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Redescription of *Kenkia rhynchida*, a Troglobitic Planarian from Oregon, and a Reconsideration of the Family Kenkiidae and its Genera (Turbellaria, Tricladida, Paludicola)

With 7 Text-figures

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ABSTRACT A poorly known North American cave species of the genus *Kenkia* (Turbellaria, Tricladida, Paludicola), *Kenkia rhynchida* HYMAN, 1937, is redescribed in the present paper. The status of the family Kenkiidae and its genera is also discussed. The genera *Kenkia* HYMAN, 1937 (syn. *Macrocotyla* HYMAN, 1956), and *Sphalloplana* DE BEAUCHAMP, 1931, are redefined. Thus, the genus *Kenkia* now contains four species: *K. rhynchida* HYMAN, 1937; *K. hoffmasteri* (HYMAN, 1954); *K. glandulosa* (HYMAN, 1956); and *K. lewisi* (KENK, 1975). The genus *Sphalloplana* now contains about 20 species, most from the U.S.A. but two from Japan and one from South Korea.

The purpose of this paper is to present a redescription of a rare and unusual cave-adapted planarian, one which prompts a re-examination of the paludicolan family Kenkiidae and its genera.

In 1937, L. H. HYMAN described a remarkable cave-adapted triclad, *Kenkia rhynchida*, collected by C. L. HUBBS in 1934 in the waters of Malheur Cave in Oregon. In this same paper (HYMAN, 1937), she also created the genus *Speophila* for another assemblage of cave-adapted planarian, and she created the family Kenkiidae to contain these two genera as well as *Sphalloplana* DE BEAUCHAMP, 1931, yet another genus of cave-adapted triclad. Small though it may be, this family of cave planarian, with its few genera and several species, has continued to perplex triclad researchers. One of the chief problems has been that HYMAN's original material on which the description of *Kenkia* was based was poorly preserved, and not until recently has new, and well-fixed material become available to permit a much-needed restudy of *K. rhynchida*.

In 1972, MITCHELL visited Malheur Cave and collected a single specimen of *K. rhynchida*, apparently the first collection of the planarian since it was first found by HUBBS in 1934. Unfortunately, the animal disintegrated after being photographed. Shortly thereafter, however, Mrs. E. M. BENEDICT began a series of visits to Malheur Cave related to her studies of pseudoscorpions, and she was fortunate enough to collect a few additional specimens of *K. rhynchida*, some of which were sent to us live and others fixed in Bouin's fluid.

MATERIALS AND METHODS

The material was prepared for study in KAWAKATSU's laboratory. Specimens were fixed in Bouin's fluid and then transferred to 70% ethyl alcohol. They were then paraffin embedded and cut in serial sagittal section at 8 micrometers. Staining was with Delafield's hematoxylin and erythrosin. The numbers used in text to designate each sample and specimen are those employed by KAWAKATSU in his permanent recording system.

SPECIES DESCRIPTION

Order TRICLADIDA
Suborder PALUDICOLA or PROBURSALIA
Family Kenkiidae HYMAN, 1937
Genus *Kenkia* HYMAN, 1937

Kenkia rhynchida HYMAN, 1937

The principal literature for this species is HYMAN, 1973 and 1951; KENK 1972 and 1975; and KAWAKATSU, 1978.

External features. Based on HYMAN's (1937) original description, this species has long been thought to be of unusual body form. HYMAN wrote as follows: "The preserved specimens were 2–4 mm. long, white and devoid of eyes as usual in cave planarians, and of the general shape of a minute turtle. The main portion of the body is oval, strongly convex above, concave below; from the anterior end there projects a snout about 1/4~1/5 the body length . . . Owing to the peculiar shape of the animal the pharynx and copulatory apparatus are forced into the slightly thickened posterior end and the postpharyngeal region is suppressed . . . Some rough sketches sent to me by Dr. HUBBS show that the shape in life is practically the same as in the preserved specimens." The preceding suggestions of an unusual body shape were incorporated by HYMAN (1937) into her definition of the genus *Kenkia* as follows: "Kenkiidae of abnormal body form, body oval, concave below, postpharyngeal region absent, pharynx and copulatory apparatus at the posterior end; . . ." The newly-collected specimens of *K. rhynchida*, however, demonstrate

