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North American Triclad Turbellaria.

XI. New, Chiefly Cavernicolous, Planarians

Libbie H. Hyman

Several years' accumulation of triclad material has furnished the occasion for this article. Although the material of fresh-water triclads sent me for identification frequently consists of common, well-known species, new forms turn up with sufficient frequency as to illustrate once more the paucity of knowledge of the fresh-water invertebrates of this country. Four of the five forms herein described are cavernicolous and add to the number of cave planarians of the United States, notable for their adhesive organ and for their excessive speciation, since each locality so far investigated harbors a different species. The North American cave planarians (for earlier descriptions, see Hyman, 1937b, 1939) comprise an array of forms not paralleled in any other country. They appear to have evolved endemically from the genus *Phagocata*.

Order TRICLADIDA

Suborder PALUDICOLA or PROBURSALIA

Family PLANARIIDAE

Genus PHAGOCATA Leidy 1847

Phagocata gracilis monopharyngea, new subspecies

Fig. 1

Material.—Many specimens sent by Dr. Leslie Hubricht.

Form.—Closely similar to *Phagocata gracilis* (illustrated in Kenk, 1935, Hyman, 1937a); large, broad, to 15 mm. long preserved, probably longer in life; anterior end truncate, without adhesive organ, with slightly indicated auricles.

Color.—Dark gray, judged from preserved specimens.

Eyes.—Somewhat irregular, two eyes or two main eyes, on or both accompanied by one or two small eyes.

Digestive system.—Single, somewhat elongated pharynx.

Reproductive system.—No testes found; animals appear spent; collected in April whereas usual breeding season of *Phagocatas* is late fall or early winter. Sperm ducts present posterior to pharynx; at level of penis bulb they turn dorsally and enter separately the penis bulb, opening separately into bulbar lumen (Fig. 1). Penis bulb rounded, moderately muscular, fibers

coursing mostly parallel to its external contour; bulbar lumen¹ rounded, continuous with broad ejaculatory duct proceeding to tip of conical penis papilla. Ovaries have well-developed parovaria; common ovovitelline ducts enters roof of male antrum, accompanied by eosinophilous cement glands. Copulatory bursa large, located just anterior to penis bulb, lined by tall wavy epithelium; canal proceeds posteriorly above male antrum, widens considerably distally and joins common antrum shortly behind entrance of ovovitelline duct (Fig. 1).

Locality.—Collected at the outlet of a tile drain, Haskins, Iowa, April 24, 1942.

Type.—One whole mount, A.M.N.H. no. 325. Cotype, set of serial sections of the copulatory apparatus (2 slides) A.M.N.H. nos. 326-327.

Remarks.—After some hesitation, I have decided to consider this form a subspecies of *Phagocata gracilis*. *Phagocata gracilis*, one of the most common planarians of the eastern United States, appears to be a polytypic species, i.e., one that is split up into geographic races (see Mayr, 1942, for a discussion of polytypic species). The typical form is polypharyngeal with a very muscular penis bulb and long slender penis papilla. It ranges from Virginia and Pennsylvania westward to the Mississippi and probably also southward but within this range shows some variation in small details of the copulatory apparatus (Kenk, 1935, Hyman, 1937a). Some years ago I distinguished the New England form under the name *woodworthi* (Hyman, 1937a), also polypharyngeal, and indistinguishable externally from *gracilis* but differing greatly in the details of the copulatory apparatus, especially in the short, truncate, less muscular penis. These two forms are certainly as different in the copulatory apparatus as any established species of planarians, but I found that transitional forms exist in New Jersey. Therefore *woodworthi* should probably be reduced to a subspecies of *gracilis* and the nominative form then becomes *Phagocata gracilis gracilis*. The present Iowa specimens appear to constitute a monopharyngeal variant of *P. g. gracilis*; their copulatory apparatus differs from that of the latter chiefly in the less muscular penis bulb and the shorter penis papilla.

Family KENKIIDAE
Genus SPHALLOPLANA Beauchamp 1931

Sphalloplana alabamensis, n. sp.
Figs. 2, 3

Material.—Two specimens sent by the U.S. National Museum.

