X STUDIES IN INDIAN HELMINTHOLOGY, No II

By F. H. STEWART, *M.A., D.Sc., M.B., Capt., I.M.S.,*
Hon. Assistant, Indian Museum.

THE ANATOMY OF *POLYSTOMUM KACHUGAE*, SP. NOV., WITH NOTES ON THE GENUS *POLYSTOMUM*.

Polystomum kachugae, sp. n.

(Plates xxvi—xxix.)

Two specimens were found in the urinary bladder of a water tortoise (*Kachuga lineata*, Gray) at Lucknow. They were fixed in boiling alcohol, 70%: one specimen was stained with borax-carmine and mounted entire, the other after being stained with the same stain and sketched in oil of cloves was cut into serial sections. I am indebted to my friend Major Walton, I.M.S., for the opportunity of obtaining the specimens at the Medical College, Lucknow, and to Dr. Annandale for the identification of the tortoise.

The body of this new Polystome measures 6·5 mm. in length and 2 mm. in breadth at the level of greatest breadth. It is bluntly pointed at the head, becoming broader in the first 2 mm; the second 2 mm. of length correspond with the greatest breadth. There is a slight but sudden narrowing 1·8 mm. from the posterior extremity. The cotylophore is 1·33 mm. in breadth, the part of the body immediately preceding it is 1·3 mm.

The mouth is subterminal and flattened, of crescent shape when looked at from the ventral surface. The dorsal lip projects downward into the mouth (Pl. xxvii, fig. 2). Eye spots are not present. Four longitudinal lines of nuclei occur on the ventral surface, outlining the sheaths of the ventral nerve cords. The aperture of the genital atrium is situated 1·15 mm. from the anterior extremity.

The cotylophore bears six cup-shaped suckers (Pl. xxvi, fig. 1) the largest of which measures ·4 mm. in diameter. Each sucker projects freely from the surface. The wall of the organ is seen in sections (Pl. xxix, fig. 18) to consist of an outer layer of ectoderm (o.e.), a loose fibrous layer (f.l.), an outer cuticular layer (o.c.l.), a muscular layer (m.l.), an inner cuticular layer (i.c.l.), and an inner ectodermal layer (i.e.l.). The cup formed by the outer cuticular, muscular, and inner cuticular layers is perforated at the base, retractor muscles being attached to the margins of the perforations.

The inner and outer cuticular layers completely enclose the muscular layer, becoming continuous with one another at the mouth of the cup and at the perforation at the base The fibres of the muscular layer radiate from the centre of the sucker cup, in such a manner that when they contract (acting from the outer cuticular layer as a fixed surface) they enlarge the cavity of the cup and thereby produce a vacuum. This action is aided by the retractor muscles attached to the perforation.

The cotylophore bears two pairs of hooks situated between the posterior pair of suckers (Pl. xxvi, fig. 1). One pair is large and sabre-shaped, 0·9 mm. in length, the points curved boldly forward (h.1.). Plate xxix, fig. 18 exhibits the base of such a hook in transverse section. The hooks of the second pair are short, 0·166 mm. in length, fine and simply curved (Pl. xxvi, fig. 1, h.2).

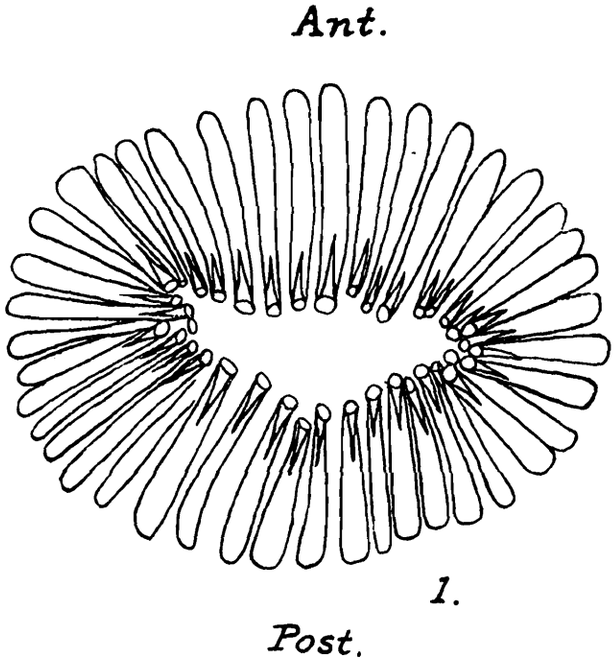


FIG. 1.—The circlet of atrial hooks as seen from the ventral surface, × 650.

