

THE TAXONOMICS OF THE GENUS *PROTOGYNELLA* JONES,  
1943 (CESTODA: HYMENOLEPIDIDAE), WITH  
A DESCRIPTION OF *PROTOGYNELLA PAUCIOVA*  
N. SP. PROVIS<sup>1</sup>.

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Jones (1943) established the genus *Protogynella* to receive a species of small tapeworm which he recovered from the short-tailed shrew, *Blarina brevicauda* (Say), collected in Virginia. He described this tapeworm, *Protogynella blarinae*, as having an unarmed rostellum. In addition the tapeworm was characterized as having a single testis which developed in each proglottid after the ovary had reached maturity, thus giving rise to a protogynous condition.

Rausch and Kuns (1950) recovered a small tapeworm from *Blarina brevicauda* in southern Wisconsin which they identified as *Protogynella blarinae*. However, they reported that the rostellum was armed with 45 hooks about 5  $\mu$  long and therefore suggested a modification of the generic concept.

Locker and Rausch (1952) reported *P. blarinae* from shrews collected in Oregon. They noted that the rostellar hooks were more numerous in the Oregon specimens, and suggested that *P. blarinae* was variable in this respect.

During 1950 the intestinal tracts of 30 short-tailed shrews were examined by the writer. Five of these shrews were infected heavily with minute tapeworms of the genus *Protogynella*. The material from three shrews was decomposed too badly to be of value for study. However, 260 specimens from a shrew collected in Hocking Co. and 29 specimens from a shrew collected in Franklin Co., Ohio, were recovered in good condition and form the basis for the present study.

OBSERVATIONS AND DISCUSSION

The specimens of *Protogynella* from Hocking Co. were compared with the type specimen of *P. blarinae* (Slide No. 165133, Helminthological Collection of the U. S. National Museum) and were found to be identical. Close examination of the type specimen revealed six proglottids, directly at the base of the scolex, containing a single testis each. These testes were poorly differentiated by the stain, and it seems probable that they had been overlooked in the original study. The seminal vesicles in about the seventh proglottid, which had been described as devoid of sperm and in an immature state, actually contained sperm. This condition, together with the fact that the testis develops before the ovary, rules out protogyny for this species.

The rostellum of the type specimen is partially protruded. Only a few hooks are visible; the rest have apparently been lost. Dr. A. W. Jones re-examined the type and paratypes of *P. blarinae* from Virginia as well as about 75 specimens from Ohio, at the author's suggestion, using the phase microscope. He concluded (personal communication) that the number of hooks may be variable, but is probably close to 250. The hooks occur in several irregular rows or tiers, thus forming a band around the face of the rostellum.

To justify the erection of the genus, Jones (1943) had maintained that the unique combination of characters of *P. blarinae* would not allow its inclusion in any established genus of the family Hymenolepididae. The observations of

<sup>1</sup>In part from a thesis presented in partial fulfillment of the requirements for the degree Master of Arts in the Department of Zoology and Entomology, the Ohio State University.

Rausch and Kuns (1950) and Locker and Rausch (1952) together with the present study reveal that two of the morphological bases used in establishing the genus, i.e., protogyny and an unarmed rostellum, were fallacious. Nevertheless, the characters of *P. blarinae* remain unique within the family. The single testis would immediately place this tapeworm in the genus *Haploparaxis* Clerc, 1903, since this is the only genus in the family which possesses this important characteristic. Clerc, however, in defining the genus states: "Rostellum armé d'une couronne simple de crochets." In *P. blarinae*, the hooks are arranged in several closely set rows. Moreover, the extremely large number of hooks is important since in *Haploparaxis* the hooks number only ten with the exception of *H. dujardini* (Krabbe, 1869) which possesses forty-six. In addition, all known species of *Haploparaxis* are confined to avian hosts. Thus the single testis of *Protogynella*, together with the morphology of the rostellum, the extremely small size of the worm, and the fact that its host is a mammal, justify the retention of the genus.