¹ It is customary to term the cavity of the penis bulb seminal vesicle but as it does not serve for sperm storage in triclad (in fact sperm are never seen in it except during copulation), I propose hereafter to call this cavity the bulbar lumen. Other changes in terminology that I suggest for the Turbellaria in general are: sperm ducts in place of vasa deferentia, spermiducal vesicles for the enlarged parts of the sperm ducts usually called false seminal vesicles that actually are the true storehouses of sperm, bursal canal for the outlet of the seminal or copulatory bursa, antrum to replace altogether the over-worked term atrium; and for the triclad, ovovitelline ducts in place of oviducts.

Form.—Elongate, tapering to blunt posterior end; anterior end truncate with a central adhesive organ, no auricles; 5.6 mm. long; margin with exceptionally long rhabdites (Fig. 2).

Color.—Presumably white in life; preserved specimens brown.

Eyes.—Lacking.

Adhesive organ.—Similar to that of other members of the genus (Beauchamp, 1931, Hyman, 1939). Consists of an irregular depression lined with an altered epidermis permeated with the outlets of eosinophilous glands. Depression is surrounded by muscle fibers, mostly radial, that join both the dorsal and the ventral longitudinal muscles of the body wall. The organ is less muscular than that of other species of the genus.

Copulatory apparatus.—Distinguished by its excessive glandularity. Testes relatively few, prepharyngeal (Fig. 2). Sperm ducts enter separately beginning of the ejaculatory duct which forms a small rounded chamber (Fig. 3). From this duct runs through penis bulb without forming any enlargement. Penis short, rounded, with slightly muscular bulb; covering epithelium of the penis papilla tall and very glandular, filled with the outlets of subepithelial gland cells. Common oviduct enters roof of male antrum. Dorsal and rear wall of common genital antrum also very glandular, receiving outlets of numerous eosinophilous gland cells. Copulatory bursa relatively small; bursal canal presents distally two successive enlargements, of which the distal one, opening into the roof of the common antrum, is somewhat glandular.

Differential diagnosis.—*S. alabamensis* is distinguished from other species of the genus by the excessive glandularity of the penis papilla and wall of the common antrum.

Locality.—Old Saltee Cave, Limrock, Alabama, March 16, 1931.

Type.—One whole mount, U.S.N.M., no. 20639; cotype, one set of sagittal serial sections (2 slides), U.S.N.M., no. 20639.

Sphalloplana virginiana, n. sp.

Figs. 4, 5

Material.—Many specimens sent by Dr. J. A. Fowler.

Form.—Slender, of moderate size, preserved specimens to 12 mm. in length, probably longer in life, anterior end bluntly rounded provided in the center with a weak adhesive organ, margin except anterior end provided with a band of unusually long rhabdites (Fig. 4).

Color.—White.

Eyes.—Lacking.

Adhesive organ.—This consists of the usual irregular depression lined with the outlets of eosinophilous gland cells. From the inner end of the depre-

sion a small band of muscle fibers constituting a retractor muscle proceeds dorsally and joins the dorsal subepidermal musculature.

Reproductive system.—Testes ventral, limited to prepharyngeal region. Sperm ducts form usual expanded spermiducal vesicles as they approach the copulatory apparatus; they enter separately the ejaculatory duct (Fig. 5). Penis papilla of moderate size, rounded, not very muscular with slightly developed bulb. Ejaculatory duct a wide canal that has the peculiarity of opening on the ventral surface of the penis papilla (Fig. 5) and is hence asymmetrical located in the papilla. Papilla lies in male antrum into the roof of which opens the common ovovitelline duct accompanied by eosinophilous glands. Copulatory bursa relatively small, lying above penis bulb; bursal canal courses above male antrum and, widening slightly, opens into rear part of common genital antrum. All parts are weakly muscular; muscle fibers are best developed in the wall of the antrum. There is also a general lack of glandular elements in connection with the copulatory apparatus.

Differential diagnosis.—The outstanding characteristic of this species is the asymmetrical position of the ejaculatory duct, which opens ventrally at the base of the papilla instead of running through the center of the papilla to its tip as is usual in tricladids. To insure that this unusual feature was not accidental, a second specimen was sectioned and showed the same condition.

Locality.—Pool in Showhalter's Cave near Lexington, Va., Oct. 30, 1943. A single specimen taken in another cave five miles from Showhalter's Cave was so twisted and distorted that it could not be identified with certainty.