Alimentary System.—The flattened mouth leads into the first pharynx—a spherical muscular bulb (Pl. xxvi, fig. 1. Pl. xxvii, 2, 3, and 4, ph.1) which possesses walls of great thickness and a comparatively narrow lumen. The second pharynx (Pl. xxvi, fig. 1. Pl. xxvii, 5 and 6, ph.2) is identical in shape with the first, and lies dorsal and posterior to it. From the second pharynx a narrow, short and muscular oesophagus leads into the intestine (Pl. xxvi, fig. 1. xxviii, 7, 8. xxix, 14, 17. int.) an organ of the customary two-limbed type. The limbs are unbranched and devoid of anastomoses. They extend backward into the region of the cotylophore.

The Skin.—The ectoderm exhibits structure only in a few sections (Pl. xxvii, fig. 5). In these it appears to consist of a high palisade like epithelium. Nuclei are not visible except in the

covering of the outer wall of the suckers (Pl. xxix, fig. 18) where minute point-like nuclei occur. The ectoderm rests on a fibrillar basement membrane, beneath which lies the loose connective tissue in which the organs of the body are embedded.

Nervous System.—The central nervous system is composed of a ring surrounding the second pharynx. The dorsal portion of this ring lies at the junction of the first with the second pharynx (Pl. xxvii, fig. 4) and contains six to eight large ganglion cells. The ventral portion of the ring lies somewhat further back (Pl. xxvii, fig. 6). The lateral portions (Pl. xxvii, fig. 5) give off stout nerves to the margins of the body. Two dorsal, two lateral, and two ventral longitudinal nerve cords are present. (Pl. xxix, fig. 14. d.n.c., l.n.c., v.n.c., and Pl. xxvi, fig. 1 v.n.c.)

Reproductive System.—In regard to the reproductive system, the two specimens at the disposal of the present writer are as

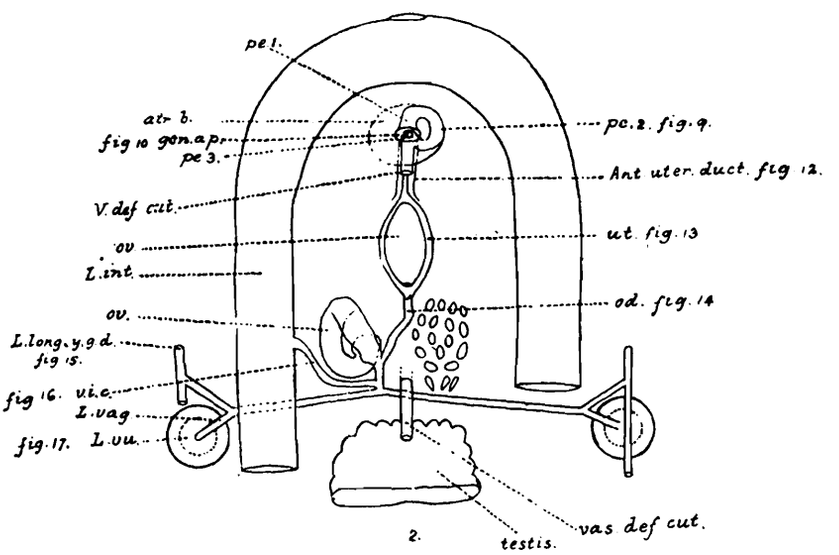
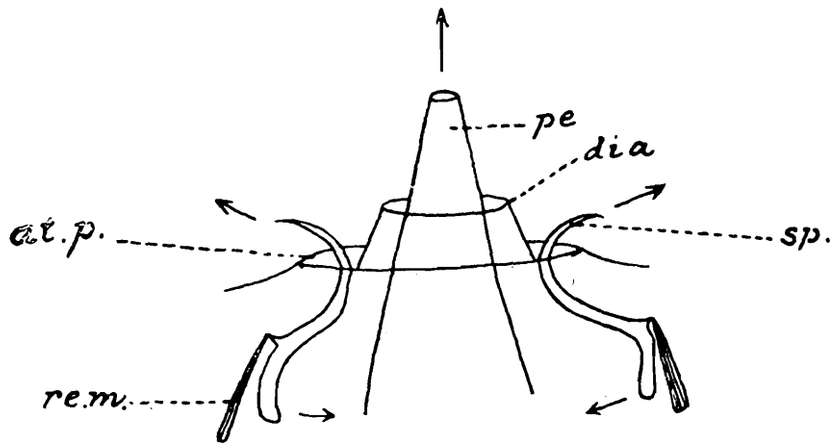