#### **Protogynella** Jones, 1943 *genus emended*

*Diagnosis:* Size small, usually less than 1 mm. in length; strobila not serrate; 15 to 32 proglottids in specimens observed. Scolex roughly spherical with four muscular, unarmed suckers. Rostellum muscular, protrusible; armed with a large number of minute, Y-shaped hooks occurring in a single row or in several overlapping rows or tiers. Common genital pores unilateral. Female organs median and ventral to male organs; male and female ducts pass dorsally to excretory canals. Vitellarium ventral, compact, aporal to ovary and seminal receptacle. Testis dorsal, single, evident only in very young proglottids. Uterine pocket fills entire gravid proglottid except region of male system. Single layer of longitudinal muscles, central to band of circular muscles. Condition of protogyny not present.

The following redescription of *P. blarinae* is based on the type specimen and the material from Hocking Co.

#### **Protogynella blarinae** Jones, 1943

(Figures 1, 2, 5 to 9, and 12)

*Diagnosis:* Total length 440 to 750  $\mu$ ; greatest width 101 to 162  $\mu$ , attained in gravid proglottids. Scolex prominent, 115 to 138  $\mu$  long and 149 to 190  $\mu$  in diameter; four muscular, unarmed, cup-shaped suckers 46 to 68  $\mu$  in diameter. A muscular, armed, protrusible rostellum, 54 to 63  $\mu$  in diameter, surrounded by a sac 102 to 123  $\mu$  long and 61 to 89  $\mu$  in diameter. Rostellar hooks about 250 in number and about 4  $\mu$  long. Hooks Y-shaped, arranged in 2 or 3 overlapping rows or tiers. Strobila slightly flattened dorso-ventrally; edges not serrate; consisting of 17 to 32 proglottids which are wider than long. A single layer of non-fasciculated longitudinal muscle fibers. Genital pores unilateral, dextral. Two pairs of undulating longitudinal excretory canals passing ventral to genital ducts; transverse connectives lacking; dorsal canal 0.7  $\mu$  in diameter; ventral canal 2.0  $\mu$  in diameter. Testis single, compact, and ovoid with long axis transverse; located dorsal and aporal to sagittal plane; maximum size, reached in 6th or 7th proglottid, 17.2 by 6.9  $\mu$ . Cirrus sac 34 to 53  $\mu$  long and 7 to 10  $\mu$  in diameter; located slightly dorsal to medial-frontal plane and extending from the genital atrium to midline of proglottid; internal seminal vesicle 18  $\mu$  long. Cirrus 13.5 by 2.5  $\mu$  when retracted; without spines. External seminal vesicle elongate, pyriform, recurved porad dorsal to cirrus sac. Vagina ventral to cirrus sac, 1.4  $\mu$  in diameter and lined with cuticle for 13.8 to 16.5  $\mu$  of its length; vaginal cuticle provided with minute papillae. Seminal receptacle transversely elongate; ventral to cirrus sac and dorsal to ovary. Ovary ovoid with long axis transverse; located ventral and median in proglottid;

maximum size, reached in 13th or 14th proglottid, 32.4 by 13.0  $\mu$ . Vitellarium roughly spherical; located aporal to ovary; largest diameter, 10  $\mu$ . Uterus transverse, sac-like, occupying entire gravid proglottid except region of cirrus sac. Two to six terminal uteri each with 6 to 8 fully embryonated eggs enclosed in membranes. Eggs ovoid, 46.2 to 63.2 (av. 57.2)  $\mu$  by 37.0 to 46.2 (av. 41.5)  $\mu$  in size. Three egg membranes present; outer membrane 0.7  $\mu$  thick, pitted on surface; middle membrane thin, irregular, granular; inner membrane 1.4  $\mu$  thick, hyaline, typically with two filaments at each pole. Larval hooks 11.7 to 12.4  $\mu$  long.

*Host: Blarina b. brevicauda* (Say)

*Locality:* Charlottesville, Virginia (type) and Hocking Co., Ohio.

*Habitat:* Small intestine.

*Life cycle:* Unknown.

