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INTRODUCTION

Mr. Allyn G. Smith, Associate Curator of Invertebrates of the California Academy of Sciences, described the genus *Speleodiscoides* A. G. Smith, 1957, and its type species, *Speleodiscoides spirellum* A. G. Smith, 1957, from dead shells collected in Violin Cave on the west bank of the South Fork of Dry Creek, Amador County, California. For want of living specimens, he placed the genus provisionally in the family Endodontidae.

On 10 January 1966, Mr. David Bauer, collector, found several live specimens of *S. spirellum* along a wooded, leaf-covered, rocky slope on the right bank of a tributary to Indian Creek at a point 2.3 road miles along State Highway 49 southeast of Coloma (from Mt. Murphy's Road intersection), at an elevation of about 1500 feet.

On 10 April, 1969, Allyn Smith, David Bauer, and I returned to this locality and in a short time collected over three dozen specimens including ten live adults. I have dissected eight of these specimens to date and can now report on the anatomy of *Speleodiscoides spirellum*.

MATERIALS AND METHODS

Only structures more commonly used in comparative anatomy and taxonomic evaluation were examined.

The living animals were observed under the dissecting microscope and notes made on pigmentation of body wall and mantle, shape of foot, and presence of pedal and suprapedal grooves.

Stained whole mounts of genitalia were prepared and permanently embedded on slides in Permount. Several radulas and jaws were also prepared and mounted, some in Euparal and some in Turtox CMC-9AF mounting medium. Ovotestes were embedded in paraffin, sectioned 7 μ, and stained with Harris' hemalum and eosin to reveal the cellular character of the gametocytes; the gross morphology of the ovotestes was better revealed in stained whole mounts of carefully dissected specimens. The pallial complex, consisting of heart, lung, and kidney was examined and drawn to scale in relation to other organs in the vicinity, and subsequently preserved with other dissection remnants in 70 percent ethanol.

RESULTS

SHELL. The shell has been well described in the original description (Smith, 1957). It should be added here, however, that fresh shells did show several internal, paired conical teeth along the outer wall of the body whorl. There were usually two pairs, the first located about 1/3 to 1/4 whorl behind the aperture and the second about 1/2 whorl behind the first. In size, shape, and position, they resemble the teeth of *Helicodiscus parallelus* (Say) and *H. eigenmanni* Pilsbry as illustrated by Pilsbry (1948).

Older shells often showed no trace of any teeth, these having been apparently resorbed.

LIVING ANIMAL. The living animal is an outstanding example of the Aulacopoda pedal structure (Pilsbry, 1946). The pedal groove is distinct and situated well above the lateral angle of the foot; the beating cilia could be easily observed along the lateral band of the sole below the groove, by means of properly reflected light under the dissecting microscope. The suprapedal groove is narrower but also distinct. There is evidence of a mucus pit at the tip of the tail, just below the pedal groove, but serial sectioning of this region was not undertaken.

The animal is apparently blind. There are no pigmented eye spots at the end of the ommatophores. The tips of all four tentacles, however, contain a trace of orange pigment, possibly a carotenoid.

The body wall is white and translucent; the jaw can be seen through the body wall as a thin, dark, transverse line inside the buccal mass midway between the two sets of tentacles. The mantle and mantle collar are also completely devoid of pigment.

Reproductive system. The reproductive system is usually the most useful anatomical indicator of generic relationship. In *Speleodiscoides spirellum*, the most outstanding characteristics are: 1) a very long, narrow, cylindrical albumin gland; 2) an extremely long spermathecal duct with a spermatheca located well posterior of the albumin gland; 3) an even longer hermaphroditic duct connected at its base with a long, winding talon, and at its apical end with ovotestes consisting of many thin, parallel, cylindrical tubules.

The relatively enormous length of the entire gonoduct, 24 mm. from ovotestes to gonopore, is simply a reflection of the many close coils that make up this animal. Figure 1, drawn directly from a stained whole mount, shows the size relationship of the various component organs of the reproductive system.

Details of unusual structures are shown in figures 2 to 5. Figure 2 shows the basal part of the hermaphroditic duct which is convoluted and connects at the carrefour with a long, thin, tubular talon which loops over and around the albumin gland and comes to lie embedded in the thin connective tissue surrounding the genitalia. Figure 3 shows the spermatheca in relation to the pallial-kidney-heart complex. It lies just posterior to the pericardium and is partly secured by a loop of the anterior aorta. This is the normal relationship in many land snails. An unusual feature is that the albumin gland is absent from this complex due to the fact that the lower genitalia are located much farther anteriorly and do not begin to reach the area of the heart-kidney complex.

