

***Sphaeridiotrema globulus* (Rudolphi, 1814) (Digenea): evidence for two species known under a single name and a description of *Sphaeridiotrema pseudoglobulus* n.sp.**

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Experimental infection of domestic ducklings with metacercariae believed to be those of *Sphaeridiotrema globulus* from snails in Quebec, Canada, and New Jersey, U.S.A., revealed that there are two species known under this name. Study of museum specimens has confirmed that the New Jersey specimens represent the original *S. globulus*; the specimens from Quebec represent a new species. The two species can be separated reliably on the basis of egg size: *S. globulus* (New Jersey) has smaller eggs (mean 97 ± 4 (SD) μm ; range 91–108 μm) than *S. pseudoglobulus* n.sp. from Quebec (mean 116 ± 5 μm ; range 103–125 μm). The cirrus in *S. pseudoglobulus* has a basal bulb not found in that of *S. globulus*. There are fewer uterine coils anterior to the acetabulum in *S. pseudoglobulus*. Comparison of 6-day-old populations of each species revealed several statistically significant differences in the mean size of internal organs. The overall sizes of the body, ovary, and eggs and the width of the posterior testis were greater in *S. pseudoglobulus*; the pharynx, length of the posterior testis, and number of eggs in the uterus were greater in *S. globulus*. No differences were found in the size of the oral sucker, acetabulum, or anterior testis.

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Des expériences d'infection de canards domestiques avec des métacercaires de ce que nous croyions être *Sphaeridiotrema globulus* provenant d'escargots du Québec, Canada, et du New Jersey, États-Unis, ont montré qu'il y avait deux espèces associées sous ce nom. L'examen de matériel de musée a confirmé que les spécimens du New Jersey représentent l'espèce originale *S. globulus* et que les spécimens québécois appartiennent à une espèce inédite. Les deux espèces se distinguent de façon sûre d'après la taille des oeufs : *S. globulus* (New Jersey) a des oeufs plus petits (moyenne 97 ± 4 μm (écart type); étendue 91–108 μm) que ceux de *S. pseudoglobulus* n.sp. du Québec (moyenne 116 ± 5 μm , étendue 103–125 μm). Seul le cirre de *S. pseudoglobulosus* possède un bulbe basal. Il y a aussi chez cette espèce moins de circonvolutions utérines antérieures à l'acétabulum. Des comparaisons de populations des deux espèces à l'âge de 6 jours ont montré plusieurs différences significatives dans la taille moyenne des organes internes. En général, le corps, l'ovaire, les oeufs et la largeur du testicule postérieur étaient plus grands chez *S. pseudoglobulosus*, alors que le pharynx, la longueur du testicule postérieur et le nombre d'oeufs dans l'utérus étaient plus grands chez *S. globulosus*. Il n'y avait pas de différence de taille dans la ventouse orale, l'acétabulum et le testicule antérieur.

[Traduit par la rédaction]

Introduction

Sphaeridiotrema globulus (Rudolphi, 1814) is a cosmopolitan digenean that infects the digestive tract of waterfowl. It causes a severe enteritis that may be fatal to the host. Huffman and Roscoe (1989) and Mucha and Huffman (1991) have studied the pathogenic effects of this fluke in experimentally infected mute swans (*Cygnus olor*), Canada geese (*Branta canadensis*), and mallard ducks (*Anas platyrhynchos*) and have confirmed that this organism is the etiological agent responsible for the pathogenesis reported by earlier authors (e.g., Price 1934; Testi 1962; Francalanci and Manfredini 1969; Campbell and Jackson 1977; Roscoe and Huffman 1982, 1983).

Sphaeridiotrema globulus has recently been implicated in annual late-summer mortality of dabbling ducks (*Anas* spp.) in southwestern Quebec observed by Hoeve and Scott (1988). They reported heavy infections of *S. globulus* in dead ducks

found in late summer and suggested that this parasite might be a factor in recurring annual mortality previously believed to be due to another digenean, *Cyathocotyle bushiensis* Khan, 1962, by Gibson et al. (1972). However, the typical enteritis reported by Huffman and Roscoe (1989) did not occur in ducklings experimentally infected with *Sphaeridiotrema* from southern Quebec (Gagnon 1990; C. Gagnon, unpublished data).