Type.—One whole mount, A.M.N.H., no. 314. Cotype, one set of sagittal serial sections (5 slides), A.M.N.H., nos. 315-319.

Sphalloplana kansensis, n. sp.

Fig. 6

Material.—One specimen sent by Hubricht.

Form.—Large, broad, thin, 20 mm. long, anterior end truncate with a conspicuous adhesive organ; marginal rhabdites only a little larger than elsewhere. As there are no distinctive external features, it was thought necessary to illustrate the specimen which has been sectioned.

Color.—White.

Eyes.—Lacking.

Adhesive organ.—Similar to that of *Sphalloplana percoeca*; consists of an irregular depression lined by the outlets of eosinophilous glands; a moderate musculature is attached to the internal surface of the organ.

Reproductive system.—Testes dorsal, limited to the prepharyngeal region. Terminal parts of sperm ducts enlarged to form spermiducal vesicles enter separately ejaculatory duct which ascends dorsally, then turns posteriorly and after a short sinuous course becomes straight and passes along the center of the

low rounded penis papilla (Fig. 6). Penis bulb only slightly developed; penis papilla weakly muscular. Male antrum elongated, passing obliquely backwards, lined by a very tall epithelium. Copulatory bursa large, oval, lined by very tall epithelium ventrally, short dorsally; has very long slender bursal canal, passing posteriorly above penis, then turning ventrally and widening greatly to open into antrum. Common antrum is thus small, dividing at once into bursal canal and male antrum. Very large and long common oovovitelline duct, after receiving the two oovovitelline ducts curves posteriorly and ventrally to enter roof of male antrum near opening of latter into common antrum. Usual eosinophilous cement glands accompany oovovitelline ducts and also open into rear wall of common duct. A peculiarity of this species not found in any other planarian is the attachment of irregular blind epithelial outgrowths to the wall of the common antrum.

Differential diagnosis.—This species differs from other species of *Sphaloplana* in the very long bursal canal, very large common oovovitelline duct, and epithelial evaginations of the common genital antrum.

Locality.—Purity Springs, near Augusta, Butte County, Kansas, May 18, 1942. Although taken in a spring, this species is undoubtedly a cave planarian for it lacks eyes and has the typical aspect of other Kenkiidae.

Type.—One set of sections (3 slides), A.M.N.H., nos. 311-313.

Genus **SPEOPHILA** Hyman 1937

Speophila hubrichti, n. sp.

Figs. 7, 8

Material.—Many specimens sent by Dr. Leslie Hubricht.

Form.—Large, broad, to 17 mm. long preserved, evidently longer in life; anterior end broadly rounded with a central conspicuous adhesive organ; body tapers posteriorly to bluntly pointed end; margin with usual band of large rhabdites (Fig. 7).

Color.—White.

Eyes.—Lacking.

Adhesive organ.—Consists of a deep pit with irregularly folded walls that take an intense eosin stain; the pit is surrounded by a halo of eosinophilous glands. The rear end of the pit is provided with a complex musculature.

Nervous system.—The nervous system appears to lack definite cerebral ganglia but the ventral cords in the proximity of the inner end of the adhesive organ break up into a complicated network which supplies the adhesive organ and the anterior margins. This form of nervous system seems to be the rule with Kenkiidae having a highly developed adhesive organ.

Reproductive system.—Testes dorsal, limited to the prepharyngeal region.

Sperm ducts, after usual expansion to form spermiducal vesicles proceed to penis bulb where after a very short narrowing they enter separately a narrow ejaculatory duct. This traverses the penis bulb, then widens into a broad canal proceeding to penis tip. Penis very large, consisting of muscular bulb and long penis papilla with wide lumen (Fig. 7). Copulatory bursa very large, oval; narrow bursal canal runs caudad above penis bulb, then widens greatly as it curves ventrally to enter antrum. Common antrum thus very small, dividing at once into above large distal part of the bursal canal and the elongated male antrum. Expanded part of bursal canal runs asymmetrically to right side of male antrum. Antrum and distal expanded part of bursal canal lined by tall epithelium, underlain by considerable thickness of muscle fibers. Outer wall of penis papilla has dense muscular layer under the epithelium. Ovovitelline ducts accompanied by usual eosinophilous cement glands approach rear part of male antrum, and unite to common duct that enters roof of male antrum near entrance of latter into common antrum.

