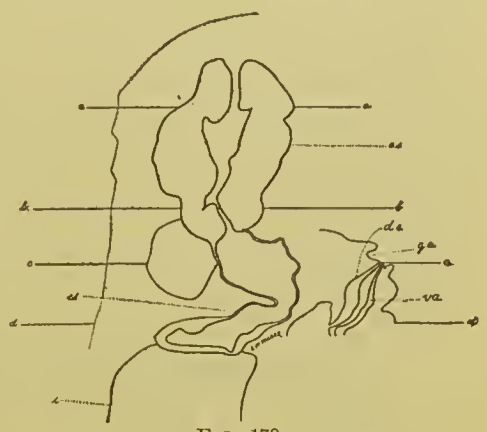

FIG. 179.

FIG. 180.

Almost at once, however, the dorso-ventrally expanded lumen resulting from the retraction of the dorsal and the ventral suctorial walls, above described, begins to contract and continues progressively to decrease to the level of origin of the pouches. In this region the lumen becomes very abruptly greatly narrowed dorso-ventrally by the projection upward into the lumen from its dorsal wall of a transverse tongue-like ridge recalling a similar structure in *Ps. stanleyii* (fig. 179). In transverse sections the first portion of the suctorial lumen is a transverse slit, the second portion is at first fusiform or diamond-shaped in outline, eventually becoming crescentic with the concavity of the crescent ventrad (fig. 181). By the projection

upward of the tongue-like transverse ridge the horns of the crescentic lumen become partly separated from the body, so that at this level the lumen, as in *Ps. stanleyii*, somewhat suggests the letter H. The terminal portion of the suctorial lumen also appears as a transverse slit in section.

The lumen of the sucker and that of its pouches is lined with a cuticle-like layer; in the first portion of the sucker the cuticle is beset with conical papillæ of moderate size.

From its point of origin the esophagus passes at first ventro-caudad, then at about its equator it bends abruptly and sharply dorsad with a tilt caudad. Viewed ventrally the esophagus is apparently much shorter than the sucker, but in sagittal plane it is at once seen that it slightly exceeds the length of the latter. The esophageal wall is muscular throughout, but in the caudal half the muscular layer is particularly well developed, attaining a maximum thickness of about 67μ. Because of the obliquity of this portion of the esophagus certain of the transverse sections cut its wall almost tangentially, and consequently the observer is readily misled into interpreting such a section as indicating an enormously thick muscular wall (fig. 183). Viewed ventrally, therefore, this portion of the esophagus would have somewhat the appearance of a muscular bulb, such as Shipley describes and pictures.

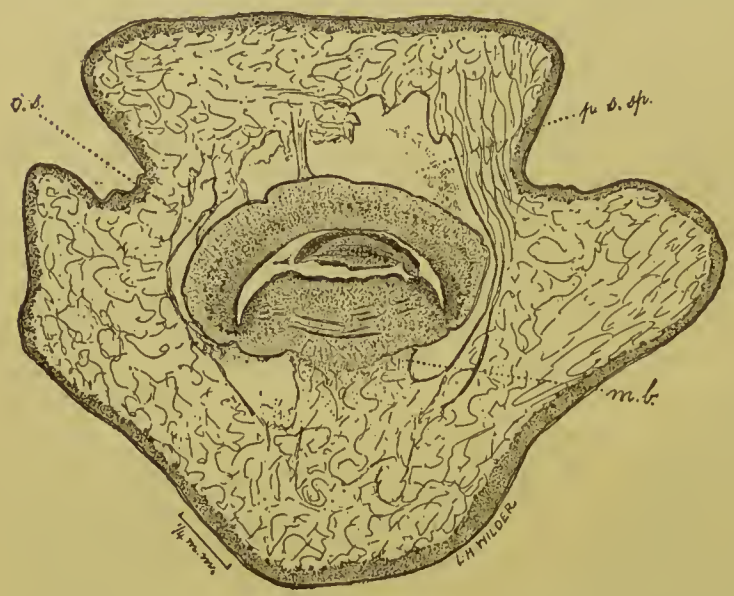

FIG. 181.

The first half of the esophagus is dilated in the dorso-ventral diameter, but compressed from side to side. The esophageal lumen is lined throughout with a rather thick cuticular layer.

The intestines spring from the lateral aspects of the caudal portion of the esophagus. At first they arch caudo-laterad, they then pass directly caudad in relation to, though at some distance from, the dorso-lateral aspect of the body. They terminate by cecal extremities slightly caudad of the junction of the fourth with the caudal fifth of the body length, or slightly caudad of the plane of the cephalic margin of the acetabulum, the right tube extending slightly farther caudad than the left. In transverse section the ceca appear compressed from side to side with proportionately a greatly elongated

dorso-ventral diameter, the former bearing a relation of 1 to about 5 of the latter.

Genital system.—With the exception of the vitellaria and the copulatory apparatus the genital organs are situated in the intercecal area.

Male organs.—The testes are in the axial region of the body, though somewhat nearer the venter than the dorsum; the superior testis is in the equatorial zone of the worm, occupying in this region about one-seventh of the body length; the inferior or caudal testis also occupies about one-seventh of the body length in a zone contiguous to and immediately caudad of that of the superior testis. Both testes are deeply indented by fissures and sulci in such a manner as readily to lead to the erroneous interpretation that the testes are side by side in close apposition, particularly as the caudal aspect of the superior and the cephalic aspect of the inferior testis are in close apposition and their contiguous lobes marked off by their fissures and sulci overlap slightly, and consequently portions of both testes appear in certain of the transverse sections (fig. 185).

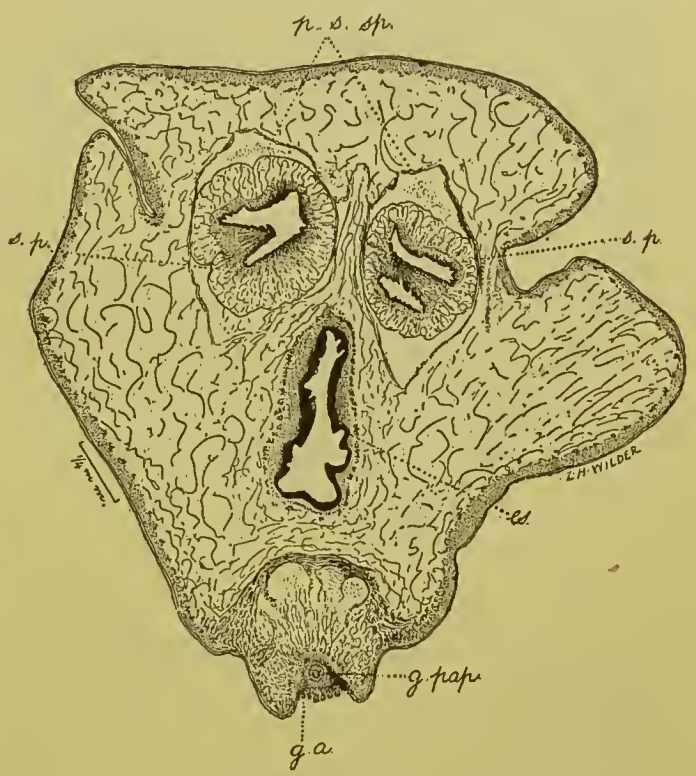

Fig. 182.

A vas efferens springs from the dorso-cephalic aspect of each testis (fig. 184); then it passes cephalo-dorsad, that from the superior testis tending to the left and that from the inferior to the right of the median sagittal plane. At about the level of the cephalic aspect of the superior testis the left vas efferens approaches close to the mesial aspect of the left intestine; it then curves inward as it courses cephalo-dorsad and very soon enters the complex of the coils formed by the vas deferens amongst which it can not be followed. The right vas, as already stated, passes cephalo-dorsad and to the right immediately after its origin from the caudal testis. It skirts the caudal aspect of the superior testis, then after reaching the right caudo-dorsal aspect of this testis it bends and proceeds almost directly cephalad in close relation to the right dorso-lateral aspect of the superior testis

until it reaches a level a little short of that at which the left vas efferens originates, when it begins to tilt dorsad, at the same time becoming considerably distended with spermatozoa (fig. 184). Shortly beyond this point it begins to wind and enters the coil-complex of the vas deferens, beyond which point it is impossible to trace it satisfactorily. The two vasa efferentia presumably enter into the formation of the vas deferens and it would appear, though this can not be made out satisfactorily in this series of sections, as if each, before their union, became considerably distended and coiled, their coils being indistinguishable from those of the first portion of the vas deferens.

The vas deferens presents at first a thin-walled intricately coiled dilated portion or vesicula seminalis. These coils are in the intercecal space, elongated from venter to dorsum and dorsum to venter and winding cephalad; they are succeeded by a muscular-walled segment or pars musculosa, the wall of which, measured at a favorable point, was about 60μ thick. This portion is relatively short, uncoiled, though making about one spiral turn in its somewhat sinuous course ventro-cephalad. In its turn, at about the level of the esophageal fork, this is abruptly succeeded by a short greatly dilated portion with muscular walls intermediate in thickness between those of the vesicula and pars musculosa. This portion, which Shipley interpreted as the vesicula seminalis and which corresponds to the vesicula seminalis interna of the forms with a cirrus pouch, appears homologous with the type of pars prostatica of *Homalogaster philippinensis* and that of *Ps. stanleyii*, more particularly the latter, in which the prostatic cells are few, while in this (*Watsonius watsoni*) species no prostatic cells at all can be distinguished. It is abruptly succeeded by a thin walled duct of a much smaller caliber which with the terminal portion of the uterus close to its ventral aspect at

FIG. 183.

once plunges into a sharply delimited muscular mesh as it proceeds cephalo-ventrad. This is relatively long and eventually opens at the vertex of a genital papilla by a small pore separate from and immediately cephalad of the opening of the metraterm. This terminal portion of the vas deferens is homologous with the ductus ejaculatorius. It may be well to describe at this point what may be designated as the copulatory apparatus.

In the median line of the ventral surface at a point about one-fourth the length of the worm from its oral margin is a well-marked ring-like elevation or bulging which encircles a second more sharply

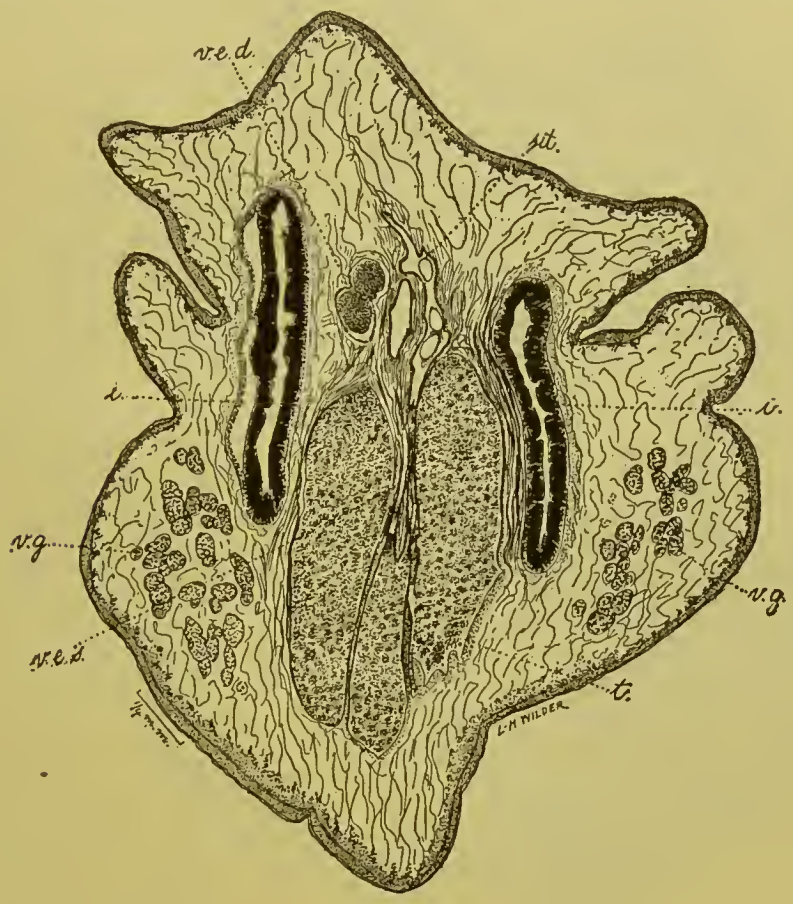

FIG. 184

defined truncated cone-like bulging measuring about 225 μ from base to vertex, about 600 μ in transverse diameter at the base, and about 375 μ at the vertex. The vertex of this second cone-like projection is depressed or crateriform and may perhaps be regarded as the genital atrium, from the dorsal wall of which the genital papilla projects. These structures are well shown in surface view in figure 175 and in transverse section in figure 182. The crateriform depression into which the genital papilla projects is beset by numerous quite small papillæ. The form of the genital papilla can not be made out satisfactorily;

one gains the impression that it is a low, broad, rounded elevation. In sections it may be seen that the internal structure of the genital bulging is made up of a muscular mesh which is sharply delimited from the body parenchyma by a well-defined curved (with convexity dorsad) muscular layer of transverse, radiating, and vertical bundles. It is this curved limiting layer (somewhat suggestive of a cirrus pouch) that, as already mentioned, is pierced by the ductus ejaculatorius and the terminal portion of the uterus or metraterm. The structure of this copulatory apparatus suggests the probability that it may be collapsible or retractible. The genital papilla is just caudad of the level of the base of the sucker (or origin of the esophagus).