#### *Development of Genitalia*

A study of serial transverse sections and toto-mounts of *Protogynella blarinae* revealed a rather unique development of the sexual organs. Functional testis and ovary do not occur in the same proglottid. The testis develops, matures, and completely disappears before the ovary reaches maturity.

The testis is evident in the proglottid immediately at the base of the scolex, and it reaches its maximum size in the sixth or seventh proglottid (fig. 5). At this time the cirrus sac and external seminal vesicle are still in the formative stage. The genital atrium and vagina are evident as cavities in the mesenchyme. The lumen of the seminal receptacle arises by the differentiation of a group of cells at the extreme poral side of a ventral mass of formative tissue.

After the testis has reached its maximum size, spermiogenesis occurs, and the testis disappears completely in the ninth to eleventh proglottid. The cirrus sac, seminal vesicles, vagina, and seminal receptacle become functional in the first or second proglottid in which spermiogenesis is occurring at which time the seminal vesicles and seminal receptacle contain sperm (fig. 6).

In the sixth proglottid, the anlage of the ovary appears in the most ventral portion of the mass of formative tissue. The ovary becomes distinct in about the eighth proglottid. The anlage of the vitellarium also appears in the sixth proglottid. It becomes more fully differentiated in succeeding proglottids.

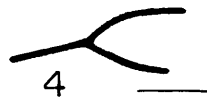
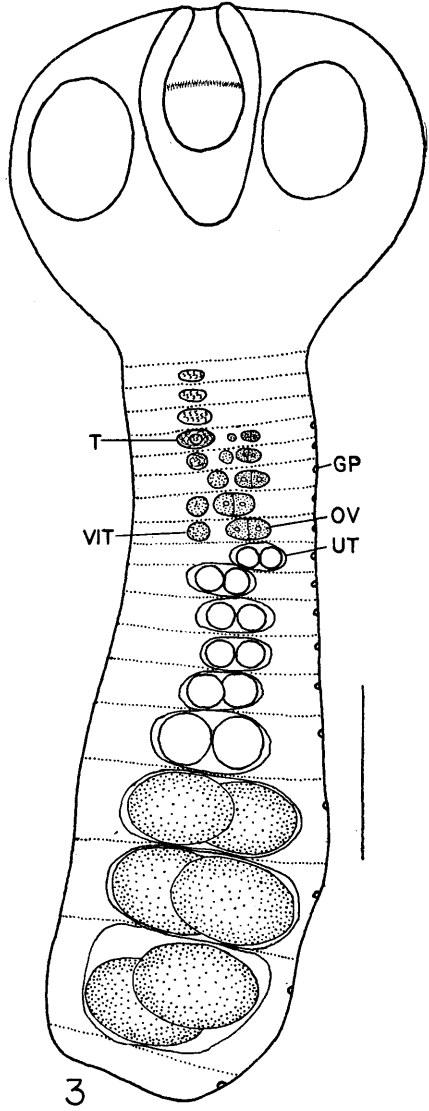
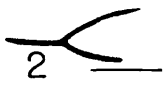
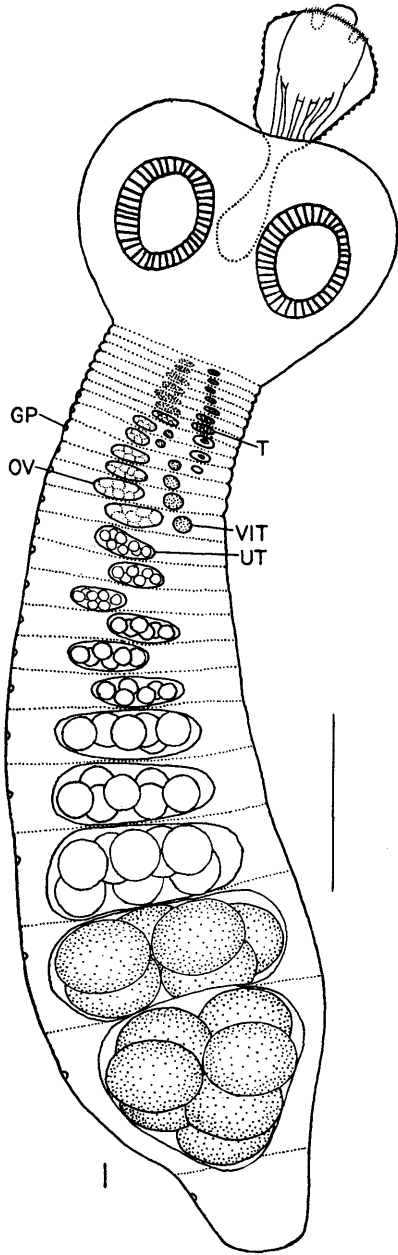
The ovary and vitellarium reach their full size in the thirteenth or fourteenth proglottid. In the following proglottid, the ovary has disappeared, and a uterus containing zygotes or early cleavage stages is present (fig. 9). The uterus develops from the dorso-median mass of formative tissue, its lumen appearing in this group