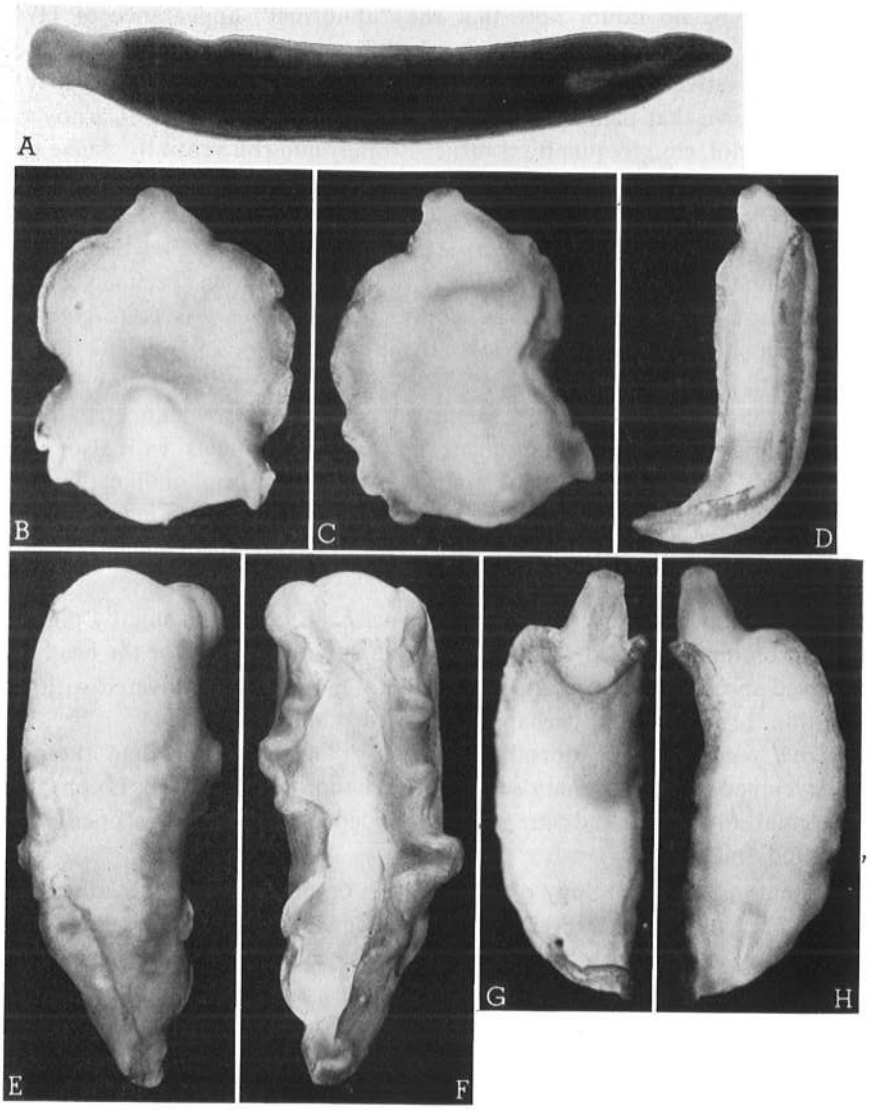


Fig. 1. *Kenkia rhynchida*, entire animal. —— A, Living, dorsal (reproduced from MITCHELL'S color slide, photogram). B–H, Preserved. B, Dorsal (1243 a); C, ventral (1243 a); D, ventral (1243 b), note protruded snout and marginal adhesive zone; E, dorsal (1244 a); F, ventral (1244 a); G, dorsal (1244 b), note protruded snout; H, ventral (1244 b), note pharynx and copulatory apparatus.

clearly that the species is of normal planariid body form (Fig. 1 A). In general appearance, *K. rhynchida* would seem to be quite similar to *Sphalloplana buchanani* (HYMAN, 1937) from caves in Kentucky (see HYMAN, 1937, fig. 16) and to *S. pricei* (HYMAN, 1937) from caves in Pennsylvania (see HYMAN, 1937, figs. 20 and 21).

There can be no doubt now that the "abnormal" appearance of HYMAN's specimens (see HYMAN, 1937, fig. 1) resulted from strong contraction caused by an improper fixative, perhaps formalin or alcohol. KAWAKATSU and MIYAZAKI (1972) have shown that planarians killed in some kinds of fixatives (Carnoy's fluid, ethanol, methanol, etc.) frequently contract strongly and roll ventrally. The appearance of our Bouin's-fixed specimens is shown in Fig. 1 (B–H). In most specimens the dorsum became convex and the body margins rolled ventrally. Even so, a more or less normal planariid body form persisted in some (Fig. 1 D–F). One contracted strongly resulting in an ovoid shape (Fig. 1 B and C). In one specimen, especially, the musculature of the adhesive organ contracted in such a way as to give the appearance of a snout (Figs. 1 G and H). If the ovoid shape of B and C in Fig. 1 is combined with the ventrally-rolled margins of D in Fig. 1 and the "snout" of G and H in Fig. 1, then an appearance is achieved that is almost identical to HYMAN's illustration (1937, fig. 1). When quiescent, living specimens will also contract rather strongly and assume a more or less ovoid shape, not unlike that seen in Fig. 1 (B and C). This contraction upon quiescence can be much more pronounced than that described by MITCHELL (1974) for the kenkiid *Sphalloplana zeschi* from Texas.

Although appearing entirely white, *K. rhynchida*, in fact, is slightly pigmented, having microscopic, pale brownish spots on the dorsum, except for the head region. In preserved specimens, dorsal and ventral body margins were covered with a wide band of thin, brownish film, perhaps coagulated rhabdites.

Internal features. The dorsal epithelium is much thicker than the ventral. A well developed, wide marginal zone of many rhabdite-forming cells is conspicuous. The marginal adhesive glands are well developed, and their pores open ventrally near the body margin.

The anatomy and histology of the adhesive organ have been described well by HYMAN (1937). We can, however, supplement her discussion of the organ. Figure 2 shows a sagittal view of the adhesive organ reconstructed from serial sagittal sections (Specimen No. 1244 a). As Fig. 1 (B–H) indicates, the head, containing little else save the adhesive organ, assumes a more or less snout-like appearance upon fixation. It tapers anteriorly. The head is covered with the same type of epithelium as covers the remainder of the body except at its tip. Beneath the epithelium, there are three layers of subepithelial muscle fibers, a thin outer layer of longitudinal ones, a wider middle layer of circular ones, and a thin inner layer of longitudinal fibers. These muscle layers increase somewhat in thickness progressing posteriorly.

The center of the head is occupied by a long, well developed, tubular adhesive organ (Figs. 2, 3 A and C). The orifice is lined with a glandular epithelium containing eosinophilous granules; this epithelium is also reflected onto the anterior tip of the head surrounding the orifice. The anterior two-thirds of the organ is a rather wide canal and is irregularly lobed. This portion is lined by a highly glandular epithelium. Small cyanophilous rods are contained in the gland cells