FIG. 185.

Female organs.—The ovary is in the axial region of the body in the intercecal area a little nearer the left than the right intestine, caudo-dorsad of the caudal testis and dorso-cephalad of the acetabulum and in a zone directly caudad of and slightly overlapping the zone of the caudal testis (fig. 186) superiorly and to a slight degree overlapping the acetabular zone inferiorly (caudally). The ovary is dorso-ventrally elongate, measuring about 0.66 mm. in this and about 0.25 mm. in the transverse diameter. From its dorsal-cephalic aspect (fig. 186) the oviduct takes origin. This passes directly dorsad for about 150μ of its length and then bends caudad, almost immediately penetrating the cephalic aspect of the shell gland, at the same time giving off Laurer's canal. The latter proceeds dorsad (fig. 187) with but a slight inclination caudad and reaches the dorsum in about the median line or only slightly if at all to the right of it, and at a point in a plane marking the caudal limit of the ovarian zone and therefore only slightly caudad of that of the superior limit of the acetabular zone (or superior margin of the acetabulum) (fig. 188).

The shell gland is placed directly dorsad of the ovary; the caudal limit of its zone is the same as that of the ovarium, though because the vertical diameter of the shell gland is slightly less than that of the latter the zones of the two glands are not quite coextensive, the upper (cephalic) limit of the shell gland being slightly below (caudad) of that of the ovary. As already mentioned the oviduct penetrates the cephalic aspect of the shell gland, in the substance of which it unites with the common vitello-duct. The duct resulting from this union at once

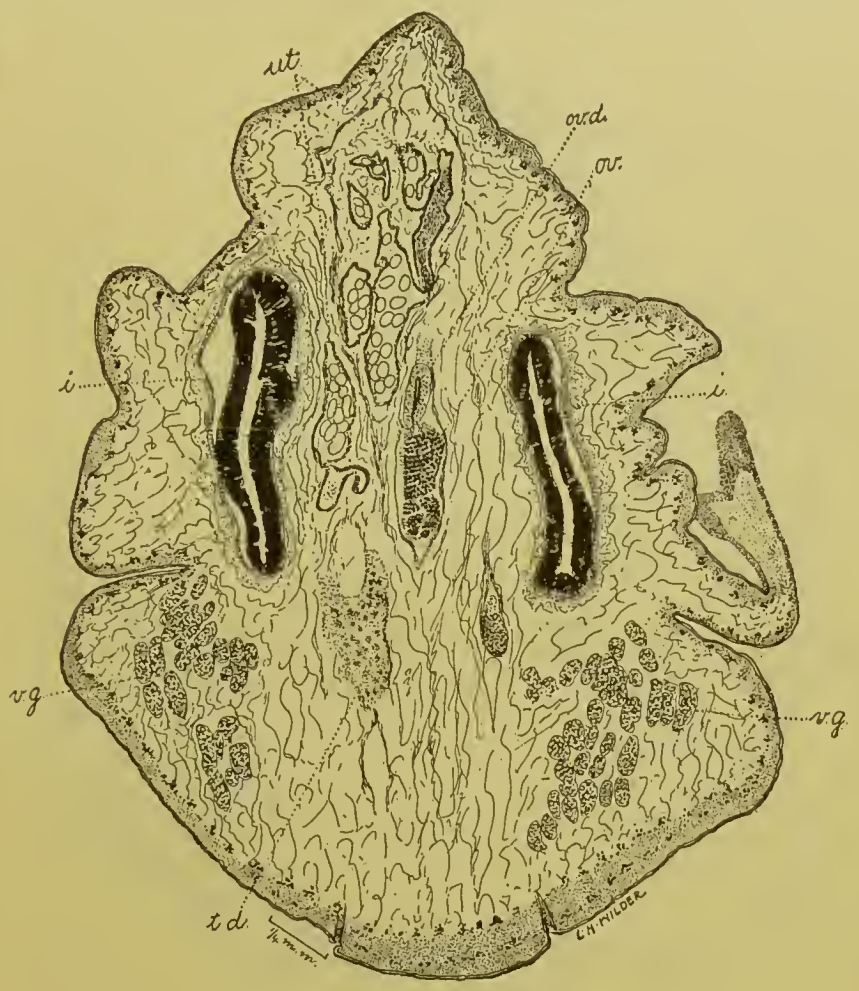

FIG. 186.

forms a fusiform dilatation, the ootype, which passes ventrad with a slight obliquity to the right and caudad in the major axis of the shell gland. The continuation of the ootype becomes the uterus which emerges from the ventral pole of the gland (fig. 187). After emerging, the uterus passes vento-dextrad into the field between the ovary and the right intestine, but doubles back before it has quite reached the frontal plane of the ventral margin of this intestine, and thus completes a loop directed ventrad. On reaching a point to the right of the dorsal pole of the shell gland it dips caudad, the loop thus formed

coming into close relation to the right aspect of the dome of the excretory vesicle. After forming this loop the uterus continues dorsad until it reaches the field to the right of the line of Laurer's canal and dorsomediad of the right intestinal cecum, where it forms some coils and begins its ascent cephalad, forming dorso-ventral loops, at first in the field between the right intestine on the one side and the ovary and shell gland on the other; later these loops are in the median line in the intercecal area between the testes and the dorsum. The uterus winds its way cephalad in this field, dorsad of the testes, until it

FIG. 187.

reaches the level of the caudal aspect of the vas deferens. Here it tends ventrad to gain the ventral aspect of the vas deferens, arching across the cephalic aspect of the superior testis. At the same time it ceases to form coils, proceeding in a sinuous but direct course cephaloventrad. From the level of the esophageal fork it is continued as the metraterm, and, as already mentioned, this pierces the muscular mesh of the copulatory apparatus to open immediately caudad of the ductus ejaculatorius at the vertex of the genital papilla.

The first loop formed by the uterus after its emergence contains a considerable number of vitelline cells, suggesting the idea of a yolk

reservoir. It is probably on this account that Shipley was led into interpreting this as a separate structure, to which he applied the name "yolk reservoir." In the remaining loops a considerable number of eggs were noted. Here and there in the coils dorsad of the testes there are masses of spermatozoa in which some of the eggs are embedded.

The vitellogene glands, consisting of a moderate number of loosely aggregated, well-developed follicles, are situated in the fields between the ceca and the ventro-lateral aspect of the body; that is, ventrad

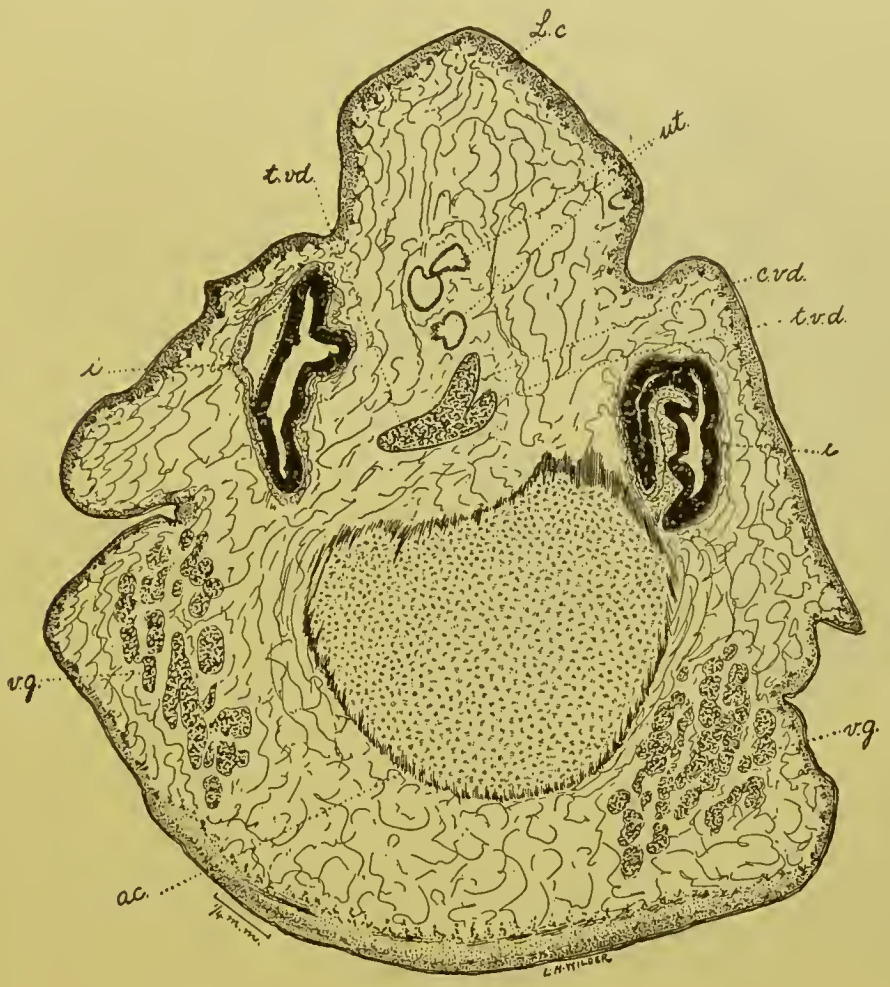

Fig. 188.

and ventro-laterad of the ceca and ventro-laterad of the upper (cephalic) portion of the acetabulum. Longitudinally they extend from about the level of the esophageal fork to or slightly caudad of the level of the upper margin of the acetabular aperture. The gland of the left side is a little shorter than that of the right. A duct of considerable caliber, distended with yolk cells, leaves the gland of each side—that of the left at a point slightly cephalad of the superior margin of the ovary; that of the right at about the level of the ootype. These ducts, the transverse vitello-ducts, pass dorso-mediad and more or less caudad ventrally of the intestinal ceca to unite close to the

caudal aspect of the shell gland. From their point of union, which is not dilated into a reservoir, a common vitello-duct arises and passes very obliquely dorso-cephalad and almost at once penetrates the shell gland. The common, like the transverse ducts, is distended with yolk cells and at first is of about the same caliber as the latter, but as it enters the substance of the shell gland its caliber becomes rapidly reduced in diameter. As has already been stated, it joins with the oviduct to form the ootype.

Excretory system.—The excretory vesicle is in the caudal portion of the body, dorso-cephalad of the acetabulum. It is relatively small; its dome extends a short distance cephalad into the caudal portion of the intercecal space, attaining the level at which the vitello-ducts unite; caudad it extends to about the level of the upper margin of the acetabular aperture. Here it gives off a thick-walled duct which passes dorso-caudad to open on the dorsum, apparently slightly to the left of the median line, at a point in a plane slightly cephalad of that of the ower margin of the acetabular aperture, and therefore at some considerable distance caudad of the pore of Laurer's canal. The excretory duct is lined with a cuticular layer. Excretory canals are seen to enter the excretory vesicle, but they can not be satisfactorily traced.

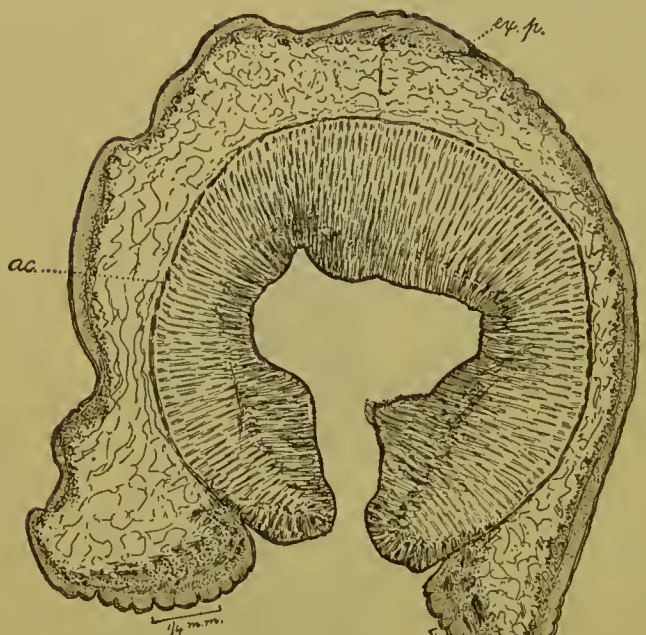

Fig. 189.