#### EXPLANATION OF FIGURES IN PLATE I

1. Ventral view of *Protogynella blarinae* Jones, 1943. Cirrus sacs and accessory organs have been omitted for clarity. Scale has value of 100 microns.
2. Rostellar hook of *P. blarinae*. Scale has value of 2 microns.
3. Ventral view of *P. pauciova* n. sp. provis. Cirrus sacs and accessory organs have been omitted for clarity. Scale has value of 100 microns.
4. Rostellar hook of *P. pauciova*. Scale has value of 2 microns.

#### ABBREVIATIONS USED IN PLATES

AU	anlage of uterus
GP	genital pore
OV	ovary
T	testis
UT	uterus
VIT	vitellarium



of cells in about the thirteenth proglottid (fig. 8). The uterus is closely applied to the dorsal ovarian wall. The seminal receptacle, which has elongated aporad, is in close proximity to the dorsal surface of the uterus.

Exactly how the eggs enter the uterus and are fertilized was not apparent in this study. Apparently, however, the ovarian wall ruptures, and ova are liberated into the uterus. Fertilization would appear to be intra-uterine. Whether a duct leads from the seminal receptacle to the uterus could not be determined. Such a sperm duct might not be necessary. In the Acoleidae, in which the vagina is absent, fertilization is accomplished by the injection of sperm from the cirrus directly into the mesenchyme. This would suggest that sperm might leave the seminal receptacle and migrate through the mesenchyme into the uterus where the ova are fertilized. Yolk material also enters the uterus at this time, but its method of entrance is unknown.

Cleavage and formation of hexacanth embryos occur in succeeding gravid proglottids. The eggs, which are fully embryonated in two to six terminal uteri, are surrounded by three membranes. Such eggs are liberated by the rupture of the proglottid. One or more terminal proglottids, devoid of eggs but retaining cirrus sacs, are usually present. Atrophy and sloughing of these proglottids presumably occurs.

#### *Variation within the Genus*

Toto-mounts and serial sections of *Protogynella* from Franklin Co., Ohio, have been studied, and several striking differences in comparison to the typical *P. blarinae* were noted.

In *P. blarinae*, the genital pores are dextral, the cirrus is aspinose, and there are from six to eight eggs in each gravid proglottid, each egg being provided with two filaments at each pole. In the 29 specimens of *Protogynella* from Franklin Co., the genital pores are sinistral, the cirrus is spinose, and there are only two eggs in each gravid proglottid. These eggs are without polar filaments.

Dr. Robert Rausch has kindly sent the author several slides of *Protogynella* from *Sorex v. vagrans* Baird collected in Oregon and from *Sorex c. cinereus* Kerr collected in Wisconsin. As is so often the case when working with helminths of shrews, decomposition had set in before the cestodes were removed from the host, and the material is consequently in poor condition. The following superficial observations were made, however, using the phase microscope.