Given the apparent variability in pathogenesis, there is a practical need to distinguish between the different populations of this fluke. This study compares the morphology and morphometrics of adult *Sphaeridiotrema* grown experimentally in domestic ducklings from metacercariae obtained locally near Montréal, Quebec, and from New Jersey, U.S.A. We present data showing that the adults from the two localities can be differentiated on morphological and statistical grounds and that, in fact, two species are known as *S. globulus*. We pro-

TABLE 1. Comparison of the morphometrics of 6-day-old *Sphaeridiotrema* from Quebec and New Jersey sources reared experimentally in domestic ducklings with those of *S. globulus* given by Price (1934)

	<i>Sphaeridiotrema</i>						<i>P</i>	<i>S. globulus</i> (Price 1934)
	Quebec specimens			New Jersey specimens				
	Mean	SD	Range	Mean	SD	Range		
Body								
Length (mm)	1.1	0.1	0.9–1.38	0.9	0.1	0.6–1.2	***	0.68–0.85
Width (mm)	0.78	0.1	0.6–0.95	0.7	0.9	0.5–1.02	*	0.56–0.79
Oral sucker								
Length	138	16	120–182	133	16	96–168	ns	
Width	173	22	125–216	177	18	139–221	ns	150–165 ^a
Pharynx								
Length	96	12	72–120	107	14	81–156	***	90
Width	94	12	67–120	106	18	72–156	***	60–75
Acetabulum								
Length	347	54	240–480	313	78	168–432	ns	260–375
Width	419	34	336–475	421	37	312–480	ns	390–413
Ovary								
Length	140	22	110–197	113	14	86–144	***	
Width	173	27	120–216	136	17	96–182	***	135 ^a
Anterior testis								
Length	218	42	120–288	203	51	120–312	ns	225–387 ^b
Width	279	47	168–360	303	62	192–432	ns	150–320 ^b
Posterior testis								
Length	160	41	96–288	197	48	120–228	**	225–387 ^b
Width	349	42	250–408	297	49	206–408	***	150–320 ^b
No. of eggs per fluke	9	3	5–15	23	10	6–50	***	Up to 60
Eggs <i>in utero</i>								
Length	116	5	103–125	97	4	91–108	***	90–105
Width	71	5	62–84	63	4	53–72	***	60–67
Egg in feces								
Length	126	5	120–136	105	7	96–115	***	
Width	82	2	76–89	73	3	67–84	***	

NOTE: Measurements are given in micrometres unless stated otherwise. Minimum $n = 28$ for Quebec, 27 for New Jersey. One hundred fecal eggs were examined. Comparisons between experimental populations: *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

^aDiameter.

^bAnterior and posterior testes not reported separately.

pose that the specimens from Quebec are identical with those described as *S. globulus* by Szidat (1937) and represent a similar, but heretofore unrecognized, species.

Materials and methods

Metacercariae were obtained from *Bithynia tentaculata* collected from the Rivière du Sud, near Lacolle, Quebec, and from *Goniobasis virginica* collected from Lake Musconetong, New Jersey, referred to hereafter as the Quebec and New Jersey specimens, respectively. The snails from Quebec were crushed, then digested in acid pepsin at 40°C for 15 min. The digest was passed through a 100 µm mesh screen and the residue was searched microscopically for metacercariae. Metacercariae from New Jersey sources were removed from their snail hosts and shipped to Montréal in saline. The Quebec metacercariae were used fresh; those from New Jersey were 7–10 days old.

Domestic ducklings (*Anas platyrhynchos*) were obtained from Brome Lake Duck Farms, Knowlton, Quebec. They were maintained on a diet of unmedicated laying mash (Nutribec Ltd., Montréal) and were provided with food and water *ad libitum*.