ILLUSTRATIONS.

Fig. 175.—Ventral view, × about 4. (After Shipley, 1905, fig. 1.)

Fig. 176.—Profile view, × about 4. (After Shipley, 1905, fig. 4.)

Fig. 177.—Ventral projection (diagrammatic) to show internal anatomy: *d. e.*, ductus ejaculatorius; *es.*, esophagus; *e. g.*, esophageal ganglion; *g. a.*, genital atrium, with openings of ductus ejaculatorius (upper pore) and metraterm (lower pore); *i.*, intestinal ceca; *o. s.*, oral sucker; *ov.*, ovary; *p. m.*, pars musculosa; *p. p.*, (?) pars prostatica; *s. g.*, shell gland (dorsally of ovary); *s. p.*, suctorial pouch; *t.*, testes; *t. vd.*, transverse vitello-ducts; *ut.*, uterus; *v. e. d.*, right vas efferens; *v. e. s.*, left vas efferens; *v. g.*, vitellaria; *v. s.*, vesicula seminalis. Enlarged. Original.

FIG. 178.—Ventral projection of oral sucker (*o. s.*), suctorial pouches (*s. p.*), and portion of esophagus (*es.*). *a–a*, *b–b*, *c–c*, planes of section. Enlarged. Slightly diagrammatic. Original.

FIG. 179.—Profile projection of oral sucker (*o. s.*), suctorial pouch of left side (*s. p.*), and esophagus (*es.*). Shows also the position of the genital atrium (*g. a.*). *a–a*, *b–b*, *c–c*, *d–d*, planes of section. Slightly diagrammatic. Enlarged. Original.

FIG. 180.—Transverse section through plane *a–a* figs. 178 and 179. Shows oral sucker (*o. s.*); H-formed lumen of oral sucker (with papillæ) at this level. Enlarged. Original.

FIG. 181.—Transverse section through plane *b–b* figs. 178 and 179. Shows crescentic lumen of oral sucker (*o. s.*), with transverse tongue-like ridge projecting upward into it. Shows also perisuctorial space (*p. s. sp.*) with ventral mesenterial band (*m. b.*). Enlarged. Original.

FIG. 182.—Transverse section through plane *c–c* figs. 178 and 179. Shows genital bulging with genital atrium (*g. a.*) beset with papillæ; the genital papilla (*g. pap.*) with opening of the ductus ejaculatorius; the limiting muscular layer of the copulatory apparatus; the esophagus (*es.*), suctorial pouches (*s. p.*), and extensions of the perisuctorial space (*p. s. sp.*) inclosing the pouches. Enlarged. Original.

FIG. 183.—Transverse section through plane *d–d* fig. 179. Shows metraterm (*va.*), ductus ejaculatorius (*d. e.*) just after its departure from the (?) pars prostatica (*p. p.*), which contains a mass of spermatozoa (*sz.*), and the esophagus (*es.*) with its dorsal wall cut tangentially, giving the impression of great thickness. Enlarged. Original.

FIG. 184.—Transverse section at level of origin of left vas efferens (*v. e. s.*). Shows terminal portion of right vas efferens (*v. e. d.*) distended with spermatozoa, the superior testis (*t.*), uterus (*ut.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 185.—Transverse section through overlapping portions of the superior testis (*t. s.*) and inferior testis (*t. d.*). Also shows uterus (*ut.*), intestine (*i.*), vitellaria (*v. g.*), and right vas efferens (*v. e. d.*). Enlarged. Original.

FIG. 186.—Transverse section through caudal extremity of inferior testis (*t. d.*). Shows ovary (*ov.*) with oviduct (*ov. d.*), uterus (*ut.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 187.—Transverse section immediately above level of superior margin of acetabulum. Shows ovary (*ov.*), shell gland (*s. g.*) with ootype and emerging uterus (*ut.*), Laurer's canal (*L. c.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 188.—Transverse section at level of the pore of Laurer's canal (*L. c.*). Shows acetabulum (*ac.*), formation of common vitello-duct (*c. vd.*) by the union of the transverse vitello-ducts (*t. vd.*), loop of uterus (*ut.*), intestines (*i.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 189.—Transverse section at level of excretory pore (*ex. p.*). Shows acetabulum (*ac.*) with projecting rim of aperture. Enlarged. Original.

PSEUDOCLADORCHIS Daday, 1907.

GENERIC DIAGNOSIS.[a]—*Cladorchiinæ* (p. 169): Body rather cylindrical, venter rather convex, dorsum convex, cephalic end rather attenuate, caudal end rounded, sides rounded. Ventral pouch absent. Acetabulum ventro-subterminal, large; aperture circular, medium, directed slightly ventrad. Genital pore without sucker. Excretory pore postvesicular, in equatorial zone, caudad of pore of Laurer's canal. Oral sucker with 2 sphincters, one anterior, the other esophageal, and with paired not very well-developed evaginations; esophagus springs from caudal end of sucker and is without muscular thickening; ceca straight or slightly wavy, rather long, end postequatorial, preacetabular.

Male organs: Testes 2, much smaller than acetabulum, elongate, lobate, fields separate or abut, zones overlap or nearly coincide, preovarial, quite removed from acetabulum, never in caudal third; cirrus pouch present.

Female organs: Ovary and shell gland posttesticular; vitellaria never pretesticular, are close to ceca in cecal to postcecal zones, chiefly posttesticular, "branched, tree like;" uterus chiefly in intercecal field, with tendency to transverse slings, ventral of cecal plane; Laurer's canal chiefly prevesicular, does not cross excretory canal or vesicle.

TYPE SPECIES.—*P. cylindricus* (Dies., 1836).

PFENDERIUS,[b] new genus.

GENERIC DIAGNOSIS.—*Cladorchiinæ* (p. 169): Body rather conical, dorsum convex, venter slightly convex, cephalic end attenuates gradually but considerably, caudal end slightly, sides rounded. Ventral pouch absent. Acetabulum terminal, with projecting margins, relatively large, its shallow cavity provided with prominent papillæ, aperture large. Genital pore without sucker. Excretory pore in vesicular zone, in acetabular zone, postcecal, caudad of pore of Laurer's canal. Oral sucker with one (anterior) sphincter, and with a pair of well-developed evaginations; esophagus springs from ventral aspect of base of sucker and is without muscular swelling; ceca wavy, long, end postequatorial in acetabular zone.

Male organs: Testes 2, very much smaller than acetabulum, lobate, fields separate, zones coincide, considerably removed from acetabulum, preovarial, equatorial; cirrus pouch present.

Female glands: Ovary and shell gland distinctly and considerably posttesticular; vitellaria in cecal zone, from bifurcation to end of ceca, with sparsely scattered small follicles; uterus intercecal, with marked tendency to dorso-ventral slings; Laurer's canal entirely preexcretory, does not cross excretory canal or vesicle.

Eggs: Operculated, rather numerous.

TYPE SPECIES.—*Pfenderius papillatus* (Cobbold, 1882) as represented by U. S. N. M. 2554.

HABITAT.—Colon of elephants, India.

PFENDERIUS PAPILLATUS (Cobbold, 1882) Stiles & Goldberger, 1910.

[Figs. 190 to 202.]

1882: *Amphist. papillatum* Cobbold, 1882a, 240–242, figs. 10, pl. 24, fig. 11 (in *Elephas indicus*).—Braun, 1892a, 580, 663; 1893a, 874, 905; 1893d, 466.—Fischœder, 1902a, 49 (in *Elephas indicus;* India).—Sonsino, 1895, 184, 187, figs. 4–5.

SPECIFIC DIAGNOSIS.—*Pfenderius* (p. 232): Body 4.5 mm. to 5.5 mm. long, 2.5 to 2.75 mm. broad, 1.7 mm. thick; pearl tint or opaque olive green in color (alcohol specimen);

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[a] Based on Daday, 1907.

[b] Dedicated to Dr. Charles A. Pfender, in recognition of his work on the Index-Catalogue of Medical and Veterinary Zoology.

rather conical, but bent slightly ventrad, greatest diameter between third and fourth fourth of body, attenuating gradually and considerably cephalad, slightly caudad; dorsum convex longitudinally and transversely, venter slightly convex from side to side, straight to slightly convex longitudinally; lateral margins curved both longitudinally and in transverse plane; transverse section of body transversely elliptical to circular. Genital pore in esophageal zone about one-fourth of body length from oral margin. Acetabulum terminal, with projecting margin, about 1.7 mm. in transverse, 1.4 mm. in dorso-ventral diameter, aperture directed slightly ventrad, 1.28 by 1.2 mm., cavity shallow, surface with prominent papillæ which attain 90μ long by 60μ broad at base. Mouth terminal at bluntly pointed cephalic extremity, with small papillæ; oral sucker with 2 caudal lateral bulbs, and with a well-defined sphincter about 120 to 140μ from oral margin; perisuctorial space very narrow; esophagus markedly curved dorsad, convexity ventro-caudad; ceca wavy, extend to acetabular zone, then curve slightly cephalad and terminate. Excretory pore about dorso-median, slightly caudad of preacetabular transverse plane; excretory duct almost transverse; excretory vesicle well developed, dorsal of cephalic half of acetabulum.

Male organs: Testes equatorial, ventral of ceca, fields separate, zones nearly coincide; irregularly globular, 0.4 mm.; vasa efferentia rather short, run dorso-cephalad, unite about on pretesticular plane; vesicula seminalis coiled; cirrus pouch pyriform, large, 0.44 mm. long, greatest diameter 0.32 to 0.34. mm., muscular wall 0.12 mm.; ductus hermaphroditicus present.

Female organs: Ovary posttesticular, intercecal, preacetabular, nearly or quite median, at junction of equatorial and caudal third of body; shell gland caudo-lateral of ovary; vitellaria with sparsely scattered small follicles, external, ventral, and to some extent dorsal of ceca, in cecal zone from bifurcation to end of ceca; uterus forms dilated dorso-ventral slings in suctorial field, to near cirrus pouch, then runs more directly cephalo-ventrad to ductus hermaphroditicus; Laurer's canal runs dorsally in curve (convexity caudad) in zone of shell gland, to pore slightly dextrad of median line, about 0.5 mm. cephalad of excretory pore.

Eggs: Rather numerous, elliptical, about 150 by 70μ, operculated at one pole and bearing short knob at the opposite pole.

Type.—Unknown. Cotypes U.S.N.M. 1721, 2554, 5777.

Habitat.—Colon of elephant (*Elephas indicus;* India).

Source of material.—The material consists of 7 specimens which were found in 3 bottles, as follows: 5 specimens in bottle No. 5777, 1 in bottle No. 2554, and 1 in bottle No. 1721.

The labels in these bottles bear the following data: "Name *Amphistoma papillatum;* Host *Elephas indicus;* Locality India; Determined by T. S. Cobbold; Date 1882; Presented by T. S. Cobbold; Date, 22, XII, 1882." Our material therefore represents Cobbold's original specimens.

Historical review.—Cobbold (1882a, 224, 240–242, fig. 8, pl. 24, fig. 11) originally described this species with the following diagnosis:

> Body of a bright pink color, smooth, conical, bluntly pointed in front, broadly rounded off behind, with fine and regularly disposed transverse rugæ forming distinct rings in the region of the head. Caudal sucker subterminal, very large, its cup being armed with numerous large fungiform papillæ, closely set, and regularly disposed over the entire surface of the concavity. Reproductive papillæ placed well forward. Length, one-sixth to one-fourth of an inch. Breadth, one-eighth to one-seventh of an inch. Hab. Large intestine of *Elephas indicus.*

Cobbold's figure 11, drawn from a fresh specimen, shows certain anatomical details. The outline is rather different from that of our specimens. The position of the genital pore agrees fairly well, though not exactly, with its position in our material. The acetabulum and its aperture are relatively large. No indication of suctorial evaginations is given; the esophagus is short; the ceca are long, not wavy, and end in the acetabular zone. The testes are figured as relatively much larger than those in our specimens, and as having zones which overlap slightly, fields which coincide. This latter condition does not agree with our material, which distinctly shows coinciding testicular zones and separate fields.

FIG. 190.

Braun (1892a, 580, 663; 1893a, 874, 905) refers to the papillæ in the acetabulum, to the short esophagus, and mentions the worm as a parasite in the colon of *Elephas indicus*. His later reference (1893d, 466) merely cites the worm as a parasite of the elephant.