Figure 4 shows the details of the penis and connecting structures. The penis is very small, measuring between 0.6 and 0.8 mm. The penial retractor muscle attaches to the base of the lung very close behind the mantle collar. The vas deferens attaches directly to the apical end of the penis, near the base of the penial retractor, without a visible differentiated epiphallus. The cleared, stained, whole mount shows, however, that the internal ducts at the apical end of the penis are coiled in one to two loops and surrounded by muscular tissue. When the penis is everted for copulation, it appears likely that the coiled internal loops could perform the ejaculatory function of an epiphallus. The spermathecal duct and the oviduct open separately and directly into the genital atrium along with the penis; there is no vagina, usually defined as a common female duct below the junction of the oviduct and spermathecal duct. The right ommatophore retractor passes through the penioviducal angle.

Figure 5 shows the details of the ovotestes as observed under the compound microscope at 430 X. There are approximately 10 to 15 thin, cylindrical tubules connected to the hermaphroditic duct and embedded in liver tissue. Each tubule contains several large oöcytes with clearly visible germinal vesicles and large nucleoli. In addition, each tubule also contains numerous clumps of much smaller spermatocytes. Examination of serial sections reveals that the spermatocytes are in various stages of maturation; no spermatozoa were seen, however. The oöcytes are also in various stages of growth, including some atretic cells; most oöcytes had one large nucleolus and from one to three smaller nucleoli.

Pallial complex. The pallial complex as used for comparative purposes usually includes the roof of the lung, pulmonary vein, heart, kidney, and ureter. In *Speleodiscoides spirellum*, the heart and kidney are situated one full whorl behind the mantle collar, which, as has already been stated, causes this group of organs to be well separated from the proximity of the larger genital structures, with the exception of the spermatheca (fig. 3). The anterior aorta, after looping over the spermatheca, proceeds anteriorly alongside the spermathecal duct. The pulmonary vein, heart, and pericardial cavity show no unusual features. The kidney is rectangular, closely appressed between heart and rectum, and clearly sigmurethrous.

Radula and jaw. The radula has a formula of 10 to 12-4-1-4-10 to 12. The central tooth (fig. 6a) is as wide and as long as the laterals but the tooth shank is narrower; it is tricuspid, with the side cusps very small but equal. The laterals are tricuspid; the first lateral (fig. 6b) has the endocone larger than the ectocone; on succeeding laterals, the ectocone is carried gradually higher on the mesocone so that by the fourth lateral (fig. 6c), the ectocone is much higher than the endocone. The marginals vary in number from 10 to 12 (and may show greater variation in different individuals); they are bicuspid, short, and wide, with the outer cusp gradually changing from narrower to wider (fig. 6 d-f).

The jaw (fig. 6g) is entire, arcuate, and closely plaited, the plaits appearing in some places as mere striae. It is horn color and is clearly visible in the interior of the animal through the translucent body wall.

DISCUSSION

The anatomy of *Speleodiscoides spirellum* shows this species to be an apparently blind endodontid somewhat related to Helicodiscus. It shows affinities with the American Endodontinae (Anguispira Morse, Discus Fitzinger, and Helicodiscus Morse) in that the jaw is entire and finely plaited, and with the Punctinae (Radiodiscus Pilsbry and Ferriss, Punctum Morse) in that the kidney is squarish and in broad contact with the hind gut. The long, cylindrical albumin gland, the tubular, filiform ovotestes, and the unusually long spermathecal and hermaphroditic ducts (even for this family) clearly separate Speleodiscoides from all other American endodontids. It should probably be placed in a separate subfamily from the Endodontinae and Punctinae, but this suprageneric work is left here for researchers who are more familiar with the worldwide characteristics of the entire family. It is hoped that this detailed account of Speleodiscoides anatomy will prove useful.

ACKNOWLEDGMENTS

I wish to acknowledge the invaluable assistance of Allyn Smith and David Bauer in helping me to obtain live animals. Their camaraderie, combined with the pleasure of collecting along a wooded stream in the Mother Lode country, has made this endeavor a very pleasant undertaking. I also wish to thank Linda Eyster, a high school student from Lafayette, Louisiana, who worked in my laboratory at the University of Arizona during a National Science Foundation summer seminar in 1970, for preparing several radula and jaw mounts and assisting me in their description.