Differential diagnosis.—*S. hubrichti* differs from other species of *Speophila* in the very large penis with its elongated papilla. The distal expansion of the bursal canal is also seen in *S. buchanani*.

Locality.—Taken by Hubricht in Morrison's Cave, near Burksville, Monroe County, Illinois, in spring near Kimmswick and spring near Selma, Jefferson County, Missouri, all during June, 1937, and most abundantly in Kohn's Cave near Ste. Genevieve, Missouri, Sept. 13, 1941.

Type.—One whole mount, A.M.N.H., no. 320; cotype, one set of sagittal sections of copulatory apparatus (4 slides), A.M.N.H., nos. 321-324.

Family DENDROCOELIDAE

Genus PROCOTYLA Leidy 1857

PROCOTYLA TYPHLOPS Kenk 1935

There was received for identification from the U.S. National Museum a single specimen of a triclad taken in the burrow of a crayfish, *Procambarus rathbunae* (Hobbs), near Crestview, Florida, by H. H. Hobbs, Oct. 17, 1941. The animal was sectioned and the copulatory apparatus was found to agree in all particulars with Kenk's description of *Procotyla typhlops*. The specimen, however, differed from Kenk's material in that it had a pair of small eyes. That these are true eyes was verified on the sections. Hence it appears that this species is not necessarily blind. The sections have been deposited in the U.S.N.M.

GENERAL REMARKS

The present contribution makes a total of eleven species of cave planarians known for the United States, if *Sphalloplana kansensis*, as yet found only in a spring, be included. Present findings indicate that every sizable cave or group of caves in a given region has its own species. Evidently residence in a cave constitutes a form of geographical isolation leading to speciation. It may be of interest to list here the known species with their localities.

Family PLANARIIDAE

Phagocata subterranea Hyman, 1937 Indiana

Family KENKIIDAE

<i>Sphalloplana percoeca</i> (Packard) 1880	Kentucky
<i>Sphalloplana mohri</i> Hyman, 1939	Texas
<i>Sphalloplana alabamensis</i>	Alabama
<i>Sphalloplana virginiana</i>	Virginia
<i>Sphalloplana kansensis</i>	Kansas
<i>Speophila pricei</i> Hyman, 1937	Pennsylvania
<i>Speophila buchanani</i> Hyman, 1937	Kentucky
<i>Speophila hubrichti</i>	Illinois, Missouri
<i>Kenkia rhynchida</i> Hyman, 1937	Oregon

Family DENDROCOELIDAE

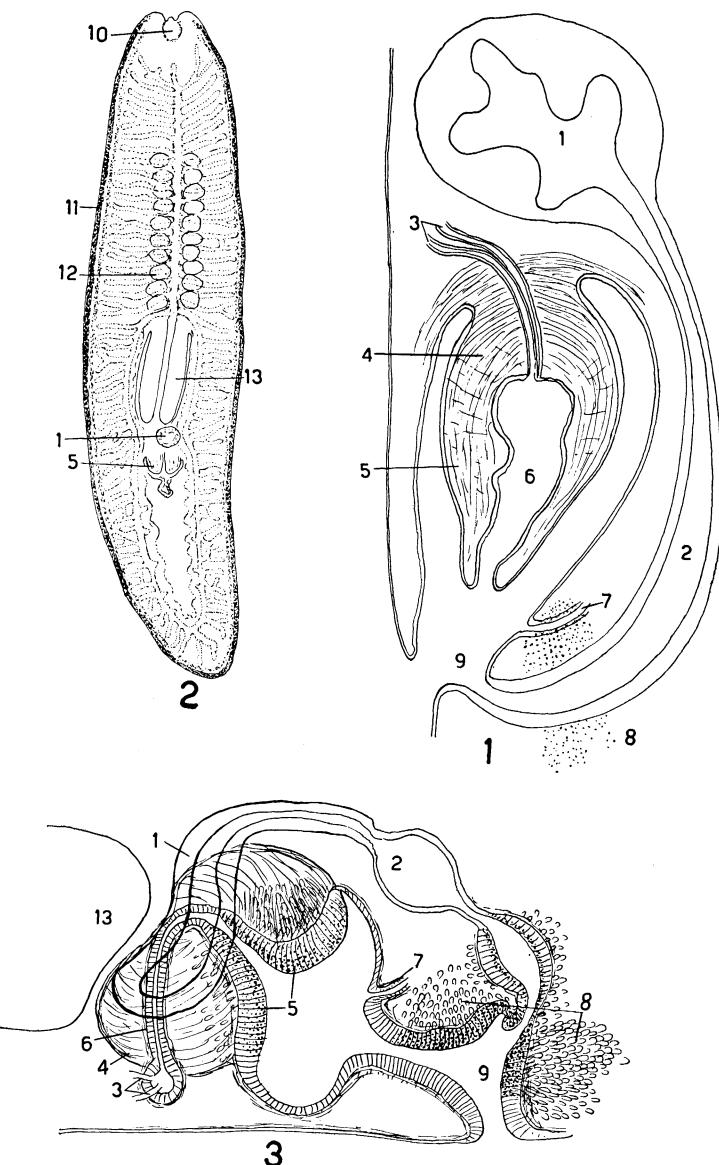
Sorocelis americana Hyman, 1939 Oklahoma