Sonsino (1895, 184, 187 (6, 9), figs. 4–5) figures *Amphist. papillatum* with an outline so very distinct from Cobbold's figure that a question might arise as to whether he is dealing with the same species.

Fischœder (1902a, 49; 1903h, 631) adds no new observations.

In view of the position of the testes, as figured by Cobbold, the question naturally arises as to whether we are dealing with the same or with a different species. As our material represents some of Cobbold's material, and as various authors have been misled in interpreting the relative position of the testes, especially in the case of rather thick trematodes, we hesitate to draw the conclusion that our material represents an undescribed species. Should more of Cobbold's original material be found, or should the Indian elephant prove to harbor another amphistome which agrees with Cobbold's illustration, it will then become necessary to accept the name *papillatum* for that form and to recognize our material as representing a new species.

FIG. 191.

EXTERNAL CHARACTERS.

SIZE.—The specimens, measured in alcohol, varied in length between 4.5 and 5.5 mm. and in greatest width between 2.5 and 2.75 mm. They were, however, more or less shrunken and had evidently

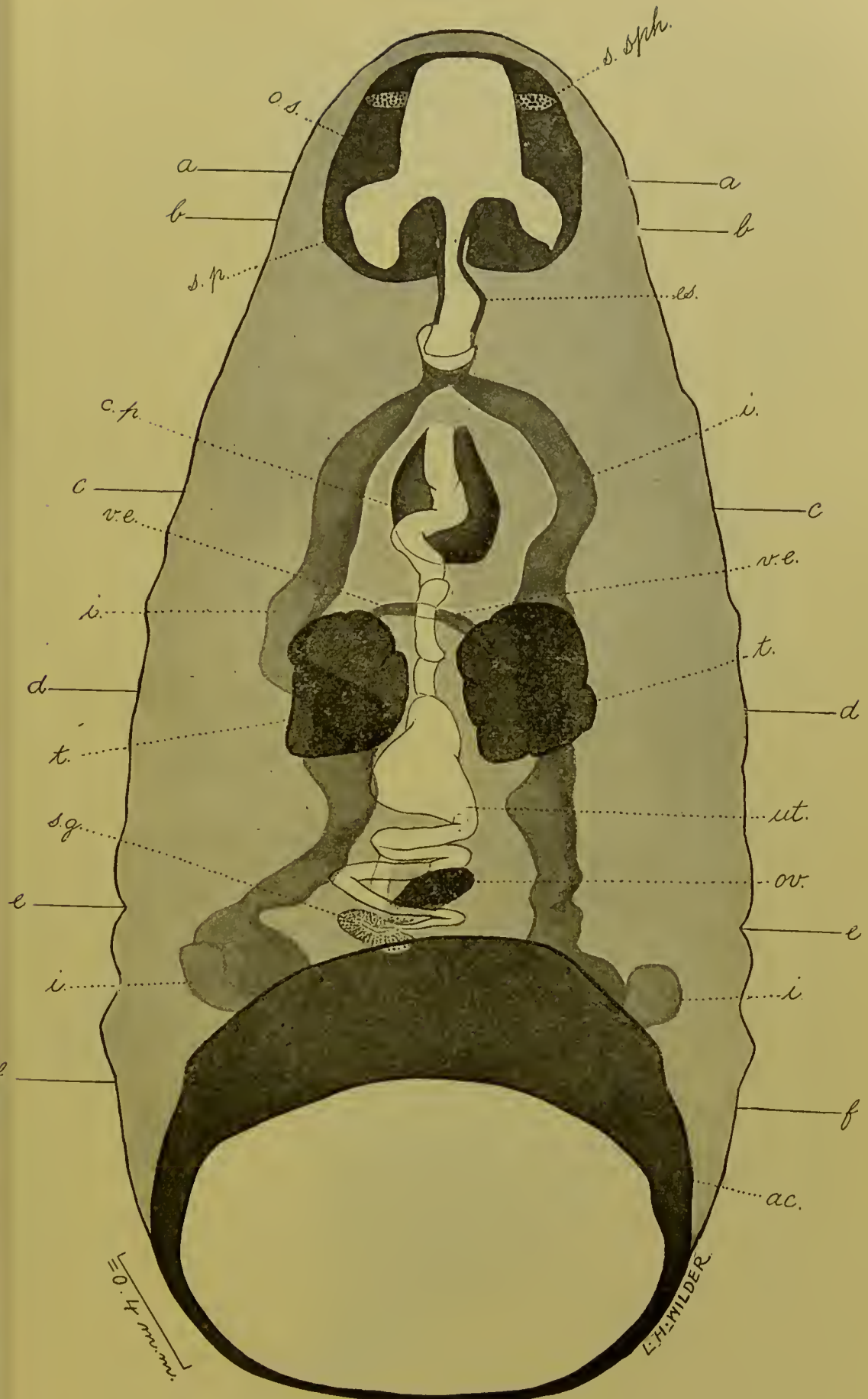
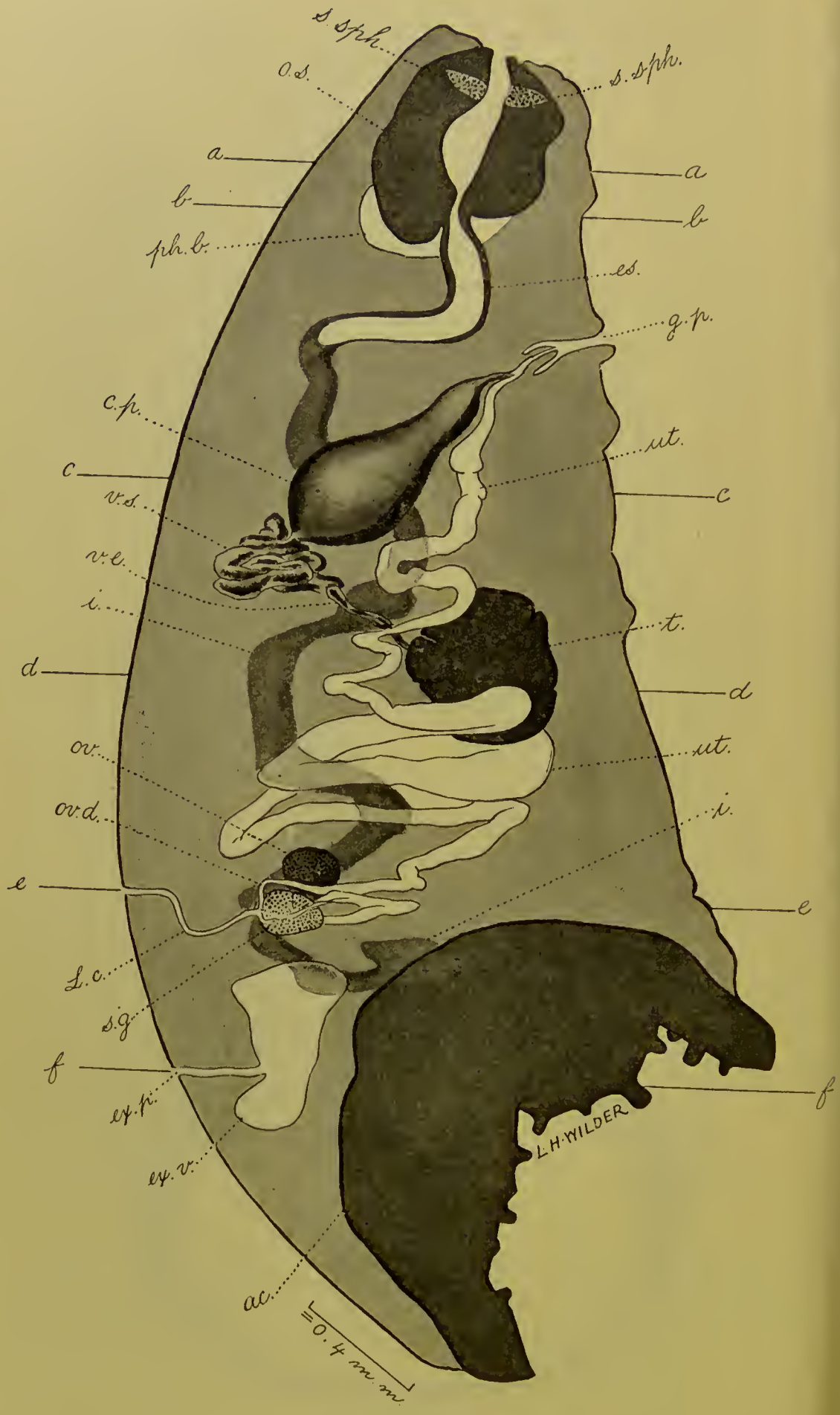


Fig. 192.


s.sph.
o.s.
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a
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ph.b.
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c
v.s.
v.e.
i.
t.
d
d
ov.
ut.
ov.d.
i.
e
e
l.c.
s.g.
f
f
ex.p.
ex.v.
L.H.WILDER
ac.
=0.4 m.m.

FIG. 193.

undergone some distortion, so that these measurements must be regarded only as approximations to the original.

After sectioning, one of the specimens measured 4.14 mm. in length, 2 mm. in greatest transverse, and 1.70 mm. in greatest dorso-ventral diameter.

Color.—Five of the specimens were of a pearl tint. These were slightly translucent, enabling the observer to determine the position of the testes. The remaining two specimens were of an opaque olive-green color.

Form.—As has been stated, the specimens were obviously shrunken and variously distorted.

One of them, however, had undergone these changes to so slight a degree as to serve fairly well for the purpose of this description.

This worm (shown in figs. 190, 191) appeared somewhat conical in form, but bent slightly ventrad. Its greatest width was at the junction of the third with the terminal fourth of the body length.

Fig. 194.

From this region the body tapers in both directions; gradually and considerably toward the bluntly pointed oral extremity, slightly in the direction of the caudal extremity. The dorsum is arched both longitudinally and transversely; the venter is slightly convex from side to side, but straight or slightly concave in a longitudinal direction. The lateral margins are curved slightly both longitudinally and in a transverse plane. In transverse section the outline of the body is transversely elliptical to circular.

Surface.—The surface cuticle is without spines or scales. It is marked, however, by fine transverse striations. The bluntly pointed, attenuated extremity presents the oral aperture, which is encircled by a narrow ridge marked off from the surface by a narrow, fairly deep groove (fig. 194). Concentric with this and about equally spaced there are observed four shallow grooves (fig. 194).

Genital pore.—In the median longitudinal line of the venter, about one-fourth of the body length from the oral margin, there appears a slight, globular bulging of relatively small diameter, which presents the aperture of the genital pore. This pore leads into an elongate irregularly cylindrical chamber about 0.28 mm. long, from the fundus of which there arises a papilla, about 105μ in height and about 120μ in

diameter at the base, which almost fills the corresponding portion of the lumen of this chamber. At the vertex of this (genital) papilla is the porus hermaphroditicus.

At the caudal extremity, encircling the aperture of the acetabulum and at a distance of about 0.20 mm. therefrom, there is a shallow circular groove. This groove marks the region at which the acetabulum emerges from the embrace of the caudal portion of the body of the worm. The portion of the caudal extremity of the worm between this groove and the margin of the acetabular aperture, and having somewhat the appearance of a collar, is formed by the projecting portion of the acetabulum.

Acetabulum.—The acetabulum occupies the caudal extremity of the body, and, as already described, a portion emerges at the surface at the

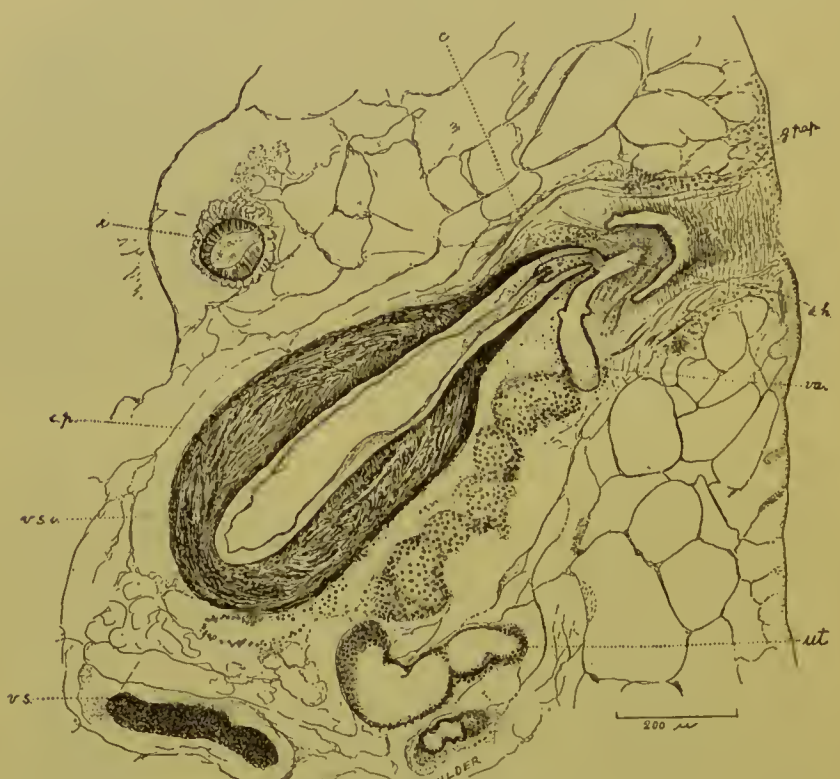

FIG. 195.

caudal extremity of the worm and forms a well-defined rim around the crateriform cavity, somewhat as in *Ps. stanleyii*, but without the deep narrow groove of the latter to mark it off. Measured from a reconstruction of a sectioned specimen the acetabulum was about 1.70 mm. in greatest transverse and 1.40 mm. in greatest dorso-ventral diameter, with an aperture 1.28 mm. in greatest transverse and 1.20 mm. in greatest dorso-ventral diameter. The cavity of the acetabulum is shallow, and this surface is beset by teat-like papillæ, some of which, in sections, measured 90μ in height and 60μ in diameter at the base.