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SYMBOLS USED IN FIGURES 1-6

ag	albumin gland
ao	aorta
au	auricle
cm	columellar muscle
es	esophagus
ga	genital atrium
go	genital orifice
hd	hermaphroditic duct
in	intestine
ki	kidney
li	liver
lp	lumen of penis
ma	mantle
oo	developing oöcyte
ot	ovotestes
ov	oviduct
pc	pericardium
pe	penis
pr	penial retractor
pt	prostate
pv	pulmonary vein
rc	rectum
sd	spermathecal duct
sp	spermatheca
ta	talon
ur	ureter
ut	uterus
vd	vas deferens
vt	ventricle

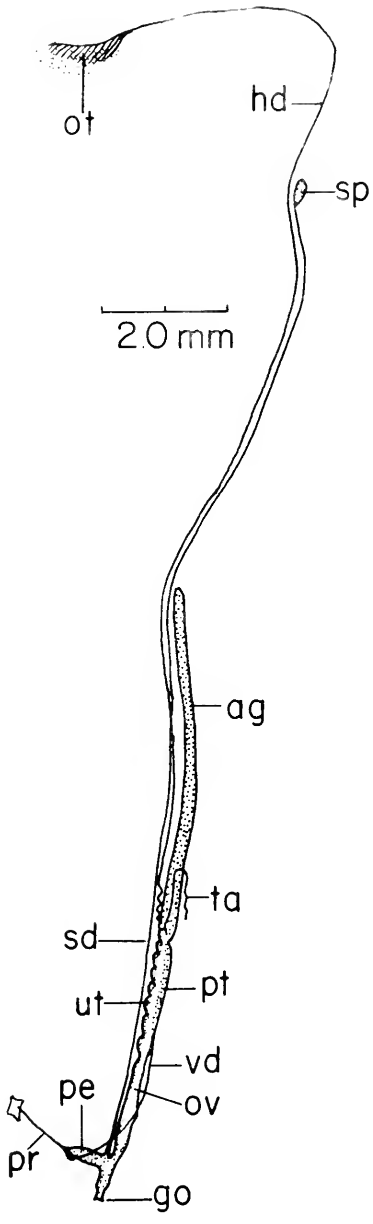
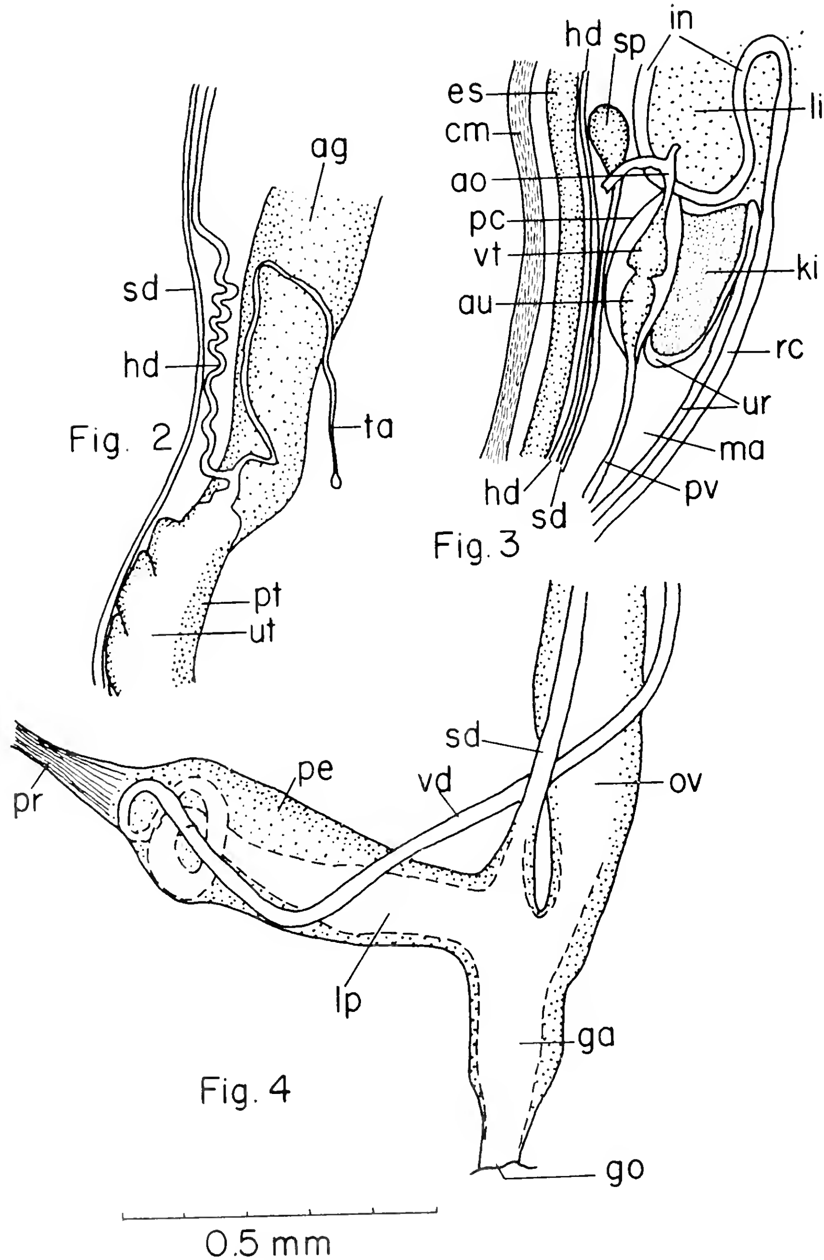