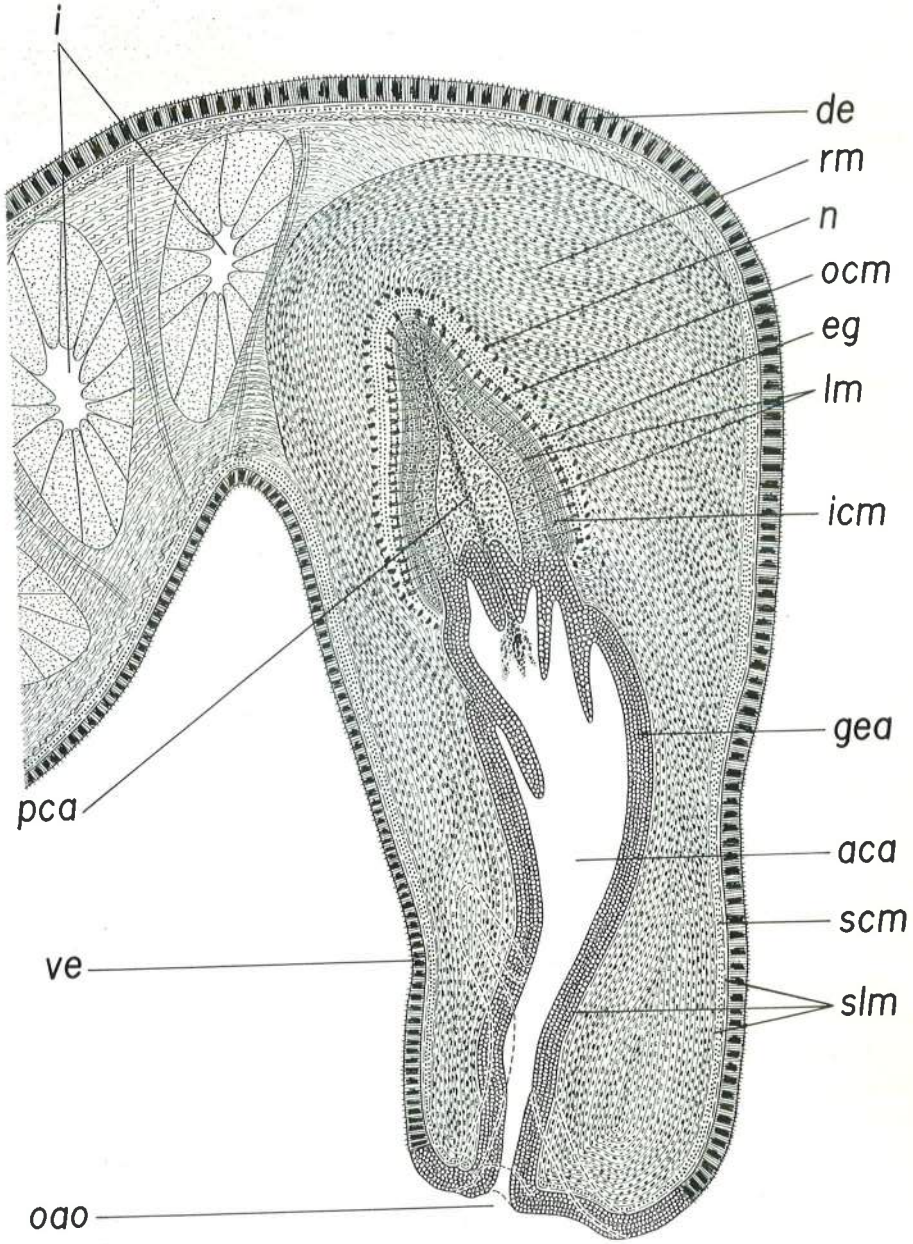


Fig. 2. *Kenkia rhynchida*, drawing of the adhesive organ from serial sagittal sections (1244 a). aca, anterior cavity of adhesive organ; de, dorsal epithelium; eg, eosinophilous gland; gea, glandular epithelium of adhesive organ; i, intestine; icm, inner circular muscle fibers; lm, longitudinal muscle fibres; n, nucleus; oao, orfice of adhesive organ; ocm, outer circular muscle fibers; pca, posterior cavity of adhesive organ; rm, retractor muscle, scm, subepidermal circular muscle fibers; slm, subepidermal longitudinal muscle fibers; ve, ventral epithelium.

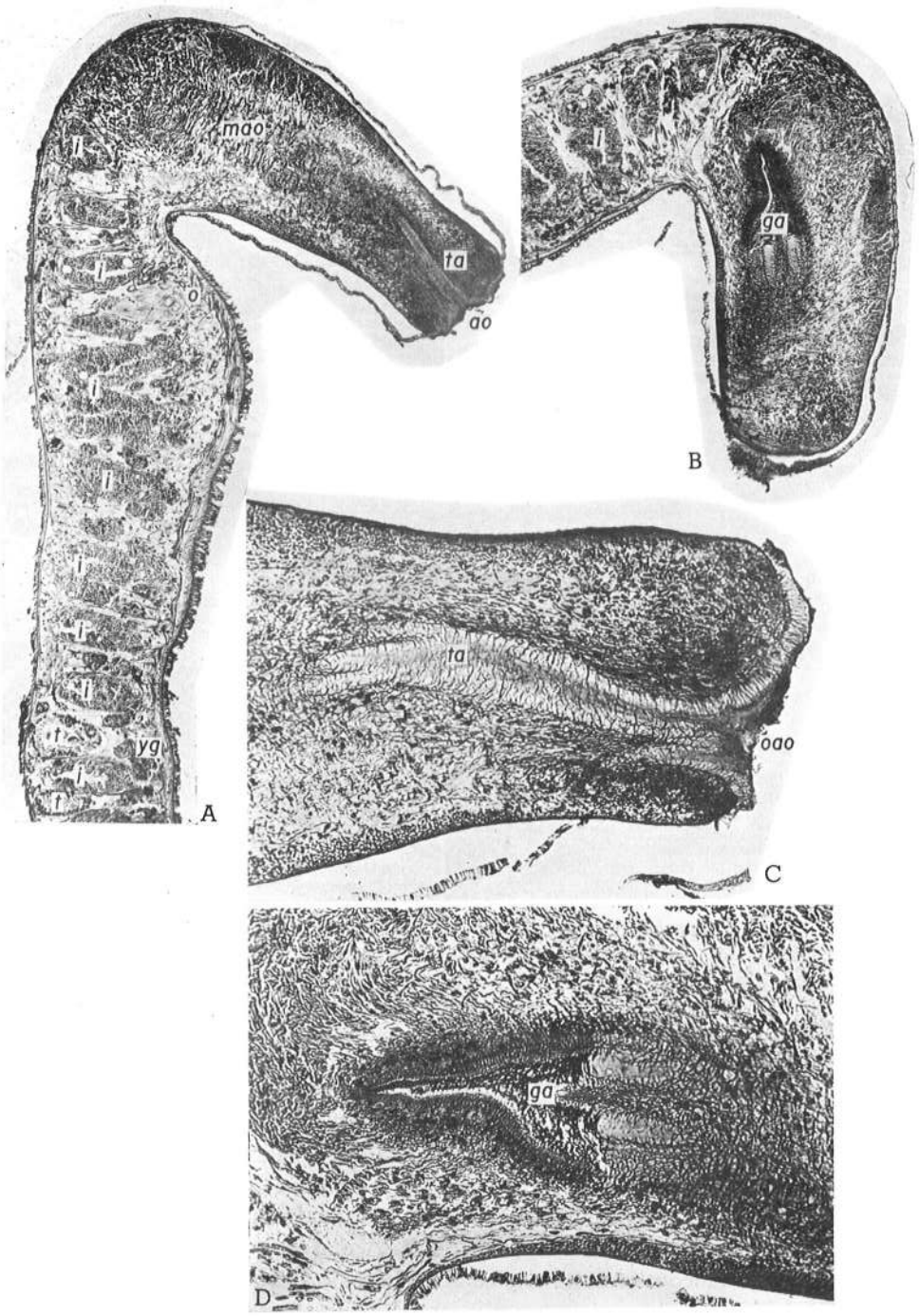
along with many feebly eosinophilous granules. Beneath the epithelium there is a thin longitudinal muscle fiber layer.