INTERNAL ANATOMY.

DIGESTIVE TRACT.—The bluntly-pointed cephalic extremity of the worm is pierced by the oral aperture. This aperture is transversely elliptical, and its margins are beset by small conical papillæ (fig. 194). This aperture leads directly into the oral sucker, a relatively large muscular apparatus (figs. 192, 193, 196, 197). The caudo-lateral aspects of the sucker are prolonged somewhat caudad of the transverse plane of its base into the forms of lateral bulbs. Measured from a reconstruction of one sectioned specimen, its greatest longitudinal axis was 0.64 mm., the greatest dorso-ventral diameter about 0.52 mm., and the greatest transverse diameter 0.78 mm. Measurements from sagittal sections of another specimen gave 0.66 mm. for the greatest longitudinal axis, 0.70 mm. for the greatest dorso-ventral, and about 0.72 mm. for the greatest transverse diameter. The bulbs measured from the reconstruction were about 0.40 mm. in greatest dorso-ventral and 0.30 to 0.34 mm. in greatest transverse diameter and extended about 60μ caudad of the base of the sucker.

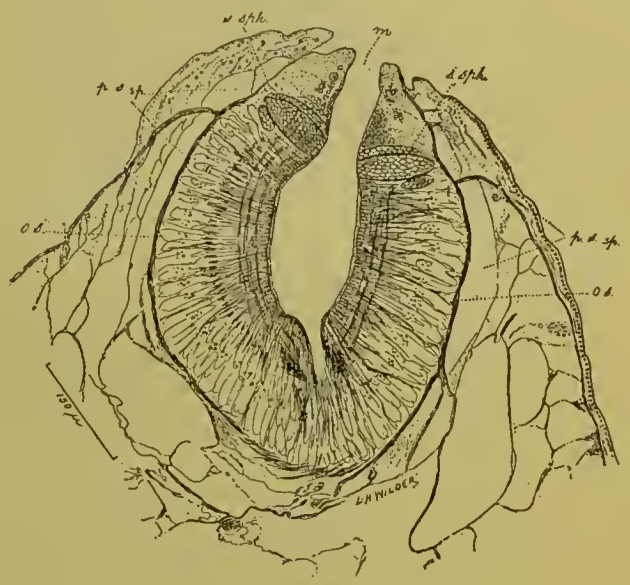

FIG. 196.

The body of the sucker appears to be inclosed in a very narrow space (fig. 196) and appears to be retained in its position by attachments at its poles and by dorso-ventral mesenterium-like and muscular bands. The long axis of the sucker coincides with the long axis of the body of the worm. In median sagittal section, the sucker has something of an oval outline with the blunt end of the oval corresponding to the base. About 120μ to 140μ caudad of the oral margin there is observed in the muscular wall a well-defined sphincter-like muscular bundle measuring about 100μ in thickness. Caudad of this sphincter the muscle walls maintain a substantially uniform thickness throughout up to the point of formation of the canal leading into the esophagus. Cephalad of the sphincter, however, the thickness of the walls becomes progressively and rapidly less, so that the muscular rim forming the oral aperture as it projects on the surface is relatively thin and sharp (fig. 196).

In transverse section the outline of the sucker is that of a blunt ellipse with its major axis in the transverse diameter of this region of the worm. Studied in median sagittal section, the base of the sucker appears slightly beveled at the expense of its ventral aspect, from which region the esophagus is seen to take its departure. On each side of and closely embracing this portion of the esophagus the caudo-lateral projections of the sucker or suctorial bulbs may be seen.

In form these bulbs are irregularly globular. Their walls, considerably thinner than those of the body of the sucker, are of relatively loose muscular mesh-like structure. The lumen of the sucker is a transversely wide, dorso-ventrally narrow space; it is

Fig. 197.

directly continuous with the irregular and variable lumen of the bulbs. Both are lined by a thin cuticle-like layer.

The esophagus, as already described, takes its departure from the ventral aspect of the base of the sucker. It passes at first caudad, describing a slight curve in its course with its convexity ventrad, then turns almost directly dorsad, and having reached a point about one-fourth the body length from the oral margin and about one-fourth the dorso-ventral diameter of the worm in this zone from the dorsum the esophagus curves directly caudad and almost immediately forks into two lateral intestinal tubes. This fork is slightly caudad of the genital pore. The intestinal tubes from their point of origin pass at first latero-caudad then in dorso-ventrally wavy course caudad. They finally terminate by bending abruptly

ventro-cephalad in a hook-like form at a point in a transverse plane slightly caudad of that of the cephalic margin of the acetabulum.

As in the other species of this group, the esophagus is inclosed in a well-marked layer of cells. The lumen of the esophagus is lined by a cuticle-like layer, which ceases abruptly at the fork. The intestines are lined by an epithelial cell layer.

Genital system.—With the exception of the vitellogene glands and the testes the genital organs are situated in the intercecal area.

Male organs.—The testes are situated in the equatorial zone on each side of the median sagittal plane and ventrad of the corresponding intestine. They are irregularly globular in form, measuring about 0.40 mm. in diameter, but with their vertical diameter a little longer than either the transverse or dorso-ventral. From their

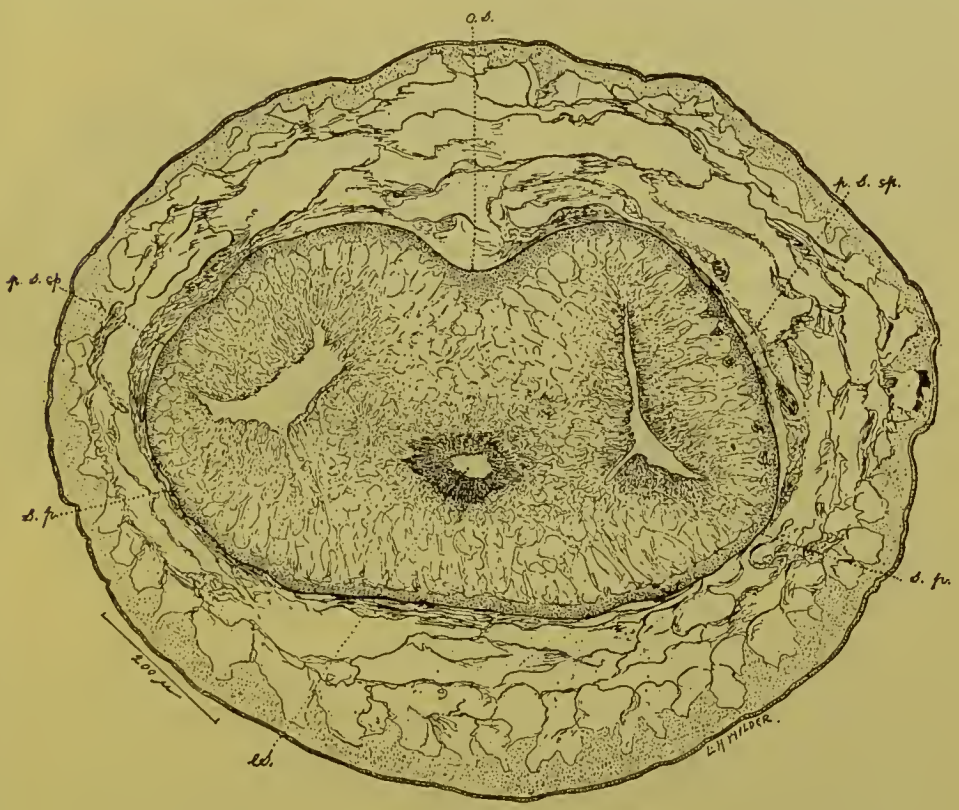

Fig. 198.

dorsal aspects, slightly above their equator, there emerges from each a vas efferens. These pass in a curved course dorso-cephalad and toward the median line to unite at about the level of the cephalic margins of the testes to form the vas deferens. The vas deferens consists first of a thin-walled, dilated, complexly coiled vesicle. This terminates abruptly in a short narrow duct, which pierces the very thick walled cirrus pouch and is continued within the latter and almost fills its lumen as a thin-walled duct (vesicula seminalis interna) to the cirrus; in a series of sagittal sections the cirrus is distinctly

seen in an invaginated condition, but with its terminal (distal) portion pointed outward (not invaginated); the canal formed by the invaginated portion unites distally with the metraterm to form a genital cloaca apparently representing a ductus hermaphroditicus, which opens on the apex of the genital papilla. The cirrus pouch is directed obliquely ventro-cephalad; in form it suggests that of an Indian club. Its walls become gradually less thick, this reduction taking place mainly at the expense of the (internal or) longitudinal layer, and its diameter becomes progressively reduced as it passes ventro-cephalad. Its greatest diameter, measured in sections, varied in two specimens from 0.32 mm. to 0.34 mm., with a thickness of wall of 0.12 mm. In length it measured about 0.44 mm. The ductus hermaphroditicus, formed as already described, pierces the axial region of the genital papilla, on the vertex of which it opens as the porus hermaphroditicus. The presence of a distinct pars prostatica can not be definitely asserted, but in two places (within at the distal end of the cirrus pouch, and without at the proximal end) are groups of nuclei which may come into consideration in this connection if well-preserved material can be obtained.

FIG. 199.

The wall of the chamber surrounding the genital papilla is provided with a well-developed muscle-complex, suggestive of the genital sucker figured by Fischœder for several species of *Cladorchis*, but the muscles are not arranged in so distinctly acetabular-like manner as Fischœder figures for the species he discusses; it therefore can not be stated that *Pfenderius papillatus* possesses a true genital sucker.

Female organs.—The ovary lies in about the median line of the body somewhat nearer the dorsum than the venter, posttesticular in a plane a little above that of the cephalic margin of the acetabulum—that is, about at the junction of the middle with the caudal third of the body. The oviduct emerges from the dorsal aspect of the ovary, passes at first directly dorsad, then curves caudad toward the dorsal aspect of the shell gland (fig. 201). The shell gland lies close to the right caudo-lateral aspect of the ovary and just at about the

level of the cephalic margin of the acetabulum. On its dorso-caudal aspect it is penetrated by the oviduct and on its caudal aspect by the vitello-duct. These ducts unite to form the ootype, the continuation of which pierces the surface of the gland and emerges from its ventro-cephalic aspect as the uterus. The uterus, immediately after its emergence from the shell gland, describes numerous compact coils in front of and to the right of the shell gland, and then, as it proceeds cephalad, to the front (ventrad of) and to the right of the ovary. Beyond this point it forms some dorso-ventral coils in the space between the ceca. These coils are dilated and filled with eggs. The uterus then continues in the axial region of the body in a more direct course cephalad. Part of its course is through the space between the caudal portions of the testes, tilting later nearer the dorsum of the body to enter the interspace between the intestines,

FIG. 200.

then it passes beneath the arch of union of the vasa efferentia to gain the ventral aspect of the cirrus pouch. In the remainder of its course it maintains this relation to the male duct forming but few coils, and terminates by uniting with the male duct to form the ductus hermaphroditicus.

Laurer's canal takes its departure from the oviduct at a point close to the dorsal aspect of the shell gland. It then passes dorsad describing a curve in its course with its convexity caudad and opens on the dorsum somewhat to the right of the median line about 0.54 mm. cephalad of the excretory pore in a transverse plane slightly above that of the cephalic margin of the acetabulum.