FIGURE 1. *Speleodiscoides spirellum* A. G. Smith, 1957. Genitalia; drawing made from projection of stained whole mount.



FIGURES 2-4. Speleodiscoides spirellum A. G. Smith, 1957. FIGURE 2. Details of genitalia in vicinity of junction of hermaphroditic duct and uterus. FIGURE 3. Pallial complex and adjacent organs. FIGURE 4. Details of lower genitalia.

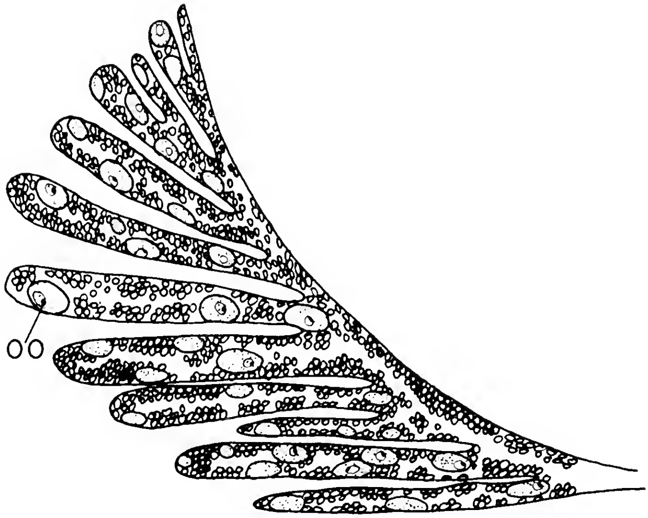


Fig. 5

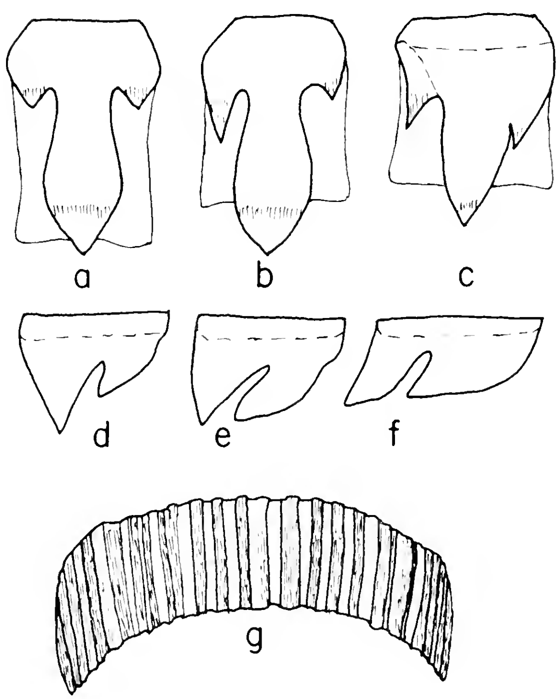


Fig. 6

FIGURES 5-6. Speleodiscoides spirellum A. G. Smith, 1957. FIGURE 5. Ovotestes. FIGURE 6. Radula and jaw; a, central tooth; b, 1st lateral; c, 4th lateral; d, 1st marginal; e, 2nd marginal; f, 5th marginal; g, jaw.