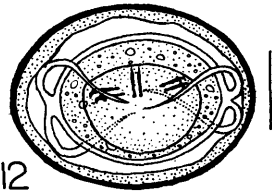
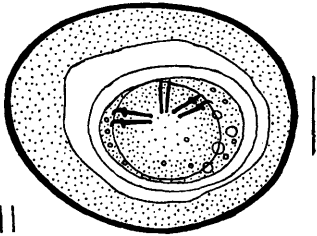
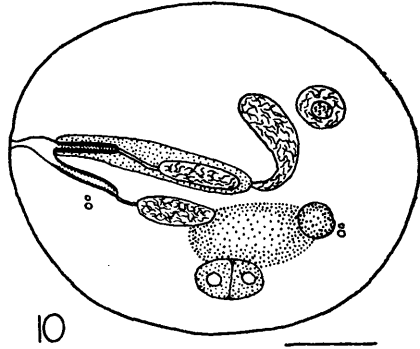
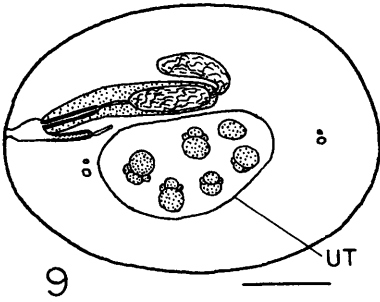
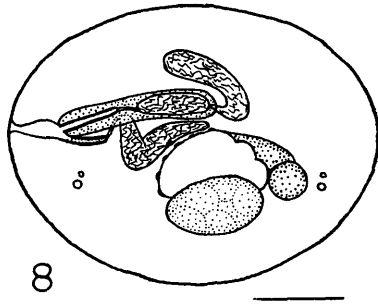
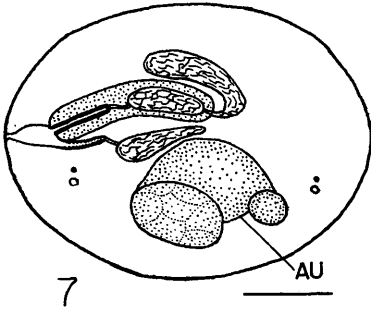
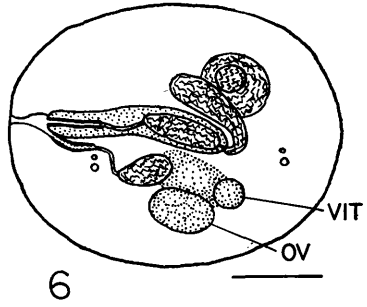
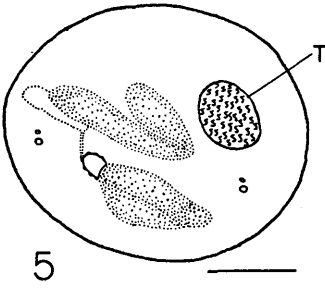
Locker and Rausch (1952) reported that the number of rostellar hooks is near one hundred in *Protogynella* from Oregon shrews. This observation has been substantiated by the writer (estimates of 94, 98, 112, 125). Unlike *P. blarinae*, the hooks occur in a single row. The genital pores in these specimens are dextral, the cirrus is spinose, and the number of eggs varies from six to eight per gravid proglottid. The presence of polar filaments could not be determined because of the shrunken condition of the egg membranes.

In the material from *Sorex cinereus* collected in Wisconsin, the rostellar hooks number about eighty (estimates of 75, 78, 81, and 87) and occur in a single row. In these specimens the genital pores are sinistral, the cirrus is finely spined, and

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#### EXPLANATION OF FIGURES IN PLATE II

5. *Protogynella blarinae*. Transverse section of sixth proglottid. Scale has value of 25 microns.
6. *P. blarinae*. Transverse section of ninth proglottid. Scale has value of 25 microns.
7. *P. blarinae*. Transverse section of twelfth proglottid. Scale has value of 25 microns.
8. *P. blarinae*. Transverse section of thirteenth proglottid. Scale has value of 25 microns.
9. *P. blarinae*. Transverse section of fourteenth proglottid. Scale has value of 25 microns.
10. *P. pauciova*. Transverse section of fourth proglottid. Scale has value of 25 microns.
11. Egg of *P. pauciova*. Scale has value of 20 microns.
12. Egg of *P. blarinae*. Scale has value of 20 microns.



there are approximately twenty eggs in each proglottid. The presence or absence of polar filaments on the inner egg membrane could not be ascertained.