The vitellogene glands consist of sparsely scattered insignificant follicles, irregularly grouped to the external, ventral, and to some extent dorsal aspect of each of the intestinal ceca. Longitudinally they extend from about the level of the esophageal fork to the level of the cecal ends of the intestines. From each of the glands a duct passes more or less transversely inward ventrally of the intestines to unite near the ventro-caudal aspect of the shell gland. From their point of union a duct passes dorsad, skirting the caudal aspect of the shell gland which it penetrates and in the substance of which it unites with the oviduct as already described.

Eggs.—Eggs were observed crowded together in some of the proximal coils of the uterus. They appeared to be elliptical in form,

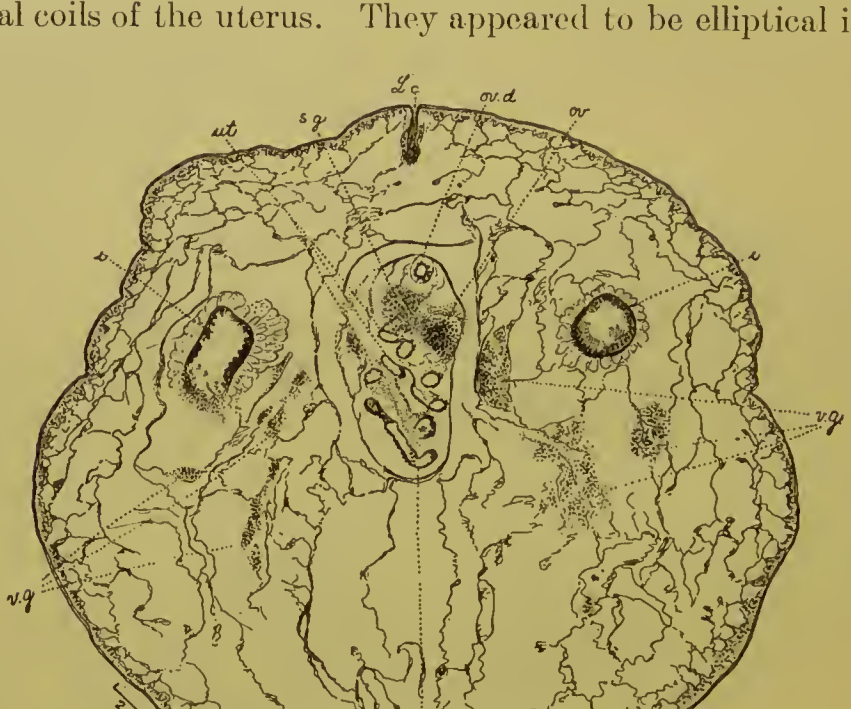

FIG. 201.

and 2 which appeared to have been sectioned in a favorable plane, measured each 150μ by 75μ in diameter. One end is operculated, and the opposite pole bears a short mammillate knob.

EXCRETORY SYSTEM.—The excretory system is well developed. An excretory vesicle of moderate size is situated dorsad of the dome of the acetabulum. From its dorsal aspect a little caudad of its equator a duct originates and passing directly dorsad opens in about the median line of the dorsum slightly caudad of the plane of the cephalic margin of the acetabular aperture and about 0.54 mm. caudad of the aperture of Laurer's canal. This excretory duct is about 0.24 mm. in length.

FIG. 190.—Ventral view. Enlarged. Original.

FIG. 191.—Profile view of same. Enlarged. Original.

FIG. 192.—Ventral projection to show internal anatomy. *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, planes of section; *ac.*, acetabulum; *c. p.*, cirrus pouch; *es.*, esophagus; *i.*, intestine; *ov.*, ovary; *o. s.*, oral sucker; *s. p.*, suctorial pouch; *s. sph.*, suctorial sphincter; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. e.*, vasa efferentia. Slightly diagrammatic. Enlarged. Original.

FIG. 193.—Profile projection of same. *a–a*, *b–b*, *c–c*, *d–d*, *e–e*, *f–f*, planes of section. *ac.*, acetabulum; *g. p.*, genital pore; *c. p.*, cirrus pouch; *es.*, esophagus; *ex. p.*, excretory pore; *ex. v.*, excretory vesicle;

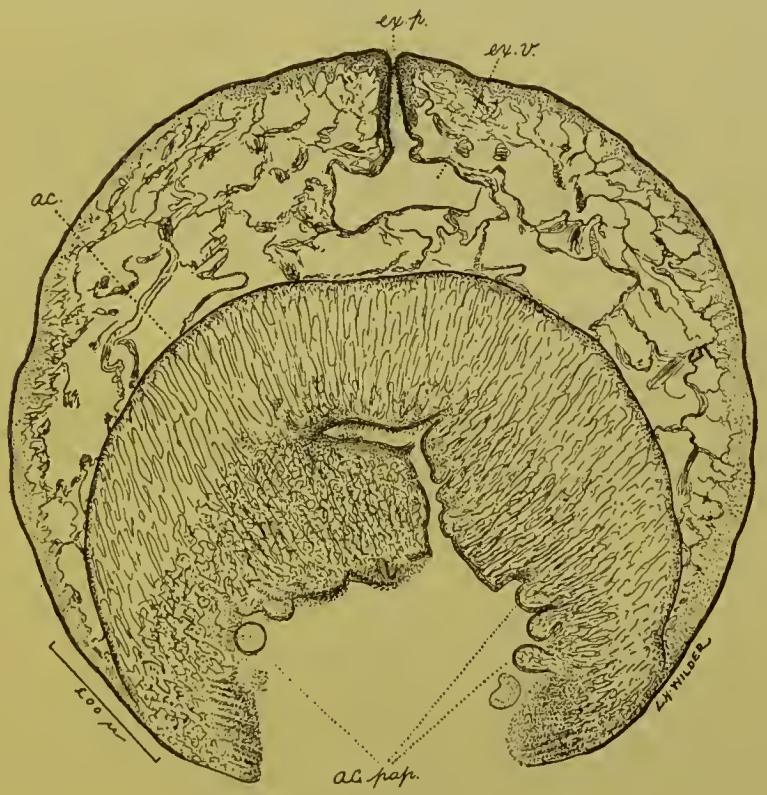

FIG. 202.

i., intestine; *L. c.*, Laurer's canal; *ov.*, ovary; *ov. d.*, oviduct; *o. s.*, oral sucker; *s. p.*, suctorial pouch; *s. sph.*, suctorial sphincter; *s. g.*, shell gland; *t.*, testes; *ut.*, uterus; *v. e.*, vas efferens; *v. s.*, vesicula seminalis. Slightly diagrammatic. Enlarged. Original.

FIG. 194.—Oral extremity seen from above and in front to show concentric grooves (slightly exaggerated) around oral aperture. (Compare fig. 196. Enlarged. Original.

FIG. 195.—Sagittal section through cirrus pouch (*c. p.*). Shows also the vesicula seminalis interna (*v. s. i.*), the small cirrus (*c.*), the ductus hermaphroditicus (*d. h.*), the genital papilla (*g. pap.*), the

metraterm (*va.*), the uterus (*ut.*), a loop of the vesicula seminalis externa (*v. s.*), some loops of the uterus (*ut.*), and a section of the intestine (*i.*). Slightly diagrammatic. Enlarged. Original.

FIG. 196.—Sagittal section through oral extremity. Shows the oral sucker (*o. s.*), the suctorial sphincter (*s. sph.*), the mouth (*m.*), and the perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 197.—Transverse section at *a–a* figs. 192 and 193. Shows oral sucker (*o. s.*) and perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 198.—Transverse section at *b–b* figs. 192 and 193. Shows oral sucker (*o. s.*), the suctorial pouches (*s. p.*), entrance to the esophagus (*es.*), and the perisuctorial space (*p. s. sp.*). Enlarged. Original.

FIG. 199.—Transverse section at *c–c* figs. 192 and 193. Shows the thick muscular cirrus pouch (*c. p.*), vesicula seminalis interna (*v. s. i.*), the intestines (*i.*), uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 200.—Transverse section at *d–d* figs. 192 and 193. Shows the testes (*t.*) and their relation to the intestinal ceca (*i.*) at this level, the uterus (*ut.*), and vitellaria (*v. g.*). Enlarged. Original.

FIG. 201.—Transverse section at *e–e* figs. 192 and 193. Shows caudal portion of ovary (*ov.*), cephalic portion of shell gland (*s. g.*), the oviduct (*ov. d.*), Laurer's canal (*L. c.*), some uterine coils (*ut.*), intestinal ceca (*i.*), vitellaria (*v. g.*). Enlarged. Original.

FIG. 202.—Transverse section at *f–f* figs. 192 and 193. Shows excretory vesicle (*ex. v.*) and pore (*ex. p.*) and acetabulum (*ac.*), with some of its papillæ (*ac. pap.*). Enlarged. Original.

Genus MICRORCHIS Daday, 1907.

GENERIC DIAGNOSIS.[a]—*Cladorchiinæ* (p. 169): Body elongate, venter concave, dorsum convex, gradually attenuate from acetabulum to mouth, caudal end rounded (on ventral view), sides rounded. Ventral pouch absent. Acetabulum large, terminal, aperture medium, directed ventrad. *Genital pore without sucker.* Excretory pore prevesicular, *equatorial*, very close to and at left of pore of Laurer's canal. Oral sucker with well-developed sphincter and with pair of evaginations; *esophagus springs ventrally* from oral sucker, cephalad of evaginations, and has a *distal* muscular thickening, ceca straight, long, end far postovarial, but preacetabular.

Male organs: Testes 2, very much smaller than acetabulum, unbranched, somewhat irregular in outline, fields apparently overlap, zones separate, preovarial, preequatorial, far removed from acetabulum, intercecal; *cirrus pouch present.*

Female organs: Ovary and shell gland *preequatorial*, at equator of vitellaria, posttesticular; vitellaria near ceca, equatorial, nearly one-third as long as body, "branched, tree-like;" Laurer's canal prevesicular.

TYPE.—*M. megacotyle* (Diesing, 1836).

Genus CHIORCHIS Fischœder, 1901.

GENERIC DIAGNOSIS.[b]—*Cladorchiinæ* (p. 169): Body straight, venter flat, dorsum convex, cephalic end attenuate, caudal end rounded, sides sharp, not divided by constriction. Ventral pouch absent. Acetabulum distinctly ventral, relatively small, extends beyond surface, margin raised, aperture large. Genital pore without sucker,

[a] Based on Daday, 1907. [b] Based on Fischœder, 1903b.

ductus hermaphroditicus present. Excretory pore prevesicular, preacetabular, caudad of Laurer's canal. Oral sucker with paired evaginations; esophagus with pronounced distal muscular thickening; ceca nearly straight, end postequatorial, posttesticular.

Male organs: Testes 2, slightly smaller than acetabulum, each with 4 lobes forming cross on ventral view, fields coincide, zones separate, preovarial, in equatorial and caudal thirds; musculosa not enormous; cirrus pouch present.

Female organs: Ovary and shell gland posttesticular; vitellaria in extracecal and cecal areas, extend through part of esophageal and entire cecal zones, close to ceca; uterus intercecal; Laurer's canal, chiefly prevesicular, does not cross excretory vesicle or canal.

TYPE.—*C. fabaceus* (Diesing, 1838).

HABITAT.—Small and large intestines of marine mammals.

Genus BALANORCHIS[a] Fischœder, 1901.

GENERIC DIAGNOSIS.—*Cladorchiinæ* (p. 169): Body small, rather conical, venter slightly concave, dorsum convex, cephalic end attenuate, caudal end slightly attenuate but rounded, transverse section circular. Ventral pouch absent. Acetabulum small, terminal, not sunken, margin (?), aperture relatively large. Genital pore with muscular ring; no ductus hermaphroditicus. Excretory pore postvesicular, posttesticular, apparently near cephalic margin of acetabular zone, caudad of pore of Laurer's canal. Oral sucker with paired evaginations; esophagus without muscular thickening; ceca long, slightly wavy, end postequatorial, in or near acetabular zone. Genital papilla absent.

Male organs: Testes 2, larger than acetabulum, elongate-elliptical, fields separate, zones nearly coincide, chiefly postovarial, postequatorial, close to acetabulum, cirrus pouch present.

Female organs: Ovary and shell gland in cephalic half of testicular zone; vitellaria S-shaped, following ceca, extend through nearly entire cecal zone, follicles united in globular groups; uterus slightly developed, intercecal, almost entirely pretesticular, not posttesticular; metraterm opens on caudal margin of pore, caudad of cirrus pouch.

TYPE.—*B. anastrophus* Fischœder, 1901.

HABITAT.—First stomach of *Cervidæ*, Brazil.

Subfamily DIPLODISCINÆ Cohn, 1904.