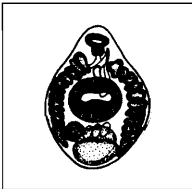

Four 3-week-old ducklings were orally intubated with 80–100 Quebec metacercariae. Four others received similar doses of New Jersey metacercariae. On day 5 postexposure, each duckling was isolated in a wire-bottomed cage for 2 h. Eggs were collected by rinsing the feces through a series of screens (100, 70, and 37 µm). Eggs trapped on the 37 µm mesh screen were fixed in 5% formalin for later

measurement. The ducklings were necropsied on day 6 postexposure. Flukes were removed from the freshly opened intestine and rinsed in saline, and where necessary, pieces of tissue were removed from the acetabulum. Most flukes were flattened under cover-slip pressure. To ensure uniform flattening, a double strip of lens cleaning tissue (Kim-wipes) was placed on either side of the specimen before the cover slip was applied. Specimens were fixed in 5% formalin (24 h), then stored in 70% ethanol. Specimens prepared as whole mounts were stained in acetocarmine. Some specimens were fixed without flattening. Most of these were sectioned at 10 µm and stained in hematoxylin and eosin. The remaining specimens were critical-point dried, coated with gold, and examined on a Hitachi 520 scanning electron microscope to determine the presence of acetabular spines.

Specimens of comparable age from blue-winged teal (*Anas discors*) from another study (Gagnon 1990) were also used, as none of the Quebec specimens in this series had everted cirri. The teal had been exposed to metacercariae from the same locality as the ducklings in this experiment. Additional specimens of different ages from experimentally infected whistling swans and mallards (New Jersey) and blue-winged teal (Quebec) were also studied.

The following museum material was also examined: 10 specimens labelled as syntypes of *S. globulus* from the Berlin Museum (No. 1530); 20 specimens of *S. globulus* from lesser scaup (*Aythya affinis*) (USNM 75388, slide numbers M1286-2 to -5); 2 specimens from a white-winged scoter (*Melanitta fusca*) (USNM 39557) identified by E. W. Price; a single specimen from a whistling (=tundra) swan, *Cygnus columbianus* (USNM 77455); and 10 paratype specimens of

TABLE 2. Variation in body shape and in the arrangement of the ovary and testes in 6-day-old *Sphaeridiotrema pseudoglobulus* from Quebec and 6-day-old *S. globulus* from New Jersey sources reared experimentally in domestic ducklings, showing the percentage of the experimental population exhibiting each body shape or arrangement of ovary and testes

	Body shape		Arrangement of testes (T) and ovary (O)			
			O	O	O	O
			T	T	TT	T T
			T	T		
Quebec	89	11	35	10	24	31
New Jersey	40	60	36	47	15	2

Sphaeridiotrema spinoacetabulum Burns, 1961 from domestic ducklings (USNM 38908) from the United States National Museum.

Measurements were made on a Wild M-20 microscope. Drawings were made with the aid of a Wild drawing tube.

Statistical analyses included *t*-tests, multiple regression, MANOVA, and discriminant analyses. Probabilities <0.05 were considered significant.

Results

Forty-four specimens from Quebec sources and 44 specimens from New Jersey sources were examined and measured. Complete sets of measurements (excluding those of the cirrus sac and cirrus) were obtained from 28 Quebec specimens and 27 New Jersey specimens.

Table 1 summarizes the measurements obtained from both experimental populations. Despite extensive overlap in the size ranges of most structures, significant differences occurred between the mean sizes of all structures but the oral sucker, acetabulum, and anterior testis. The mean lengths and widths of the body, ovary, uterine eggs, and free eggs and the width of the posterior testis were all significantly greater in the Quebec specimens. The mean dimensions of the pharynx, the length of the posterior testis, and the mean number of eggs in the uterus were significantly greater in the New Jersey specimens.

Representative specimens from the Quebec and New Jersey populations are shown in Figs. 1–5. Quebec specimens (Fig. 1) were mostly pyriform and had few uterine coils anterior to the acetabulum. The short cirrus was characterized by a conspicuous bulbous base (Fig. 2). Minute spine-like structures occurred on the acetabulum of several individuals (Figs. 9, 10).