The posterior one-third of the adhesive organ is an elongated, conical cavity (Figs. 2, 3 B and D). Its lining epithelium is tall and contains numerous, heavily eosinophilic granules. In each specimen, this posterior part of the organ was filled with the same type of granule. Beneath the epithelium of this part of the organ there are three muscle layers, a thin inner layer of longitudinal fibers, a wide middle layer of circular ones, and a thin outer layer of longitudinal fibers. Just beneath these muscle layers lies a layer of eosinophilous glands of elongated oval shape. The ducts of these glands open into the posterior part of the adhesive organ. Beneath the eosinophilous gland layer is found a rather thin layer of circular muscle fibers, beneath which, in turn, is a layer of nuclei. Attached to the greater part of the eosinophilous posterior portion of the gland are many muscle fibers, most of which curve anterodorsally to join the subepidermal muscle layers of the dorsum of the head. This particular musculature accounts for more tissue bulk in the head than any other type of tissue. In its general anatomy and histology, the adhesive organ of *K. rhynchida* is essentially similar to the adhesive organs described for other kenkiid species; it is, however, the most highly developed adhesive organ known in the family.

The structure of the pharynx is typical of the family Kenkiidae HYMAN, 1937, according to the emended family diagnosis of KENK (1975) (see also KAWAKATSU, 1978). The internal muscle zone of the pharynx consists of two layers, a thick circular layer adjacent to the epithelium of the pharyngeal lumen and a somewhat less thick layer of intermingled longitudinal and circular fibers (Fig. 6 A–C). This construction is the same as that of *Macrocotyla lewisi* described and figured by KENK (1975). The outer musculature of the pharynx consists of four layers, a very thin layer of longitudinal fibers situated beneath the outer ciliated epithelium, followed, in turn, by a thin layer of circular fibers, a moderately thin layer of longitudinal fibers, and a rather thick inner layer of irregular circular fibers. The anterior trunk of the intestine bears 12 to 16 lateral branches; each posterior trunk, 10 to 15 lateral branches.

A pair of ovaries is located just behind the level of the third or fourth diverticula of the anterior intestinal trunk (Fig. 3 A). In most specimens, a mass of sperms was found in the ampulla at the origin of the ovovitelline duct (seminal receptacle). Numerous yolk glands located between the intestinal diverticula occur throughout the body (Fig. 3 A). The testes are large and occupy almost all of the dorsoventral

Fig. 3. *Kenkia rhynchida*, sagittal sections of adhesive organ (1244 a). A, Anterior part of adhesive organ, ovary, testes and yolk glands; B, basal, glandular portion of organ; C, anterior, tubular portion of organ; D, basal, glandular portion of organ. ao, adhesive organ; ga, glandular portion of adhesive gland; i, intestine; mao, musculature of adhesive organ; o, ovary; oao, orfice of adhesive organ; t, testis; ta, tubular portion of adhesive organ; yg, yolk glands.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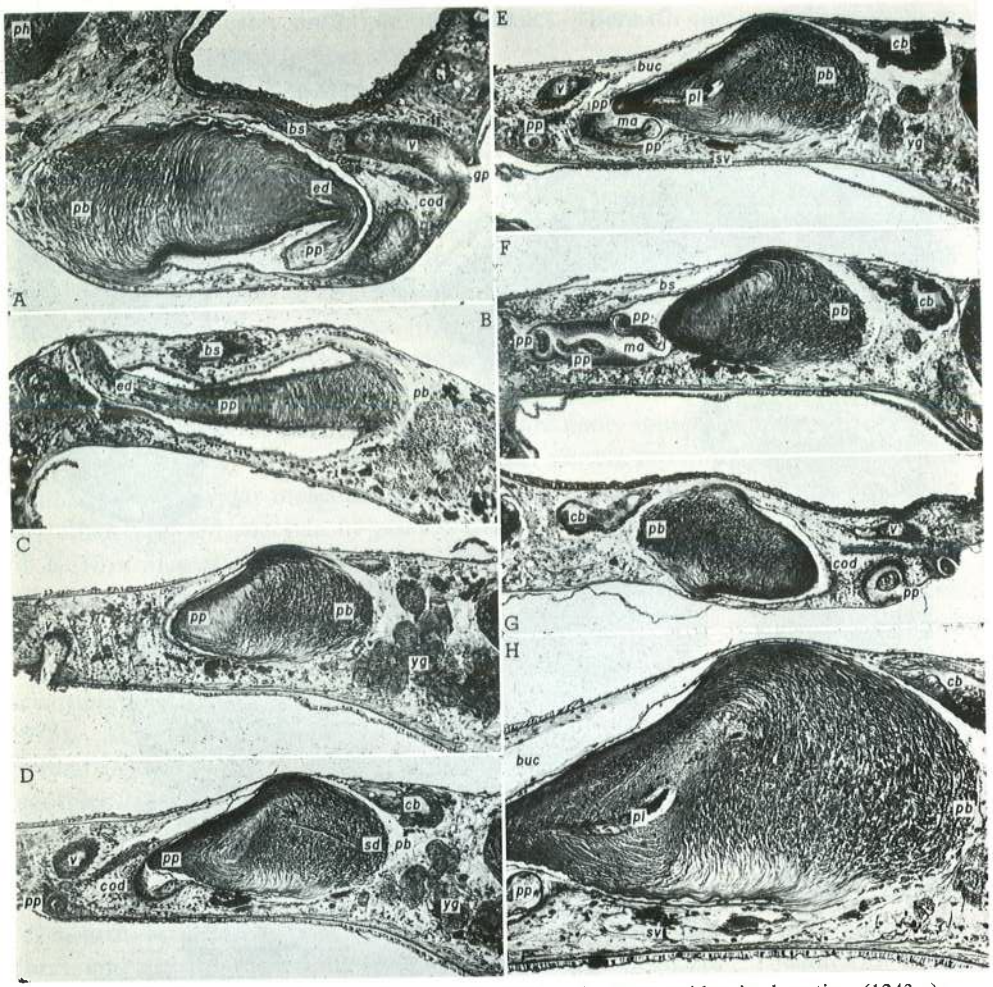


Fig. 4. *Kenkia rhynchida*, copulatory apparatus. A, Near midsagittal section (1243 a); B, near midsagittal section (1243 b); C–F, set of near midsagittal sections (1244 a); G, near midsagittal section (1244 b); H, detailed view (1244 a). bs, bursa stalk; buc, bulber cavity; cb, copulatory bursa; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; ma, male antrum; pb, penis bulb; ph, pharynx; pl, penis lumen; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle; v, vagina; yg, yolk gland.

space in the parenchyma of the prepharyngeal region (Fig. 3 A). They seem to number somewhat less than 15 on each side of the body in the largest specimen examined.