FIG. 2.—Diagram of the reproductive organs as seen from the dorsal surface in specimen No. 2. A portion of the vas deferens is assumed to have been removed to show the underlying female organs. Portions only of the longitudinal yolk ducts are figured.

mirror images the one of the other. The ovary is situated on the right side in specimen No. 1 which is represented in figure 1 of Plate xxvi and on the left side in the second specimen from which the drawings of sections have been made. In the following description the condition of the second specimen is taken as the model.

The male organs.—The testis is a broad, flat and lobulated organ (Pl. xxvi, fig. 1 te.) 2·2 mm. in length and 1 mm. in breadth, lying in the median third of the body directly under the ventral epithelium. The vas deferens (Pl. xxviii, fig. 13. Pl. xxix, figs. 14-16 v.d. and text-fig. 2) after gaining the dorsal segment of the body runs forward in the midline. When it approaches within a short distance of the genital atrium it expands somewhat to form a seminal vesicle (Pl. xxviii, figs. 8, 9, 10, 12 s.v.)

which ends in the centre of the surface of the atrial bulb. In this situation it joins the penis, a short, protrusible and muscular tube which curves outward and to the right, and then inward and backward to open into the cavity of the genital atrium (Text-fig. 3 pe. and Pl. xxviii, figs. 9 and 10 pe.). This cavity is enclosed in a muscular bulb (Pl. xxvi, fig. 1. Pl. xxviii, 9, 10 and 12. Text fig. 3 at. b.) and is divided by a diaphragm into a dorsal male atrium and a flattened ventral female atrium. The male atrium opens into the female atrium, and this in turn opens to the exterior through the atrial pore. The penis projects freely into the cavity of the male atrium (Pl. xxviii, fig. 9 pe. 1). The diaphragm is armed with a circle of forty spines which when viewed from the ventral surface appear to be straight truncated rods with recurved fine points (text-fig. 2) but when looked at from the side are seen to be S-shaped hooks (Pl. xxviii, fig. 11) sharp-pointed at the projecting extremity, and having a raised



3.

FIG. 3.—Diagram to explain the action of the atrial spines and the valvular action of the diaphragm on protrusion of the penis. See text.

point on the outer aspect at the junction of the basal and median thirds for the attachment of muscle fibres. The penis can doubtless be extruded through the atrial pore and would carry the diaphragm along with it. This protrusion would separate the points of the hooks and the circlet would embed itself firmly in any tissues with which it came into contact (text-fig. 3). Self-impregnation would be prevented by the impaction of the cone formed by the protruded diaphragm in the atrial pore, the female atrium being closed completely during the protrusion of the penis.