The New Jersey specimens were more variable, ranging from pyriform to oval in shape (Figs. 3, 4). In most specimens, a number of uterine coils lay between the acetabulum and the genital pore. The cirrus of specimens in the experimental population (Fig. 5), although wider at the base than at the tip, lacked the basal bulb seen in the Quebec specimens. No acetabular spines were present on the eight specimens examined by scanning electron microscopy (SEM).

The body shape and positions of the ovary and testes varied extensively in the experimental populations. The percentage of individuals in each population exhibiting a particular shape or gonadal arrangement is given in Table 2.

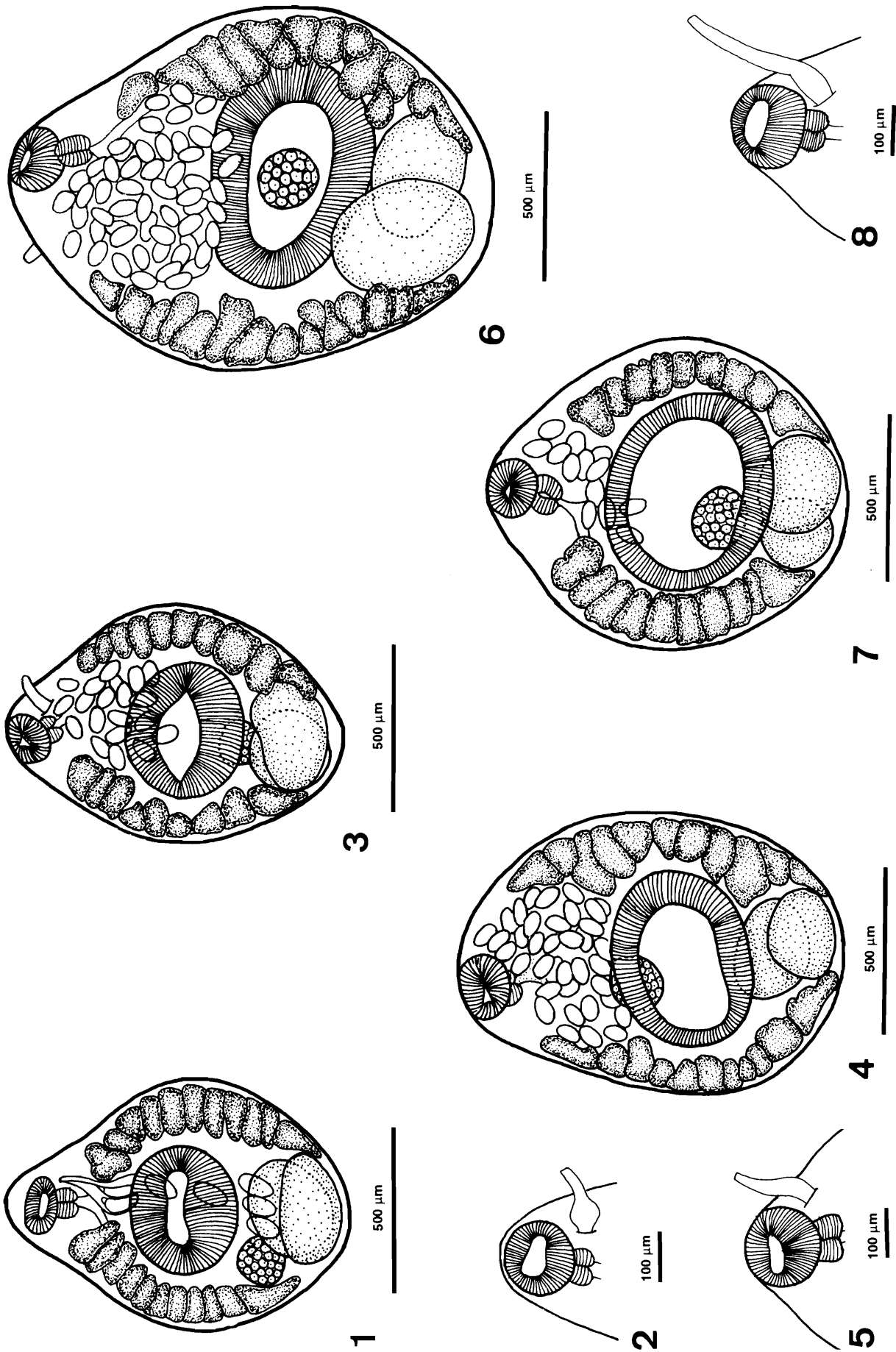
The cirrus sac and cirrus could only be measured in a few specimens and these measurements were not compared statistically. The measurements (given as the range followed by the mean \pm standard deviation in parentheses) of each are as fol-