The copulatory apparatus is shown by photographs in Fig. 4 (A–H) and by semi-diagrammatic, sagittal view drawings in Fig. 5 (A and B). The genital pore opens essentially simultaneously into a vagina and the male antrum. A common genital antrum is lacking. The male antrum is strongly curved ventrally (Fig. 5 A and B)

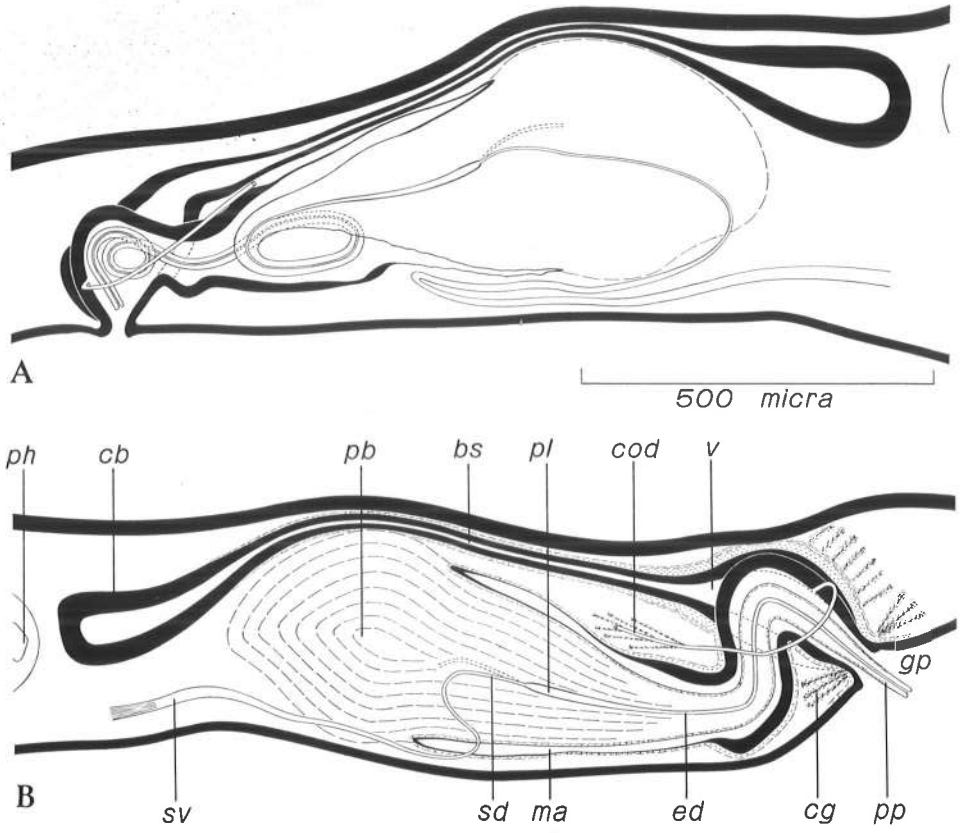


Fig. 5. Semidiagrammatic sagittal views of the copulatory apparatus. A, 1244 a; B, 1244 b. bs, bursa stalk; cb, copulatory bursa; cg, cement gland; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; ma, male antrum; pb, penis bulb; ph, pharynx; pl, penis lumen; pp, penis papilla; sd, sperm duct; xv, spermiducal vesicle; v, vagina.

and may be considerably expanded (Fig. 5 A), probably a function of state of contraction upon fixation. The wall of the anterior one-half of the male antrum is covered by a flat epithelium; the posterior one-half by a tall glandular epithelium of a nucleate type. Beneath the epithelia, there are two layers of muscle fibers, an inner circular layer, much thicker at the roof of the antrum than at the floor; and an outer longitudinal layer.

The two ovovitelline ducts converge at about the level of the mid-region of the penis papilla and form a very long common ovovitelline duct. This duct proceeds posteroventrally to the level of the genital pore, then ascends posterodorsally, and finally opens into the posterior part of the male antrum (Figs. 4 D and E, 5 A and B). Many eosinophilous glands can be seen around the anterior part of the common ovovitelline duct.

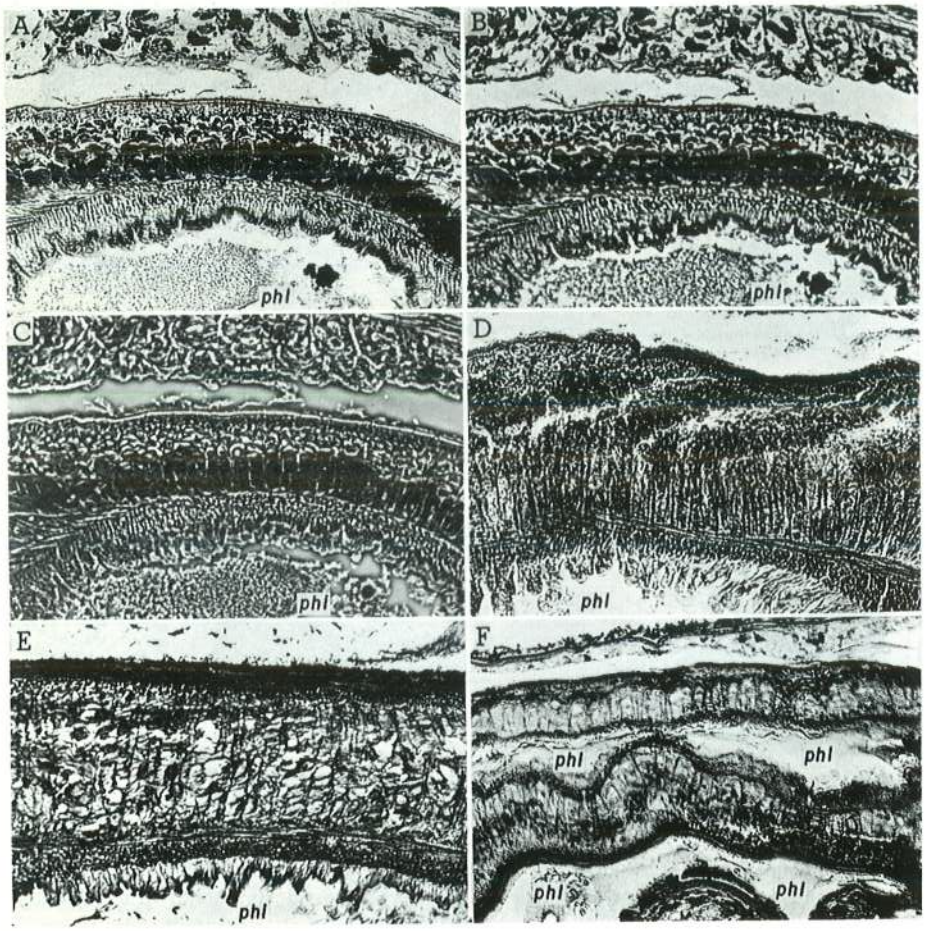


Fig. 6. Sagittal sections showing the pharyngeal musculature of several kenkiids. A–C, *Kenkia rhynchida* (1244 a). A, Ordinary microscopy; B, phase microscopy (positive contrast); C, phase microscopy (negative contrast). D, *Sphalloplana* sp. (species of Himeji) (395 a) from Japan, ordinary microscopy. E, *Sphalloplana coreana* (566 d) from South Korea, ordinary microscopy. F, *Sphalloplana zeschi* (polypharyngeal species, 1071 Ba) from Texas, U. S. A., ordinary microscopy. phl, pharyngeal lumen.