SUBFAMILY DIAGNOSIS.[b]—*Paramphistomidæ* (p. 60): [The characters of this subfamily are still in some doubt. If the excretory system of *Diplodiscus* is characteristic for the entire group, that would make an excellent subfamily character.]

KEY TO GENERA OF DIPLODISCINÆ.

Acetabulum round, opens caudad, with central excavation; 2 testes in young, coalesce in adult; genital pore near mouth; esophagus long, straight, with muscular thickening ("pharynx") at bifurcation; excretory canals with dark concretions.

Diplodiscus, p. 248.

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[a] Based on Fischœder, 1903h.

[b] *Original diagnosis.*—Amphistomiden von gedrungener, konischer Form und runden Querschnitt. Mundsaugnapf gut ausgebildet, mit 2 retrodorsalen Taschen. Ein grosser Endsaugnapf, ueber welchem dorsal der Exkretionsporus liegt. Mundœffung terminal, Darmschenkel bis zum Endsaugnapf reichend, relativ sehr breit. Leben im Enddarm von Amphibien und Reptilien.—Cohn, 1904, 242.

Acetabulum elongate-oval, ventro-subterminal, divided into 2 parts by constriction; 1 testis; genital pore slightly postbifurcal; esophagus long, straight, with muscular thickening ("pharynx") at bifurcation; excretory canals with dark concretions. *Cataliscus*, p. 248.

Acetabulum round, opens caudad, with central projecting sucker; 2 testes in adult; genital pore near mouth; esophagus short, bent, without muscular thickening ("pharynx"); excretory canals without concretions.....*Opisthodiscus*, p. 248.

Genus DIPLODISCUS Diesing, 1836.

GENERIC DIAGNOSIS.[a] [b]—*Diplodiscinæ* (?) *or Cladorchiinæ* (?) (p. 247): Body conical to cylindrical, venter concave, dorsum convex, cephalic end attenuate bluntly pointed, caudal end obliquely truncate. Ventral pouch absent. Acetabulum terminal, very large, aperture large, tilted ventrad. Genital pore without sucker. Excretory pore postvesicular, in acetabular zone, caudad of Laurer's canal; radial excretory branches profuse in acetabulum. Oral sucker with paired evaginations; esophagus with distal muscular thickening; ceca straight, long, end postequatorial, posttesticular.

Male organs: Testes 2 in young; may unite in adult, intercecal, much smaller than acetabulum, globular, unbranched, preovarial, rather distant from acetabulum, about equatorial; cirrus pouch present.

Female organs: Ovary and shell gland largely posttesticular; vitellaria extend from esophageal into postcecal zone; uterus intercecal; eggs with operculum; Laurer's canal entirely prevesicular.

TYPE.—*D. subclavatus* (Gœze, 1782).

HABITAT.—In rectum of amphibians, Europe.

Genus OPISTHODISCUS Cohn, 1904.

GENERIC DIAGNOSIS.[c]—*Diplodiscinæ* (?) (p. 247): Acetabulum with central projecting sucker. Esophagus without pharyngeal swelling.

Male organs: Testes 2, in part postovarial; cirrus pouch long and narrow.

Female organs: Ovary in testicular zone.

TYPE SPECIES.—*O. diplodiscoides* (Cohn, 1904).

Genus CATADISCUS Cohn, 1904.

GENERIC DIAGNOSIS.[d]—*Diplodiscinæ* (?) (p. 247): Acetabulum divided into 2 halves. Esophagus with distal muscular thickening.

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[a] *Diplodiscus* after Cohn, 1904, 242.—*Diplodiscinæ:* Der runde Endsaugnapf ist nach hinten gerichtet, mit zentraler Exkavation. 2 Hoden, die bei alten Exemplaren verschmelzen. Genital porus ziemlich nahe der Mundœffnung. Oesophagus lang und gerade verlaufend, ein Pharynx an der Darmgabelung. Exkretionskanæle mit den typischen dunkeln Konkrementen.

[b] Combined from various authors.

[c] *Original diagnosis.—Diplodiscinæ:* Der runde Endsaugnapf ist nach hinten gerichtet, mit centralem vorragendem Zapfen. Dauernd 2 Hoden. Genitalporus nahe an der Mundœffnung. Oesophagus kurz, um den Mundsaugnapf herum gebogen. Kein Pharynx. Die mæchtige entwickelten Saugnapftaschen reichen bis zu ⅓ der Gesammtlänge. Darm asymmetrisch. Exkretionskänal ohne dunkele Konkretion.—Cohn, 1904, 243.

[d] *Original diagnosis.—Diplodiscinæ:* Der langovale Endsaugnapf liegt subterminal-ventral und ist durch Einschnüerung in 2 Theile geteilt. Ein Hoden. Genitalporus wenig vor der Kœrper medial, dicht hinter der Darmgabelung. Oesophagus lang, gerade verlaufend; ein Pharynx an der Darmgabelung. Exkretionskanäle mit typischen Konkretionen.—Cohn, 1904, 243.

Male organs: Cirrus pouch present. Testis single, median.
Female organs: Ovary, at least in part posttesticular.
TYPE SPECIES.—*C. dolichocotyle* (Cohn, 1903).

GASTRODISCIDÆ, new family.

FAMILY DIAGNOSIS.—*Paramphistomoidea* (p. 15): Body rather discoidal, divided by transverse constriction into cephalic and caudal portions; ventral pouch absent, venter with many large papillæ. Acetabulum ventral at caudal end.
TYPE GENUS.—*Gastrodiscus* Leuckart, 1877.

This family contains two genera (*Gastrodiscus* and *Homalogaster*), which differ so strikingly from the genera of the *Paramphistomidæ* that distinct family rank seems justified. The one point which speaks against eliminating them from *Cladorchiinæ, Paramphistomidæ,* is the paired evaginations of the oral sucker.

The genera may easily be separated by the following key:

Genital glands confined to large anterior portion; acetabulum moderate; type *paloniæ*.....*Homalogaster*, p. 249.
Genital glands confined to large caudal portion; acetabulum small; type *sonsinoii*= *ægyptiacus*.....*Gastrodiscus*, p. 252.

Genus HOMALOGASTER Poirier, 1883.

GENERIC DIAGNOSIS.—*Gastrodiscidæ* (p. 249): Body divided by constriction into large cephalic, flat portion with genital glands, and small, caudal portion with acetabulum; venter flat or excavate, provided with alternating longitudinal rows of large mamma-like structures; of these, the papillæ near the middle of the rows (both longitudinal and transverse) are larger than those further from the middle; dorsum convex. Acetabulum large, caudal, ventral, not sunken, margin raised, aperture medium. Genital pore without sucker, on large protrusile papilla, ductus hermaphroditicus absent. Excretory pore postvesicular in acetabular zone, caudad of pore of Laurer's canal. Oral sucker with paired evaginations; esophagus rather long, with muscular swelling (at least in *H. philippinensis);* ceca slightly wavy, long, end postequatorial, post-testicular.

Male organs: Testes 2, smaller than acetabulum, preequatorial, lobate, widely separate from ovary and acetabulum; musculosa not enormously developed; cirrus pouch absent.

Female organs: Ovary and shell gland posttesticular; vitellaria cecal, about from bifurcation to ovary; uterus intercecal, pre-, post-, and testicular; eggs operculated; Laurer's canal entirely prevesicular.

TYPE.—*H. paloniæ* Poirier, 1883.
HABITAT.—Large intestine of ruminants. Asiatic.

HOMALOGASTER PHILIPPINENSIS Stiles & Goldberger, 1908.

[Figs. 203–205.]

A reexamination of the sectioned material that was used as the basis for the description of this species by Stiles and Goldberger, 1908, has disclosed one or two additional interesting points.

Oral sucker.—The oral sucker and suctorial pouches are inclosed in a well-marked cavity (figs. 32–36, Stiles and Goldberger, 1908). The oral sucker is held in position by attachments around its oral

extremity and by mesenterium-like strands extending from its ventral and dorsal aspects to the parenchyma. Caudally of the base of the oral sucker similar dorso-ventral strands run from the dorsomesial aspects of the bulbs toward the dorsum, anchoring them to the parenchyma, and other strands run ventrad from the esophagus. Besides these mesenterium-like strands, consisting of a loose parenchyma-like membrane, there are muscle bundles which attach these structures to the subcuticular muscle layers ventrally and dorsally. In this cavity or perisuctorial space is a considerable amount of a granular material (coagulum) in which a few cell-nuclei are scattered. These nuclei are surrounded by a narrow, clear, nongranular area, but a well-defined cell wall could not be made out.

Esophagus.—The caudal extremity of the esophagus is characterized by a somewhat fusiform bulbous enlargement (fig. 203) due to a very marked thickening of the muscular layers. Measured in sagittal section this bulbous thickening is about 280μ long with a maximum thickness of wall of about 67μ. The thickness of the esophageal wall just above (cephalad of) the beginning of this bulbous enlargement was found to be, in the same section, about 15μ.

FIG. 203.

Acetabulum.—The rim of the acetabulum projects beyond the body parenchyma, which embraces its dome in a manner resembling somewhat that in *Pseudodiscus stanleyii*, though it is not marked off as in *stanleyii* by an encircling groove (figs. 204, 205).

The foregoing observations change the original specific diagnosis to read as follows:

SPECIFIC DIAGNOSIS.—*Homalogaster* (p. 249): Body 7.5 to 9 mm. long by 4.5 to 5 mm. (or flattened to 7 mm.) broad, canoe shaped, cephalic extremity attenuated, caudal extremity rounded; when flattened, sides very convex longitudinally; dorsum may show submedian longitudinal depressions. Genital pore 1 mm. from oral margin (about one-ninth to one-seventh of body length from mouth and about at equator of esophagus), surrounded by depressed circular area bearing numerous small papillæ. Venter with alternating longitudinal rows of large papillæ extending from about 2 to 2.5 mm. from oral margin to acetabulum. Margins curved ventrally and are fairly sharp. Acetabulum about 2.5 by 2.7 to 3 mm., its margin projects beyond the body

parenchyma. Oral sucker with a single pair of evaginations; the sucker and evaginations lie in a well-marked perisuctorial space; esophagus extends to about one-fifth of body length from oral margin; the caudal end of the esophagus is provided with a fusiform bulbous muscular enlargement about 280μ long by 67μ thick; intestinal ceca narrow, slightly tortuous, long, extending to acetabulum. Excretory pore postvesicular, dorso-median, about at equator of acetabulum, caudad of pore of Laurer's canal.

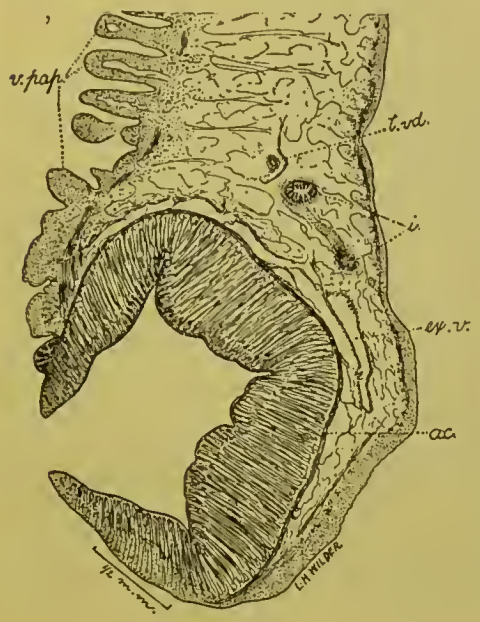

FIG. 204.

Male organs: Testes lobate in cephalic half of space between ceca; one caudad of the other; vesicula seminalis quite compactly coiled; pars musculosa distinctly but not highly developed; pars prostatica not prominent, may enlarge to quite a large diameter, thus resembling a "vesicula seminalis interna;" ductus ejaculatorius present; cirrus absent.

Female organs: Ovary and shell gland submedian, near end of one of the ceca, ovary cephalad of shell gland; vitellaria extend about from the bifurcation of the esophagus to caudal plane of ovary; uterus with many coils, well developed, passes cephalad, dorsally of testes, ventrally between vasa efferentia, ventrally of vas deferens, to pore; Laurer's canal opens dorso-median at plane of termination of ceca. Genital papilla, when extruded, resembles human penis with glans; bears on its vertex a pore, from which runs the short ductus hermaphroditicus; when retracted the papilla resembles a partially inclosed cirrus pouch.

Eggs: Egg oval, operculated, with small knob at opposite pole; 125 to 139μ by 67.5 to 86μ.

HABITAT.—Cecum of *Bos* sp., at Manila, P. I. (type locality), and Phrapatoom, Siam.

TYPE.—U. S. P. H. & M.H.S. 9580 (mounted); Cotypes 9581 and 9960.