The female organs.—(Text-figure 2). The ovary (Pl. xxvi, fig. 1 and Pl. xxix, figs. 14-16 ov.) is situated 1·7 mm. from the anterior extremity. It is a curved sausage-shaped organ, the curve forming all but a complete circle. The fundus is somewhat bulbous. The ovary leads into the oviduct, a narrow canal which runs forward to the uterus (Pl. xxix, figs. 14 and 15 od.). The latter organ

(Pl. xxviii, fig. 13) is of oval form, 0·3 mm. in length and contains a single ovum encased in an eggshell of golden colour. From the uterus the anterior uterine duct leads into the female atrium, on the ventral aspect, as has been explained above, of the atrial circlet of hooks. The two vaginae (text-fig. 3 and Pl. xxix, figs. 16 and 17 vag.) lead out of the oviduct, and pass outward and slightly backward to the vulvae. Each vulva is an open cup situated close to one of the lateral margins, on the ventral surface, and 2 mm. from the anterior extremity. The mouth of the cup is only slightly contracted and has a diameter which measures 0·045 mm. The greatest breadth of the interior of the cup measures 0·068 mm. The wall of the vulva is devoid of cell-outlines and of nuclei and thus resembles the ectoderm with which it is continuous. It is traversed by fine branching fissures which contain a darkly staining material. The vulva opens into the vagina through fissures of this nature. The darkly staining material is neither sperm nor yolk. The vulval capsule is surrounded by pear-shaped cells which possess finely granular protoplasm and large nuclei, but do not contain any obvious secretion.

The main longitudinal ducts of the yolk glands open into the vaginae close to the vulvae (Pl. xxix, fig. 17, text-fig. 3. y.g.d.). The glands extend from the level of the posterior border of the second pharynx as far backward as the anterior margin of the cotylophore. They are found immediately beneath the basement membrane on the dorsal and lateral aspects of the body, and on those portions of the ventral aspect which are not occupied by the reproductive organs. The cells of the yolk glands contain (1) granules which stain pink with carmine, and (2) golden yellow globules. The latter are more numerous than the former. The colour of the globules is identical with that of the eggshell. The granules may be of yolk, but the present writer has not been able to compare them with the contents of the uterine egg, owing to the imperviousness of the eggshell to stains and paraffin. As these glands are morphologically the same as the glands described as yolk glands in other species of *Polystomum*, the name is retained, although they appear also to function as shell glands.

Another group of glandular cells is found at the same transverse level as the ovary, but on the opposite side of the midline. They appear to be connected with the corresponding vagina, but their function is obscure. The protoplasm of these cells is filled with irregular granules.

The vitello-intestinal canal (text-fig. 2. Pl. xxix, fig. 15 v.i.c) leads from the oviduct to the left intestinal branch. The present writer did not find spermatozoa in any part of the female ducts. Yolk cells bearing granules and globules were found in the oviduct and in the left ramus of the gut near to the opening of the vitello-instestinal canal.

The Excretory System. A main longitudinal duct is present on either side of the body, situated 0·187 mm. from the lateral margin. It measures 0·238 mm. in diameter and possesses a fibrous wall.

Each duct opens into an excretory vesicle (Pl. xxvi, fig. 1. and Pl. xxviii, 7 ex. ves.), a large spherical space situated amongst the yolk glands, 1 to 1·2 mm. distant from the anterior extremity. The wall of the vesicle is composed of fine fibrous tissue and the vesicle opens on the dorsal surface by a fine pore (Pl. xxviii, fig. 7 ex.p.).

Summary of the Literature concerning the Genus **Polystomum.**

Seven species of Polystoma are known at the present day, viz:—

(1) *Polystomum integerrimum*, Rud. in *Rana temporaria*, urinary bladder.

(2) *Polystomum ocellatum*, Rud. in *Emys lutraria*, Bp., fauces.

(3) *Polystomum oblongum*, Wright, 1888, in *Sternothaerus odoratus*, Gray, urinary bladder.

(4) *Polystomum coronatum*, Leidy, 1888, in *Cistudo carolina*, Gray, nares, pharynx.

(5) *Polystomum hassalli*, Goto, 1900, in *Kinosternon pennsylvannicum*, urinary bladder.