The penis has an extraordinarily large, ovoid bulb embedded in the parenchyma and a very long, slender, and symmetrical papilla projecting into the male antrum (Figs. 4 A–H, 5 A and B). The bulb is strongly muscular consisting of muscle fibers chiefly paralleling its contours (Fig. 4 A–H). The bulb continues to the basal part of the penis papilla, which is conical and strongly muscular (Fig. 5 A and B). The middle and terminal parts of the papilla are weakly muscular. In some specimens the penis papilla is strongly curved in its course and protruded from the genital pore (Fig. 5 B). In one specimen (1244 a) the slender part of the papilla is coiled

(Fig. 5 A). The outer wall of the papilla is covered with a flat epithelium of a nucleate type similar to that lining the male antrum. Beneath this epithelium are two thin muscle fiber layers.

The penis papilla contains in its basal portion a narrow, long, tubular cavity, the beginning of the penis lumen (Fig. 4 E and H). This space continues into the slender part of the papilla as a very narrow, long, ejaculatory duct, which opens at the tip of the papilla (Fig. 5 A and B). There is no bulbar cavity nor seminal vesicle. The sperm ducts form slightly developed spermiducal vesicles on each side of the body between the level of the posterior one-half of the pharynx and the anterior level of the penis bulb. Alongside the penis bulb, the spermiducal vesicles narrow to slender ducts that proceed posteriorly to the level of the basal part of the penis papilla to then curve anteriorly, ascend vertically, and finally to open separately into the anterior end of the penis lumen (Fig. 5 A and B). The penis bulb is pierced by a considerable number of gland ducts (penis glands) containing eosinophilos granules.

The copulatory bursa is a small, club-shaped sac with a moderately wide lumen (Figs. 4 C–G, 5 A and B). It is lined with a tall, glandular epithelium. The bursal stalk, an extremely long duct narrow in most of its length, runs posteriorly close to the midline above the penis. Its terminal part forms a wide, thick-walled cavity, the vagina, which opens at the genital pore (Figs. 4 A, 5 A and B). The bursal stalk is provided with a muscle coat of inner circular and outer longitudinal fibers. This coat thickens in the wall of the vagina (Fig. 5 A and B). The wall of the vagina is pierced by the ducts of eosinophilous glands that open into the vaginal lumen. Weakly eosinophilous cement glands open immediately inside the genital pore.

The egg capsule, or cocoon, is unknown.

Material examined. Specimen Lot No. 1243. Malheur Cave, Harney County, Oregon. Altitude, about 610 m. Coll. Mrs. E. M. BENEDICT. 22 September 1973. Two specimens, both sexual. Specimen Lot No. 1244. Above locality. Coll. Mrs. E. M. BENEDICT. 6 October 1973. Two specimens, both sexual.

Deposition of Material. Two sets of serial sagittal sections (Specimen Nos. 1244 a, b) deposited in the Division of Worms, U. S. National Museum. Remaining two sets of serial sagittal sections (Specimen Nos. 1243 a, b) retained in the authors' laboratories.

STATUS OF THE FAMILY KENKIIDAE AND ITS GENERA

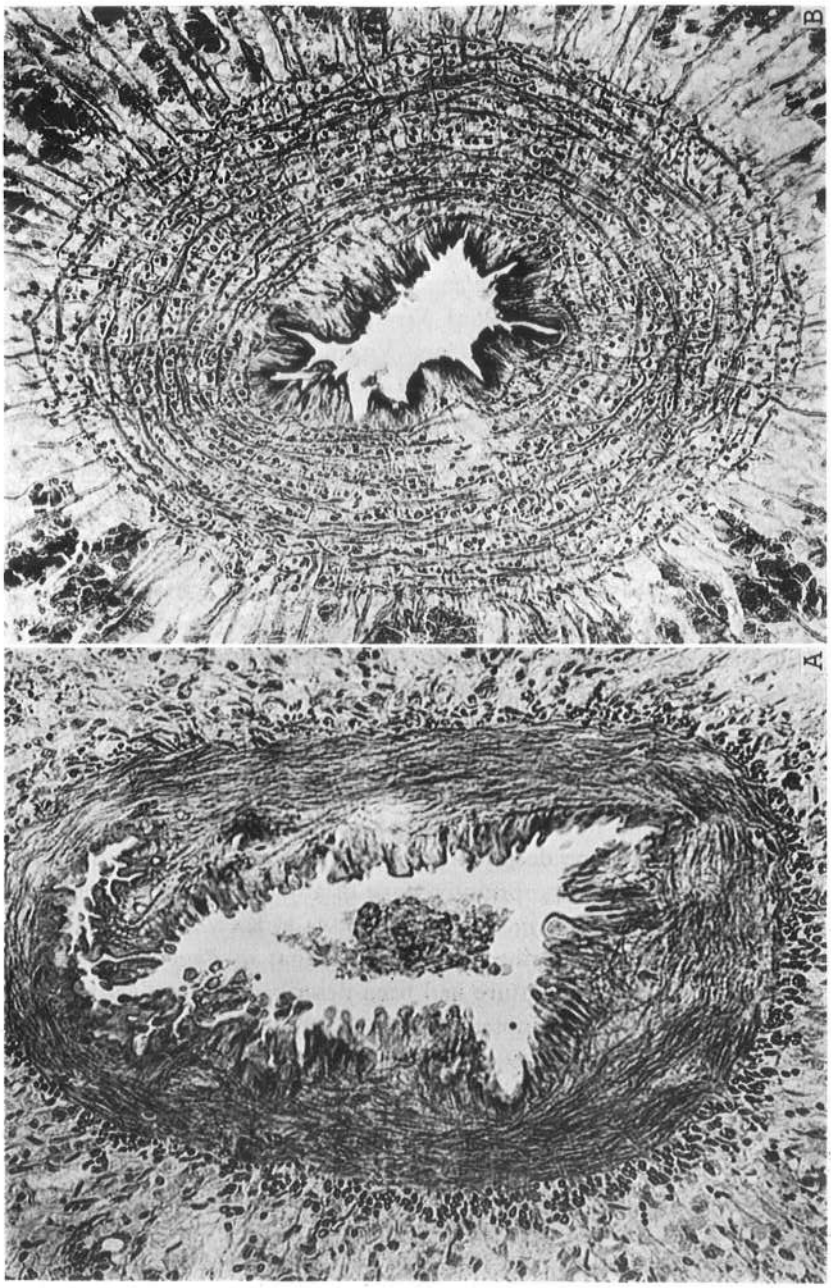
In 1930, KENK emended the definitions of the two families in the triclad suborder Paludicola to reflect the differences between them in the arrangement of muscle fibers in the internal muscle zone of the pharynx: Planariidae STIMPSON, 1857, with distinct circular and longitudinal fiber layers (Fig. 7 A); and Dendrocolidae HALLEZ, 1892, with intermingled circular and longitudinal fibers (Fig. 7 B).