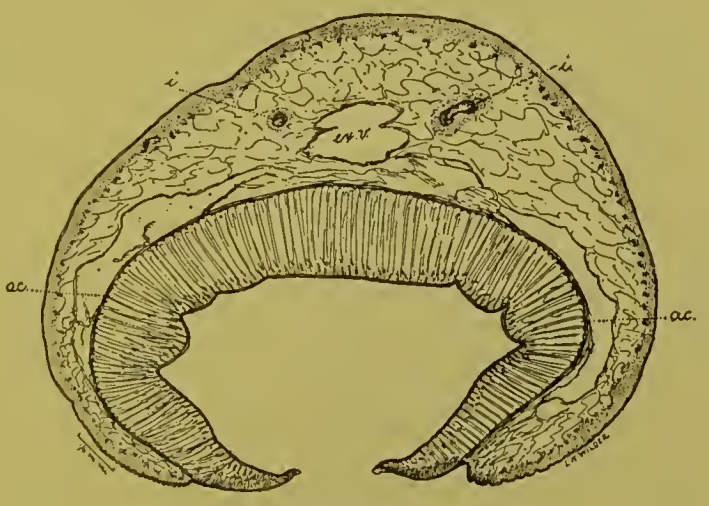

FIG. 205.

ILLUSTRATIONS.

FIG. 203.—Sagittal section shows bulbous thickening of caudal end of esophagus (*e.b.*); oral sucker (*o.s.*); perisuctorial space (*p.s.sp.*); suctorial pouch (*s. p.*); pars prostatica (*p. p.*); uterus (*ut.*). Enlarged. Original.

FIG. 204.—Sagittal section of caudal extremity to show acetabulum (*ac.*). Shows also the excretory vesicle (*ex. v.*) and intestines (*i.*), section of transverse vitello-duct (*t. vd.*), and ventral papillæ (*v. pap.*). Enlarged. Original.

FIG. 205.—Transverse section through caudal extremity. Shows acetabulum (*ac.*), excretory vesicle (*ex. v.*), and intestines (*i.*). Enlarged. Original.

Genus GASTRODICUS Leuckart, 1877.

GENERIC DIAGNOSIS.[a]—*Gastrodiscidæ* (p. 249): Body divided by constriction into small, cephalic, slender, nearly cylindrical portion without sexual glands, and large, caudal, flat, discoidal, ventrally excavate portion containing the genital glands. Ventral pouch absent. Acetabulum small, caudal, ventral, margin raised, aperture relatively large. Genital pore without sucker. Excretory pore postvesicular, in acetabular zone, caudad of pore of Laurer's canal. Oral sucker with paired evaginations; esophagus with muscular thickening; ceca not wavy, long, end postequatorial, posttesticular.

Male organs: Testes 2, larger than acetabulum, branched, diagonal, fields and zones overlap, preovarial, widely separated from acetabulum, about in equatorial third; musculosa not enormous; "cirrus pouch not completely closed."

Female organs: Ovary and shell gland posttesticular; vitellaria extracecal, extend from bifurcation into postcecal zone; uterus intercecal; Laurer's canal entirely prevesicular.

TYPE.—*Gastrodiscus ægyptiacus* Cobbold, 1876.

HABITAT.—Small and large intestines of *Equus* in Egypt and India, and *Homo* in India.

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[a] Based upon the writings of various authors.

LIST OF ABBREVIATIONS.

a. ac.....aperture of acetabulum.
a. v. p....aperture of ventral pouch.
ac.....acetabulum.
ac. pap....acetabular papillæ.
c.....cirrus.
c. p.....cirrus pouch.
c. vd.....common vitello-duct.
cu.....cuticle.
d. ac.....dome of acetabulum.
d. e.....ductus ejaculatorius.
d. h.....ductus hermaphroditicus.
e. g.....brain (esophageal ganglion).
es.....esophagus.
es. b.....esophageal bulbous thickening.
es. f.....esophageal fork.
ex. c.....excretory canal.
ex. d.....excretory duct.
ex. p.....excretory pore.
ex. v.....excretory vesicle.
g. a. c.....ventral chamber of genita atrium.
g. a.....genital atrium or dorsal chamber of genital atrium.
g. b.....genital bulging.
g. pap.....genital papillæ.
g. p.....genital pore.
g. s.....genital sucker.
g. sph.....genital sphincter.
i.....intestine.
L. c.....Laurer's canal.
m.....mouth.
m. b.....mesenterium-like strands (of oral sucker).
m. p.....musculosa-prostatica, junction of.
o. pap.....oral papillæ.
o. s.....oral sucker.
ot.....ootype.
ov.....ovary.
ov. d.....oviduct.
p. i.....pars intermedia.
p. L. c....pore of Laurer's canal.
p. m.....pars musculosa.
po. gr.....peri-oral groove.
por. h.....porus hermaphroditicus.
p. p.....pars prostatica.
pap. o. s..papillæ of oral sucker.
p. s. sp....perisuctorial space.
pa. gr.....peri-acetabular groove.
pap. g. a..papillæ of genital atrium.
par.....parenchyma.
r. ac.....rim of aperture of acetabulum.
s. b.....suctorial bulb.
s. g.....shell gland.
s. p.....suctorial pouch.
s. pap.....surface papillæ.
s. sph.....suctorial sphincter.
sz.....spermatozoa.
t.....testis (t. d., right or inferior t. s., left or superior).
t. g. p.....true genital pore.
tr. gr.....transverse grooves.
t. vd.....transverse vitello-duct.
ut.....uterus.
v. e.....vas efferens (right = v. e. d.; left=v. e. s.).
v. e. a.....arch of union of vasa efferentia.
v. d.....vas deferens.
v. g.....vitellogene glands, vitellaria.
v. m.....vesicula-musculosa, junction of.
v. p.....ventral pouch.
v. pap....ventral papillæ.
v. r.....vitellene reservoir.
v. s.....vesicula seminalis.
v. s. i.....vesicula seminalis interna.
va .....metraterm.

INDEX TO ZOOLOGICAL NAMES.

LIST OF HYGIENIC LABORATORY BULLETINS OF THE PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

The Hygienic Laboratory was established in New York, at the Marine Hospital on Staten Island, August, 1887. It was transferred to Washington, with quarters in the Butler Building, June 11, 1891, and a new laboratory building, located in Washington, was authorized by act of Congress March 3, 1901.

The following *bulletins* [Bulls. Nos. 1–7, 1900 to 1902, Hyg. Lab., U. S. Mar.-Hosp. Serv., Wash.] have been issued:

*No. 1.—Preliminary note on the viability of the *Bacillus pestis*. By M. J. Rosenau.

No. 2.—Formalin disinfection of baggage without apparatus. By M. J. Rosenau

*No. 3.—Sulphur dioxid as a germicidal agent. By H. D. Geddings.

*No. 4.—Viability of the *Bacillus pestis*. By M. J. Rosenau.

No. 5.—An investigation of a pathogenic microbe (*B. typhi murium* Danyz) applied to the destruction of rats. By M. J. Rosenau.

*No. 6.—Disinfection against mosquitoes with formaldehyde and sulphur dioxid. By M. J. Rosenau.

No. 7.—Laboratory technique: Ring test for indol, by S. B. Grubbs and Edward Francis; Collodium sacs, by S. B. Grubbs and Edward Francis; Microphotography with simple apparatus, by H. B. Parker.

By act of Congress approved July 1, 1902, the name of the "United States Marine-Hospital Service" was changed to the "Public Health and Marine-Hospital Service of the United States," and three new divisions were added to the Hygienic Laboratory.

Since the change of name of the Service the bulletins of the Hygienic Laboratory have been continued in the same numerical order, as follows:

*No. 8.—Laboratory course in pathology and bacteriology. By M. J. Rosenau. (Revised edition, March, 1904.)

*No. 9.—Presence of tetanus in commercial gelatin. By John F. Anderson.

No. 10.—Report upon the prevalence and geographic distribution of hookworm disease (uncinariasis or anchylostomiasis) in the United States. By Ch. Wardell Stiles.

*No. 11.—An experimental investigation of *Trypanosoma lewisi*. By Edward Francis.

*No. 12.—The bacteriological impurities of vaccine virus; an experimental study. By M. J. Rosenau.

*No. 13.—A statistical study of the intestinal parasites of 500 white male patients at the United States Government Hospital for the Insane; by Philip E. Garrison, Brayton H. Ransom, and Earle C. Stevenson. A parasitic roundworm (*Agamomermis culicis* n. g., n. sp.) in American mosquitoes (*Culex sollicitans*); by Ch. Wardell Stiles. The type species of the cestode genus *Hymenolepis;* by Ch. Wardell Stiles.

No. 14.—Spotted fever (tick fever) of the Rocky Mountains; a new disease. By John F. Anderson.

No. 15.—Inefficiency of ferrous sulphate as an antiseptic and germicide. By Allan J. McLaughlin.

*No. 16.—The antiseptic and germicidal properties of glycerin. By M. J. Rosenau.

*No. 17.—Illustrated key to the trematode parasites of man. By Ch. Wardell Stiles.

*No. 18.—An account of the tapeworms of the genus *Hymenolepis* parasitic in man, including reports of several new cases of the dwarf tapeworm (*H. nana*) in the United States. By Brayton H. Ransom.

*No. 19.—A method for inoculating animals with precise amounts. By M. J. Rosenau.

*No. 20.—A zoological investigation into the cause, transmission, and source of Rocky Mountain "spotted fever." By Ch. Wardell Stiles.

No. 21.—The immunity unit for standardizing diphtheria antitoxin (based on Ehrlich's normal serum). Official standard prepared under the act approved July 1, 1902. By M. J. Rosenau.

*No. 22.—Chloride of zinc as a deodorant, antiseptic, and germicide. By T. B. McClintic.

*No. 23.—Changes in the Pharmacopœia of the United States of America. Eighth Decennial Revision. By Reid Hunt and Murray Galt Motter.

No. 24.—The International Code of Zoological Nomenclature as applied to medicine. By Ch. Wardell Stiles.

No. 25.—Illustrated key to the cestode parasites of man. By Ch. Wardell Stiles.

No. 26.—On the stability of the oxidases and their conduct toward various reagents. The conduct of phenolphthalein in the animal organism. A test for saccharin, and a simple method of distinguishing between cumarin and vanillin. The toxicity of ozone and other oxidizing agents to lipase. The influence of chemical constitution on the lipolytic hydrolysis of ethereal salts. By J. H. Kastle.

No. 27.—The limitations of formaldehyde gas as a disinfectant with special reference to car sanitation. By Thomas B. McClintic.

*No. 28.—A statistical study of the prevalence of intestinal worms in man. By Ch. Wardell Stiles and Philip E. Garrison.

*No. 29.—A study of the cause of sudden death following the injection of horse serum. By M. J. Rosenau and John F. Anderson.

No. 30.—I. Maternal transmission of immunity to diphtheria toxine. II. Maternal transmission of immunity to diphtheria toxine and hypersusceptibility to horse serum in the same animal. By John F. Anderson.

No. 31.—Variations in the peroxidase activity of the blood in health and disease. By Joseph H. Kastle and Harold L. Amoss.

No. 32.—A stomach lesion in guinea pigs caused by diphtheria toxine and its bearing upon experimental gastric ulcer. By M. J. Rosenau and John F. Anderson.

No. 33.—Studies in experimental alcoholism. By Reid Hunt.

No. 34.—I. *Agamofilaria georgiana* n. sp., an apparently new roundworm parasite from the ankle of a negress. II. The zoological characters of the roundworm genus *Filaria* Mueller, 1787. III. Three new American cases of infection of man with horsehair worms (species *Paragordius varius*), with summary of all cases reported to date. By Ch. Wardell Stiles.

*No. 35.—Report on the origin and prevalence of typhoid fever in the District of Columbia. By M. J. Rosenau, L. L. Lumsden, and Joseph H. Kastle. (Including articles contributed by Ch. Wardell Stiles, Joseph Goldberger, and A. M. Stimson.)

No. 36.—Further studies upon hypersusceptibility and immunity. By M. J. Rosenau and John F. Anderson.

No. 37.—Index-catalogue of medical and veterinary zoology. Subjects: Trematoda and trematode diseases. By Ch. Wardell Stiles and Albert Hassall.

No. 38.—The influence of antitoxin upon post-diphtheritic paralysis. By M. J. Rosenau and John F. Anderson.

No. 39.—The antiseptic and germicidal properties of solutions of formaldehyde and their action upon toxines. By John F. Anderson.

No. 40.—1. The occurrence of a proliferating cestode larva (*Sparganum proliferum*) in man in Florida, by Ch. Wardell Stiles. 2. A reexamination of the type specimen

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13893—Bull. 60—10——17

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