(6) *Polystomum* sp. (=*P. oblongum*, Leidy 1888, not *P. oblongum*, Wright, 1884) Goto 1900, in *Pseudemys rugosa*, urinary bladder.

(7) *Polystomum kachugae*, sp. nov., in *Kachuga lineata* (Gray), urinary bladder.

Comparison of species.

(1) **Polystomum integerrimum,** Rud. (Literature Nos. 1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 16, 17, 18 19, 20, 21, 22, 23, 24, 26, 27, 28).

This species is distinguished from the other members of the genus by the branched character of the intestinal rami, the branches anastomosing across the midline; in the remaining species the two rami do not give off branches.

(2) **Polystomum ocellatum,** Rud. (Literature Nos. 5, 7, 16, 20, 22, 24).

Summary of No. 24 Lit. v Willemoes Suhm.—Zeitsch. f. Wissensch. Zool., vol. 22, pp. 29—39, that portion which deals with the anatomy of *Polystomum ocellatum*. The author's description is based on the work of von Siebold (20a). "Der Schildkrotenschmarotzer ist im ausgedehnten Zustande 1½ Linien lang, ½ Linie breit In seiner Körperform ähnelt er durchaus dem Polystoma der Frosche Am vorderen Leibesende zwischen Pharynx und Geschlechtsöffnung bemerkt mann jederseits eine warzenförmige Hervorragung ich beobachtete sie jedesmal, sowie dass das Thier sie willkürlich aus—und einziehen könne

Was die Napfe der Haftscheibe betrifft, so weichen sie won denen des P. integerrimum dadurch ab, dass sie von einem festen Ringe, wahrscheinlich chitiniger Substanz umgeben sind, der in felder abgetheilt ist, deren jedes 2-3 Löcher zeigt. Zwischen den beiden untersten (Saugnapfen) finden sich zwei grössere, mit den spitzen nach unten stehende, von einander

abgewandte Haken. Von Siebold found small hooklets between the large hooks "noch am erwachsenen thier in wechselender Zahl Augenflecke Est ist anzunehmen dass sie das Thier in der Jugend besitze, im Alter aber verliere. Auf eimen Mundnapf mit quergestellter öffnung folgt ein muskulöser, birnförmiger Schlundkopf, ein kurzer Oesophagus und ein Darm der in zwei Schenkel auslauft und keine weitere Verzweigungen abgiebt."

The genital pore lies "an der bauchfläche, unterhalb der stelle, wo die Darmschenkel sich spalten. Er bildet hier förmlich einen Napf. Im Cirrus liegen kleine Häkchen deren Zahl sich auf 40 belauft. Von den weiblichen Genitalien ist der am meisten in die Augen fallende Keimstock unregelmässing viereckig. Er liegt im vorderen Theile des Körpers. Die beide Dotterstöcke, grosse, gelappte Organe, welche am Rücken liegen, füllen den ganzen Raum vom Mundsaugnapf bis an die Saugscheibe aus. Ihre Ausführungsgänge vereinigen sich zum Dottergang, der, nachdem er mit dem Keimgang zusammengeflossen ist sich in den Vaginalcanal fortsetzt, wo er eine Anzahl einzelliger Drösen (deren Summe die Schalendröse ausmacht) aufnimm. An der Stelle wo diese einmönden, ist eine kleine Höhle (Ootype, van Beneden), die sich in den Eileiter oder Vaginalcanal fortsetzt. Dieser verlauft in einigen Windungen zum Porus genitalis und mundet hinter der mannlichen Öffnung in die Geschlechtskloake aus."

We gather from the foregoing description that the most noteworthy point of distinction between the species *ocellatum* and *kachugae* lies in the position of the vulvae and possibly in the form of these organs. In *P. ocellatum* they lie between the pharynx and the genital aperture, in *P. kachugae* at a considerable distance behind the genital aperture It is possible that the pit-like form of the organs in *P. kachugae* is due to the retraction of a pair of pad-like vulvae as described by Willemoes Suhm.