In 1937, HYMAN erected a third family, the Kenkiidae, to include a group of white, eyeless cave planarians. At that time, the family was comprised of the genera *Kenkia* HYMAN, 1937; *Speophila* HYMAN, 1937; and *Sphalloplana* DE BEAUCHAMP, 1931. The earliest described species that came to be included in this family was *Sphalloplana percoeca*, described in the previous century by PACKARD (1879) as *Dendrocoelum percoecum*. In 1931, DE BEAUCHAMP redescribed this species and created for it the genus *Sphalloplana*, although he did not diagnose the genus. He removed the species from the family Dendrocoelidae to the Planariidae. HYMAN then removed *Sphalloplana* to her new family, Kenkiidae, in 1937. In her 1937 paper, HYMAN described *Kenkia rhynchida*, *Speophila pricei*, and *Speophila buchanani*; and in the following years she added *Sphalloplana mohri* HYMAN, 1939; *Speophila hubrichti* HYMAN, 1945; *Sphalloplana alabamensis* HYMAN, 1945; *Sphalloplana virginiana* HYMAN, 1945; *Sphalloplana kansensis* HYMAN, 1945; *Sphalloplana georgiana* HYMAN, 1945; and *Speophila hoffmasteri* HYMAN, 1954. All of these species came from caves and springs within the United States.

In 1940, LIVANOW and ZABUSOVA described *Sphalloplana ductosacculata* from Lake Teletzkoë in the Altai Mountains in the southwestern part of Siberia. These authors placed this species in the family Planariidae, but ICHIKAWA and KAWAKATSU (1967) removed it to the Kenkiidae. Thus, this was the first presumed kenkiid to be described from outside the U.S.A. and the first known from a habitat other than cave or spring waters. Two species from Japan were added to the Kenkiidae in 1967 by ICHIKAWA and KAWAKATSU, but because of lack of sexually mature specimens, these kenkiids were referred to only as *Speophila* sp. of Himeji and *Speophila* sp. of Mts. Yatsu-ga-dake. A fourth Asiatic species was added to the family in 1967 by KAWAKATSU and KIM, *Sphalloplana coreana* from South Korea. In 1970, a new species, *Sphalloplana weingartneri* KENK, was described from a cave in Indiana.

In 1968, MITCHELL published on HYMAN's (1939) polypharyngeal species *Sphalloplana mohri*, from Ezell's Cave in Texas, and he also described four additional, closely allied species from other central Texas caves: *Sphalloplana kutscheri*, *Sphalloplana sloani*, *Sphalloplana zeschi*, and *Sphalloplana reddelli*. Based upon a detailed study of the adhesive organ of the Texas *Sphalloplana* species and a comparison of their structure to that of the adhesive organs of previously described species of *Sphalloplana* and *Speophila*, MITCHELL (1968) proposed elimination of the genus *Speophila* to become a synonym of *Sphalloplana*, a move already anticipated by HYMAN (1945). This synonymy was later accepted by others (KAWAKATSU, 1969; KENK, 1970; BALL, 1974). Thus, by 1970, the kenkiid genera numbered two:

Fig. 7. Transverse sections showing the internal pharyngeal muscle zones typical of the families Dugesiidae and Dendrocoelidae. Mallory's triple stain. Photomicrographs by Mr. E. ASAI. A, The dugesiid *Dugesia japonica japonica*; B, the dendrocoelid *Bdellocephala brunnea*. Specimens of both the species from Kanazawa City in the Hokuriku District of Honshu, Japan.


B
A

Kenkia, with a single described species; and *Sphalloplana*, with 17 described species and two species remaining undescribed.

In 1972, KENK synonymized MITCHELL's (1968) four Texas *Spallaplana* species with *Sphalloplana mohri*. This action is debatable and in need of further consideration at a later time. In 1975, KENK transferred *Sphalloplana hoffmasteri* to the genus *Macrocotyla*, and more recently he (KENK, 1977) synonymized *Sphalloplana alabamensis* with *Sphalloplana percoeca*, also suggesting that *Sphalloplana georgiana* might also be synonymous with the latter species. Also in 1977, KENK added seven new species to the genus: *Sphalloplana evaginata* from Missouri, *S. californica* from California, *S. culveri* from West Virginia, *S. consimilis* from Virginia and northeastern Tennessee, *S. subtilis* from Virginia, *S. holsingeri* from Virginia, *S. chandleri* from Tennessee, Indiana and Virginia. KENK (1977) pointed out, additionally, that the Siberian species, *Sphalloplana ductosacculata*, has the testicular zone extending to the posterior end and probably should not be placed in this genus. We agree with him. Thus, in 1980, the genus *Sphalloplana* contained 17 described species (16 from the U.S.A. and 1 from South Korea), as it did a decade previously, but with a considerably different species composition.[1)]

HYMAN's family Kenkiidae was not accepted by DE BEAUCHAMP (1961) nor by MITCHELL (1968), who proposed its elimination for a number of reasons. HYMAN (1937) defined the family as follows: "White eyeless cave planarians; arrangement of the pharynx musculature as in the family Planariidae; anterior end with an adhesive organ often developed into a deeply invaginated protrusible gland; copulatory complex as in *Phagocata*; no adenodactyls; testes relatively few, prepharyngeal; body margins with very large rhabdites." In consideration of this definition, MITCHELL (1968) pointed out that one lake-dwelling species (*Sphalloplana ductosacculata*) had been described, that one deeply-pigmented form had been recorded (an undescribed Japanese species), that a primitive type of anterior adhesive organ had been described in a planariid (*Phagocata albata* ICHIKAWA et KAWAKATSU, 1962), that the copulatory apparatus was described as similar to that in *Phagocata* (a planariid), and that the pharyngeal musculature had been described as identical to that in the Planariidae. KENK (1972) readopted the two-family classification of the suborder Paludicola, but KAWAKATSU (1969), BALL (1969), and GOURBAULT (1972) continued to recognize the three-family classification.