Most of the species belong to the genera *Sphalloplana* and *Speophila*. The latter genus is distinguished by the greater complexity of the adhesive organ. However, it is probable that all gradations in the development of the adhesive organ exist among the Kenkiidae and hence that eventually it will be impossible to draw any definite line between these two genera. I therefore anticipate that when our cavernicolous planarians are sufficiently known, *Speophila* will become a synonym of *Sphalloplana*.

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FOR ALL FIGURES: 1, Copulatory bursa; 2, bursal canal; 3, sperm ducts; 4, penis bulb; 5, penis papilla; 6, ejaculatory duct; 7, common oviduct; 8, cement glands; 9, common genital antrum; 10, adhesive organ; 11, marginal band of large rhabditides; 12, testes; 13, pharynx; 14, epithelial evaginations of antrum.

Fig. 1. Sagittal section of the copulatory apparatus of *Phagocata gracilis monopharyngea*. Fig. 2. *Sphalloplana alabamensis*. Fig. 3. Sagittal section of the copulatory apparatus of *Sphalloplana alabamensis*.

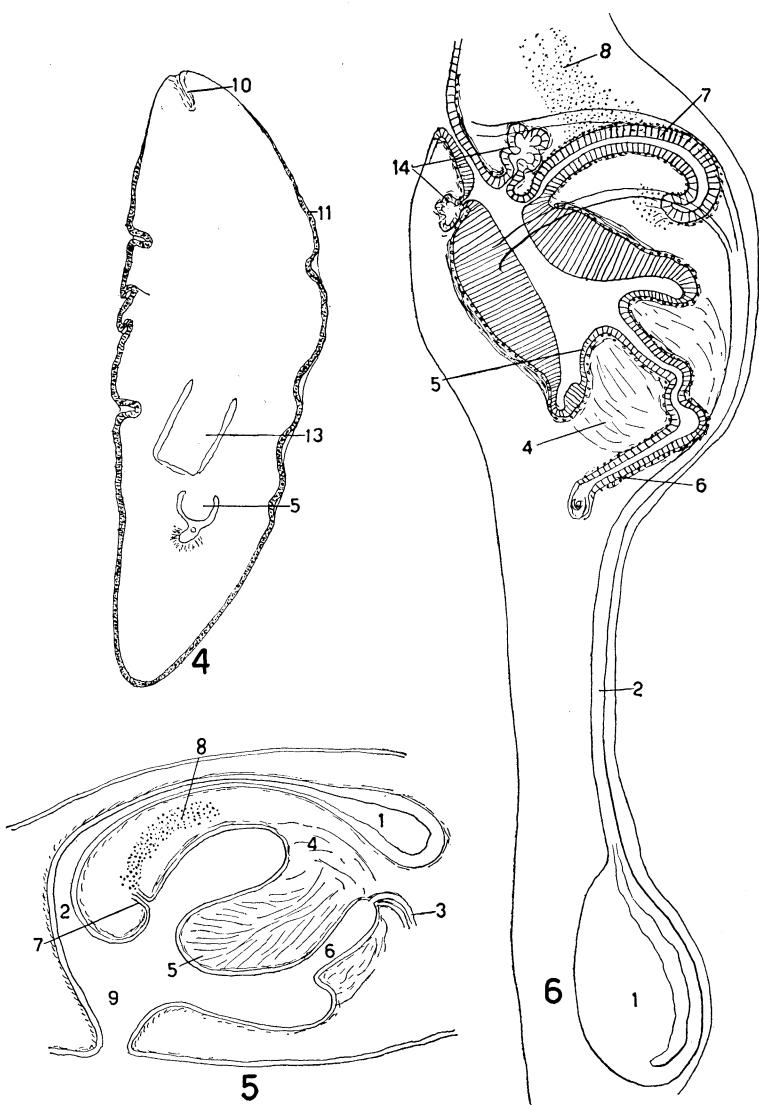
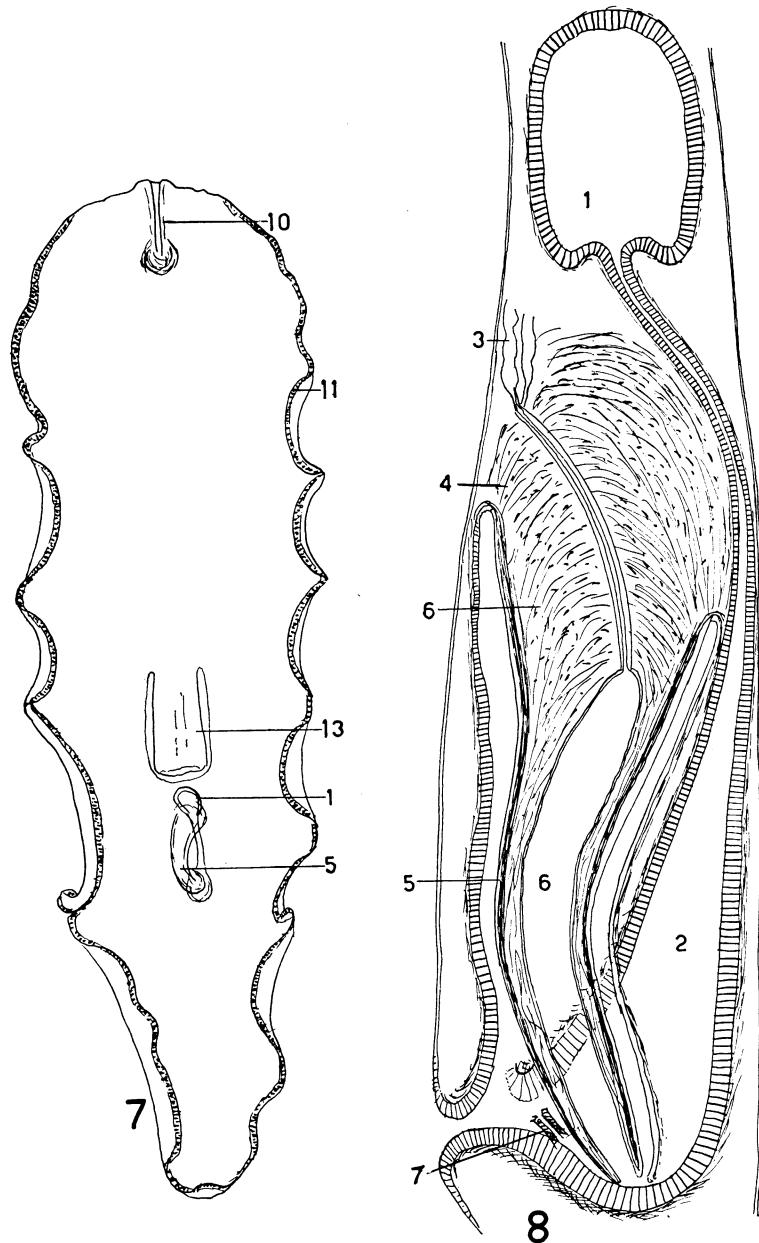


Fig. 4. *Sphallopiana virginiana*.

Fig. 5. Sagittal section of the copulatory apparatus of *Sphallopiana virginiana*.

Fig. 6. Sagittal section of the copulatory apparatus of *Sphallopiana kansensis*.

Fig. 7. *Speophila hubrichti*.Fig. 8. Sagittal section of the copulatory apparatus of *Speophila hubrichti*.