The shell gland described by von Siebold is clearly the same morphologically as the innominate gland of *P. kachugae*. It is not clear on what grounds the function of shell-formation has been attributed to the gland and it may be that the function has been taken for granted without sufficient proof, not only in the case of this gland but of the "yolk-gland" also.

(3) **Polystomum oblongum,** Wright, 1884. (Lit. Nos. 13, 25). The succeeding notes are extracted from No. 25. "Body oblong, mouth on the ventral surface of the rounded anterior end. Pharynx bowl-shaped. Intestinal caeca without anastomoses or branches. Generative outlets in front of the line of the lateral vaginae. Cirrus coronet of sixteen alternately small and large sabre-shaped pieces. Viviparous. Length up to 2·5 mm., breadth 1·5 mm. Egg greenish 0·235 mm. by 0·195. Larvae ocellate 0·5 mm. in length. The caudal lamina is somewhat narrower than the greatest width of the body and is shorter than it is broad." Six small hooks, 0·15 mm. in length, situated between the two anterior suckers, in pairs. Four small and two large hooks

between the posterior suckers, the small hooks between the large hooks. The large hooks measure 0·15 mm. "and have a proportionately deeper notch than those of *P. integerrimum.*"

Comparing the foregoing description with our species from *Kachuga lineata*, it will be seen that the two species differ in that *P. kachugae* possesses a cirrus coronet of forty equal, instead of sixteen unequal pieces, and in that it measures more than twice the length of *P. oblongum*, whereas the egg measures only half the length of that of *P. oblongum*. The number of the cotylophore hooks also is different.

Professor Wright continues—"The mouth is transversely oval, and is surrounded by a well-marked sucker. . It leads immediately into a bowl-shaped pharynx, the walls of which possess merely weak circular fibres, and from this the simple intestinal caeca arch backwards directly."

This oral sucker appears to correspond with the first pharynx of *P kachugae*, the weak bowl-shaped pharynx with the strong globular second pharynx of *P. kachugae.*

The testis of *P. oblongum* is a small solid sausage-shaped gland differing greatly from the flat lobulated testis of *P. kachugae.*

In *P. oblongum* two lateral cushions are present situated each in a depression, as in *P. kachugae*, which communicate with vaginae leading to the centre of the body. "A third canal originating from an oval body with brown contents (shell gland?) situated on the left side of the middle line, likewise was observed to take the same direction. The ovary is situated on the front of the testis on the right side of the body." The shell gland may correspond with the innominate gland of *P. kachugae.*

(4) **Polystomum coronatum,** Leidy, 1888. (Lit. No. 13). A parasite of *Cistudo carolina*, Gray. Three specimens were found in the throat, one in the nose. "These pertain to a different species from" *P. oblongum*, Leidy, 1888 (not the true *P. oblongum*, Wright, 1884) "and may prove to be the *P. ocellatum* found in a similar position in the European turtle, *Emys europea*. . Body when elongated lanceolate. Caudal disk wider than the body, cordiform with three pairs of bothria and with the body attached between the anterior two pairs; changeable in form to oblong, circular, or quadrate; with three pairs of minute hooks between the anterior pairs of the bothria and with a larger pair and two smaller pairs between the last pair of bothria. Genital aperture with a circular or a transverse oval coronet of thirty-two hooks of equal length. No eyes visible. Length elongated from 4·6 mm., contracting to about half the length and widening proportionately".

Polystomum kachugae accordingly differs from this species in the following points of anatomy,—the caudal disk is narrower, not wider than the body, does not bear hooks between the anterior pair of suckers, bears one pair of large and one of small hooks between the posterior pair of suckers. The genital aperture is furnished with forty hooks, not thirty-two.

(5) **Polystomum hassalli,** Goto 1898 (Lit. No. 10). From the urinary bladder of *Kinosternon pennsylvanicum*, in Bowie, Prince George county, Md.