In 1974, BALL proposed a different classification for the paludicolan planarians in which the suborder was divided into three families: a newly-created Dugesiidae, Planariidae, and Dendrocoelidae. He further divided the Dendrocoelidae into two subfamilies: Kenkiinae and Dendrocoelinae. Thus, in one step, BALL (1974) removed familial recognition from the kenkiids and related them to the dendrocoelids rather than to the planariids. The key to his reasoning was the genus

1) KENK (1977) classified the *Sphalloplana* species known in the United States into two subgeneric groups based upon the difference of the degree of development of the adhesive organ, i.e., the subgenus *Sphalloplana* (including 8 species) and the subgenus *Speophila* (including 8 species).

Macrocytyla HYMAN, 1956, which HYMAN described as having a dendrocoelid-type pharyngeal musculature and an adhesive organ quite similar to that of the kenkiids. BALL (1974) thus argued for common origin of the *Macrocotyla*-kenkiid type of adhesive organ and relationship of the kenkiids to the dendrocoelids because of *Macrocotyla*'s supposed dendrocoelid-type pharyngeal musculature. To do otherwise, BALL (1974) argued, two assumptions were required to derive the kenkiids from the planariids: independent origin of an anterior adhesive organ in *Macrocotyla* and the kenkiids, and convergence between the organs in the two groups. Consequently, BALL (1974) assigned *Kenkia* and *Sphalloplana* to the subfamily Kenkiinae and regarded the group as primitive dendrocoelids having the inner pharyngeal musculature arranged into two distinct layers. He likewise assigned *Macrocotyla* to his subfamily Dendrocoelinae, regarding this group as a more advanced type of dendrocoelid showing a derived pharyngeal musculature in which the inner pharyngeal muscle fibers are intermingled (see also BALL, 1977).

KENK (1975) has published on the genus *Macrocotyla*, restudying *M. glandulosa* HYMAN, 1956; removing *Sphalloplana hoffmasteri* (HYMAN, 1954), to *Macrocotyla*; and describing a new species, *M. lewisi*, from Missouri. KENK (1975) found that the inner muscle zone in *Macrocotyla*, particularly evident in *M. lewisi*, actually showed a fiber arrangement theretofore unknown among paludicolans: an inner layer of circular fibers and an outer layer of intermingled circular and longitudinal fibers. He further stated his belief that *Macrocotyla*, *Kenkia*, and *Sphalloplana* constituted a natural monophyletic group largely on the basis of the shared characteristics of a highly developed, specialized adhesive organ; limitation of the testes to the prepharyngeal region, and development of a zone of thickened marginal epithelium with large rhabdites in most species. KENK (1975) grouped these three genera and assigned familial status to the taxon. He emended HYMAN's (1937) definition of the family Kenkiidae as follows: "Tricladida Paludicola in which the internal muscle zone of the pharynx consists of two layers, a circular layer adjoining the inner epithelium and a layer of either longitudinal or intermingled longitudinal and circular fibers; anterior end with an adhesive organ containing glandular and muscular structures, often highly developed as a deeply invaginated protrusible gland; testes prepharyngeal; oviducts uniting to a common oviduct opening into the genital atrium; no adenodactyls; body margins with thickened epithelium containing large rhabdites; cocoon unstalked; generally blind, subterranean forms."

We concur with KENK (1975) in his inclination to view the assemblage of *Sphalloplana*, *Kenkia*, and *Macrocotyla* as a natural, monophyletic group, and we further concur that it is warranted to assign familial status to the group (see KAWAKATSU, 1978).

Although KENK (1975) pointed out the unusual nature of the inner pharyngeal musculature in *Macrocotyla*, he technically did not emend HYMAN's (1956) definition of the genus, which is as follows: "Dendrocoelidae with highly developed ad-

hesive organ, of the *Speophila* type; testes prepharyngeal; common ovovitelline duct entering roof of the male antrum; penis excessively glandular, partly embraced by an eosinophilous mass discharging by a pair of ducts into the sperm ducts; no adenodactyls." Now, based upon KENK's (1975) restudy of the genus *Macrocotyla* and our own restudy of the genus *Kenkia*, it may fairly be asked, what distinctions exist, if any, that warrant separation of *Kenkia* and *Macrocotyla*? In our opinion, there are none, so we propose to redefine the genus *Kenkia* as follows: Kenkiidae in which fibers of internal pharyngeal muscle zone are arranged in two layers, one of circular fibers adjoining epithelium of pharyngeal lumen and surrounding layer of intermingled circular and longitudinal fibers; with normal body form; depigmented and eyeless and with well-developed marginal adhesive zone; with anterior, highly developed, tubular adhesive organ, provided with well-developed musculature and gland ducts; monopharyngeal; testes few to moderate in number and prepharyngeal; common ovovitelline duct entering roof of male antrum; penis with bulb and well-developed papilla; no adenodactyls. Type-species: *Kenkia rhynchida* HYMAN, 1937. Thus redefined, the genus *Kenkia* now contains four species: *K. rhynchida* HYMAN, 1937; *K. hoffmasteri* (HYMAN, 1954); *K. glandulosa* (HYMAN, 1956); and *K. lewisi* (KENK, 1975).

Because of KENK's (1975) discovery of the unusual inner pharyngeal musculature in *Macrocotyla* and our finding of the same type in *K. rhynchida*, we reexamined the same musculature in some species of *Sphalloplana*, *S. zeschi* from Texas, *S.* sp. of Himeji in Japan, and *S. coreana* from South Korea. In these species, the inner pharyngeal musculature exists in essentially separate layers, one of inner circular fibers and one of outer longitudinal fibers (Fig. 6 D–F).

The genus *Sphalloplana*, redefined by MITCHELL (1968), should once again be redefined as follows: Kenkiidae in which fibers of internal pharyngeal muscle zone are arranged in two layers, one of circular fibers adjoining epithelium of pharyngeal lumen and surrounding layer of longitudinal fibers; with normal body form; usually, but not exclusively, depigmented; eyeless and with well-developed marginal adhesive zone; with anterior, conical adhesive organ, provided with musculature for extension and retraction, eversible from pit of varying depth; monopharyngeal or polypharyngeal; testes few to moderate in number and mostly prepharyngeal; common ovovitelline duct entering roof of male antrum; penis with bulb and well-developed papilla; no adenodactyls; egg capsule spherical, not stalked. Type-species: *Sphalloplana percoeca* (PACKARD, 1879). Thus redefined, the genus *Sphalloplana* now contains about 20 species, most from the U.S.A. but two from Japan and one from South Korea.

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