The observations on the various forms of *Protogynella* are summarized in table 1. Two conclusions are possible from the data which have been presented. Either *Protogynella blarinae* is quite variable in several aspects which are commonly used taxonomically, or the genus contains a number of distinct species. The presence or absence of polar filaments in the eggs, the presence or absence of spines on the cirrus, and the position of the genital pores are all clear-cut taxonomic characters. The number of rostellar hooks and the number of eggs per proglottid might be attributed to normal variation, but in each case they are correlated with other characters. The shape of the hooks does not vary significantly from group to group. However, in those specimens in which the number of hooks is approximately 100 or less, they occur in a single row around the rostellum. In the specimens with approximately 250 hooks, the hooks are arranged in several overlapping rows or tiers. These data would seem to indicate that the genotype of the various groups is different.

TABLE 1  
*Comparison of the variation in morphology of Protogynella*

	SPECIES OF <i>Protogynella</i>			
	<i>P. blarinae</i> Jones, 1943	<i>P. pauciova</i> n. sp. provis.	<i>Protogynella</i> sp.	<i>Protogynella</i> sp.
Host	<i>Blarina brevicauda</i>	<i>Blarina brevicauda</i>	<i>Sorex vagrans</i>	<i>Sorex cinereus</i>
Locality	Virginia and Ohio	Ohio	Oregon	Wisconsin
No. Eggs/Proglottid	6 to 8	2	6 to 8	circa 20
Polar Filaments	Present	Absent	?	?
Cirrus	Aspinose	Spinose	Spinose	Spinose
Genital Pores	Dextral	Sinistral	Dextral	Sinistral
Number of Hooks	circa 250	circa 250	circa 100	circa 80
Disposition of Hooks	2 or 3 overlapping rows	2 or 3 overlapping rows	single row	single row

Because of the lack of suitable material to complete a thorough study of *Protogynella* from Wisconsin and Oregon, the status of these forms must be left unsettled at this time. It is hoped that the present study will prompt the collection of suitable material and a thorough study of specimens from other geographical locations. Since the specimens from Franklin Co. have been studied in some detail, a description of them will be included as a step in the final settling of the status of the genus *Protogynella*. The name *Protogynella pauciova* is provisionally proposed for these specimens

***Protogynella pauciova* n. sp. provis.**  
(Figures 3, 4, 10 and 11)

*Diagnosis:* Total length 535 to 772  $\mu$ ; greatest width, 122 to 142  $\mu$ . Scolex roughly spherical, 225 to 345  $\mu$  in diameter; accurate determination of shape and size of scolex impossible because of distortion. Scolex with four muscular, unarmed suckers; suckers 77 to 92  $\mu$  in diameter. A muscular, armed, protrusible rostellum, 45 to 48  $\mu$  in diameter and 31 to 35  $\mu$  long, located in a rostellar sac 112 to 122  $\mu$  long and 70 to 75  $\mu$  in diameter. Rostellar hooks approximately 250 in number, about 5  $\mu$  long; located in several overlapping rows. Strobila slightly flattened dorso-ventrally; about same width along entire length; edges of strobila not serrate. Proglottids 15 to 19 in number; wider than long; not well marked off externally. A single layer of longitudinal muscle fibers. Genital pores unilateral