"Total length of the body 1·5 mm. Body proper ovate. Adhesive disk hexagonal, the hemispherical suckers occupying the angles of the hexagon and each with a minute hook in the centre, with three pairs of hooks between the most anterior pair of suckers and two pairs between the most posterior; these hooks and those in the suckers being all of the same form and measuring 0·033 mm. in length. The larger hooks between the most posterior suckers bifurcated towards the base, without any lateral process, measuring 0·125 mm. in length."

Polystomum hassalli is therefore four times as long as *P. kachugae*, possesses five pairs of small cotylophore hooks in place of one, and a hooklet in each sucker which does not exist in *P. kachugae.*

Goto describes the alimentary system of his species as follows:—"Anterior sucker large, oesophagus wanting, intestine bifurcated, tubular, without lateral branches, the two legs ending independently at the front end of the adhesive disk." The mouth of *P. kachugae* is not surrounded by a sucker: it is possible that Goto refers to a structure of the same nature as the first pharynx of *P. kachugae.*

"Common genital pore" (in *P. hassalli*) "lying midway between the front end of the body and the front end of the adhesive disk. I counted fifteen penis spines which are straight and bear a wing-like process at the middle and are 0·028 mm. long, but as their number in other species is always even, I think that there are sixteen in the present species." The distance of the atrial pore from the anterior extremity of the body in *P kachugae* is about one-fifth of the distance of the anterior end of the cotylophore from the same point.

The ovary of *P. hassalli* lies as in *P. kachugae* sometimes in the right half of the body, sometimes in the left half. The vaginal openings are lateral, without papillae, midway between the front and hind extremities of the body proper; the two vaginal canals are directed almost straight across the body and meet in the median line. In *P. kachugae* on the contrary the vaginal openings are situated at the junction of the anterior and middle thirds of the body proper. The genito-intestinal canals of *P. hassalli* lie slightly behind the vaginae, in *P. kachugae* slightly in front of them.

(6) **Polystomum** sp. (*P. oblongum*, Leidy, 1888, not the true *P. oblongum*, Wright, 1884) (Lit. Nos. 13 and 10). From the urinary bladder of *Pseudemys rugosa.*

This species is partially described from an imperfect specimen by Goto, but it is not named on account of the inadequacy of the description.

It possesses sixteen equal penis spines measuring 0·66 mm. in length (in contrast to the unequal spines in Wright's species)

and one hook in each sucker. The remaining hooks of the cotylophore had been lost.

LIST OF THE LITERATURE OF THE GENUS *POLYSTOMUM*, RUD.

(1) Baer, Nov. Acta. Akad. C.C.L. tom. 13.2., pl. 32.—P. integerrimum.

(2) Beneden v. und Hesse, Rech., pp. 84-87.—P. integerrimum.

(3) Braun, Schrift der Berliner Ges. Naturforsch. Fr. tom. 10, p 58, pl. 3.—P. integerrimum.

(4) Bremser, Icon. Helminth., pl. 10, figs. 25 and 26.—P. integerrimum.

(5) Diesing, Syst. Helminth. tom. 1, p. 413.—P. ocellatum.

(6) Diesing, Syst. Helminth. tom. 1, p. 412.—P integerrimum.

(7) Dujardin, Hist. Nat. des Helminthes, p. 320.—P. integerrimum, p. 319.—P. ocellatum.

(8) Fröhlich, Naturforsch., 25, p. 103.—P. integerrimum.

(9) Gmelin, Syst Nat., p. 3056.—P. integerrimum.

(10) Goto, Journ. Col. Japan, 12, 1900, p. 276.—P. hassalli Goto, and P. sp. ?(=P. oblongum Leidy, 1888, not P. oblongum Wright, 1884.)

(11) Ijima, Zool. Anz. hft. 7. 1884, pp. 635—639.—P. integerrimum.

(12) Leuckart, Parasit. des Mensch. 2 Aufl. 1. 2, pp. 1, 9, and 70.—P. integerrimum.

(13) Leidy, Proc. Acad. Nat. Sci. Philad. 1888, p. 127.—P. coronatum Leidy and P. oblongum Wright.

(14) Linstow, v. Compend. der Helm., pp. 177 and 198, Litt.

(15) Linstow, v. Nachtrag, pp. 61 and 69, Litt.

(16) Lühe, Süsswasser Fauna Deutschlands, 17, p. 8.—P. ocellatum and integerrimum.

(17) Pagenstecher, Trematoden, etc., p. 47, tab. 6.—P. integerrimum.

(18) Roesel, Hist. Ranarum, p. 24.—P. integerrimum.

(19) Rudolphi Entozoor. Hist. tom. 2. 1, p. 451, pl. 6.—P. integerrimum.

(20) Rudolphi, Synopsis, p. 125.—P. integerrimum, and p. 436.—P. ocellatum.

(20*a*) Siebold, v., Zeitschr. f. Wiss. Zool. bd. 1, p. 362.—P. ocellatum.

(21) Stieda, Reichert und du Bois Reymond's Arch. f. Anat. 1870, p. 660.—P. integerrimum.

(22) Willemoes Suhm, v., Arch. des Sci. Phys. et Nat. 1872, p. 99.—P. integerrimum, p. 106.—P. ocellatum.

(23) Willemoes Suhm, v., Nach. v. d. k. Med. Ges. d. Wiss. Gottingen, 1871, No. 7.—P. integerrimum.

(24) Willemoes Suhm, v., Zeitschr. f. Wiss. Zool. Bd. 22, pp. 29-39. taf. 1 and 2.—P. integerrimum and P. ocellatum.

(25) Wright, Contributions to American Helm., pp. 12-15, pl. 1. (Procs. of the Canadian Inst. Toronto, n.s., vol. 1, 1884, pp. 63 66.)—P. oblongum.

(26) Zeder, Nachtr, p. 203, pl. 4.—P. integerrimum.

(27) Zeller, Zeitschr. f. Wiss. Zool. bd. 22, pp. 1-21, pl. 1 and 2.—P integerrimum.

(28) Zeller, Zeitschr. f. Wiss. Zool. bd. 27, pp. 238-275, pl. 17 and 18.—P. integerrimum.

List of Reference Letters in Text-Figures and Plates.

Ant.—anterior; Ant.ut.d.—anterior uterine duct; ♂ at.—male atrium; ♀ at.—female atrium; at.b.—atrial bulb; at. p.— atrial pore.; b.m.—basement membrane; cav.—cavity; c.t.n.—connective tissue nucleus; cot.—cotylophore; d.—dorsal; d.g.—dorsal ganglion; dia.—diaphragm; d. lp.—dorsal lip; d.n.c.—dorsal nerve cord; ep. col.—columnar epithelium; ex. d.—excretory duct; ex. p.—excretory pore; ex. ves.—excretory vesicle; f.l.—fibrous layer; g.c.—ganglion cell; gen. em.—genital eminence; gl.—gland innominate; h.—hook; i.c.l. inner cuticular layer; i.e.—inner ectoderm of the sucker; int.—intestine; int. tr.—transverse portion of the intestine; L.—left; l.n.—lateral nerve; l.n.c.—lateral nerve cord; l.y.g.d.—longitudinal yolk gland duct; m.l.—muscular layer; mus.—muscle; o.c.—oral cavity; o.c.l.—outer cuticular layer; od.—oviduct; o.e.—outer ectoderm of the sucker; ov.—ovary; ov. fund.—ovarian fundus; par. n.—parenchyme nucleus; pe.—penis; ph.—pharynx; R.—right; sp.—spicule; su.—sucker; s.v.—seminal vesicle; te—testis; ut.—uterus; ut. ov.—uterine ovum: v.—ventral; vac.—vacuole; vag.—vagina; v.d.—vas deferens; v.i.c.—vitello-intestinal canal; v.n.c.—ventral nerve cord; v.n. co.—ventral nerve commissure; vu.—vulva; vu. c.—vulvar cells; y. d.—yolk duct; y.g.—yolk gland.