and sinistral. Excretory system composed of two pairs of slightly undulating longitudinal canals passing ventrally to genital ducts; canals without transverse connectives; ventral canal  $2.7 \mu$  in diameter; dorsal canal  $0.9 \mu$  in diameter. Testis single, compact, and ovoid; located dorsal and aporal to sagittal plane. Testis attains maximum size in fourth or fifth proglottid,  $20.0$  to  $23.4 \mu$  in transverse width and  $10.3$  to  $15.1 \mu$  in length; fully spent and no longer evident within one or two proglottids after reaching maximum size. Cirrus sac cylindrical,  $47$  to  $58 \mu$  long and  $9$  to  $10 \mu$  in diameter; located in median frontal plane and extending from genital atrium to mid-line of proglottid. Cirrus  $23 \mu$  long and  $2.7 \mu$  in diameter; armed with minute spines. An internal seminal vesicle,  $23$  to  $25 \mu$  long, occupies aporal end of cirrus sac. External seminal vesicle elongate and pyriform, recurved porad dorsal to cirrus sac. Vagina located dorsal and poral to ovary, about  $1.4 \mu$  in diameter and lined with cuticle for  $15$  to  $20 \mu$  of its length; cuticular lining provided with minute papillae. Ovary ovoid with long axis transverse; located ventral in median sagittal plane; maximum size, reached in eighth or ninth proglottid,  $14$  by  $20 \mu$ . Vitellarium spheroid; located dorsal and aporal to ovary and slightly ventral to median frontal plane; largest diameter, approximately  $14 \mu$ , reached in eighth or ninth proglottid. Uterus sac-like and transverse, taking up most of gravid proglottid except region of cirrus sac and vagina, which are pushed dorsally and persist in all proglottids. Each of three terminal uteri with two fully embryonated eggs surrounded by membranes; usually a terminal proglottid devoid of eggs. Eggs ovoid,  $69.1$  to  $87.9$  (av.  $79.1$ )  $\mu$  by  $53.4$  to  $65.9$  (av.  $61.9$ )  $\mu$ . Three egg membranes present; outer membrane thin and roughly pitted; middle membrane granular, irregular, much thicker than outer membrane; inner membrane  $2.0 \mu$  thick, hyaline, without polar thickenings or filaments. Larval hooks  $13$  to  $15 \mu$  long.

*Host:* *Blarina b. brevicauda* (Say)

*Locality:* Franklin Co., Ohio.

*Habitat:* Small intestine.

*Life Cycle:* Unknown.

*Type:* A slide bearing a whole specimen has been deposited in the Helminthological Collection of the U. S. National Museum, No. 49493.

*Protogynella pauciova* can be differentiated readily from *P. blarinae* by the number of eggs in gravid proglottids; the former possesses only two eggs per proglottid while the latter possesses six to eight per proglottid. The eggs of *P. pauciova* are larger than those of *P. blarinae* which is probably correlated with the smaller number of eggs. Polar filaments are present in the eggs of *P. blarinae* and absent in *P. pauciova*. Other differences include the position of the genital pores, which are dextral in *P. blarinae* and sinistral in *P. pauciova*, and the possession of aspinose cirri in *P. blarinae* and spinose cirri in *P. pauciova*.

#### SUMMARY

The genus *Protogynella* Jones, 1943 has been emended to conform to the facts which are now known of the morphology of this genus of cestodes. The rostellum in this genus, originally described as unarmed, is actually armed with a large but variable number of minute hooks. The protogynous development originally described for this genus was a misinterpretation, and normal androgenous development found in most cestodes has been documented. *P. blarinae* Jones, 1943 is redescribed in the light of these new facts, and a provisional new species, *P. pauciova*, is described. Morphological variation within the genus is discussed.

#### ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Dr. A. W. Jones, Department of Zoology and Entomology, University of Tennessee, Knoxville, for the loan of



paratype specimens of *P. blarinae* and for allowing the inclusion of observations made by Dr. Jones on the morphology of the rostellum of *Protogynella*. Dr. Robert Rausch, U. S. Public Health Service, Anchorage, Alaska furnished the specimens of *Protogynella* from Wisconsin and Oregon shrews, and in addition has been very helpful in pointing out the possible significance of the morphological variations which occur in this genus. Mr. Clyde Senger, Montana State College, Bozeman, has also provided the writer with specimens of *Protogynella* from the western part of the United States, and Dr. E. W. Price, U. S. Bureau of Animal Industry, graciously arranged for the loan of the type specimen of *P. blarinae*. Lastly, the writer wishes to express his gratitude to Dr. Joseph N. Miller, Department of Zoology and Entomology, the Ohio State University, for the many helpful suggestions and criticisms given during the course of this work.

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