lows: Quebec specimens: cirrus sac ($n = 10$) 252–384 μm ($307 \pm 43 \mu\text{m}$) long \times 48–84 μm ($69 \pm 11 \mu\text{m}$) wide; cirrus ($n = 7$) 120–149 μm ($136 \pm 12 \mu\text{m}$) long, basal bulb 48–67 μm ($56 \pm 7 \mu\text{m}$) wide, tip 17–27 μm ($22 \pm 4 \mu\text{m}$), distance between bulb and tip 36–72 μm ($53 \pm 14 \mu\text{m}$). New Jersey specimens: cirrus sac ($n = 9$) 225–336 μm ($283 \pm 33 \mu\text{m}$) long \times 38–67 μm ($49 \pm 10 \mu\text{m}$) wide; cirrus ($n = 5$) 115–168 μm ($145 \pm 22 \mu\text{m}$) long, basal portion 44–48 μm ($46 \pm 2 \mu\text{m}$) wide, tip 24–31 μm ($27 \pm 3 \mu\text{m}$).

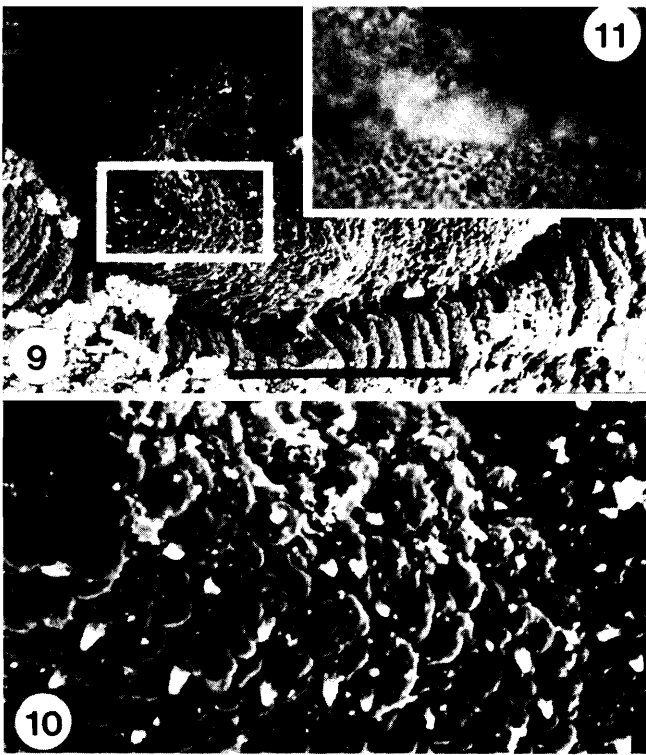
Specimens described by Price (1934) from lesser scaup from Maryland (Figs. 6–8) and those he identified from scoters from Ontario are similar to the New Jersey specimens. The only difference observed was the cirrus length. A cirrus observed in one of Price's specimens (USNM 75388, slide No. M1286-5) was much longer (336 μm long \times 72 μm wide at the base and 34 μm wide at the tip) (Fig. 8) than those observed in the experimental population. A specimen from a whistling swan in New Jersey (USNM 74455), identified by D. E. Roscoe, has a cirrus that is approximately 220 μm . These measurements indicate that the cirrus was not fully everted in the experimentally reared New Jersey specimens.

The type specimens of *S. globulus* were dry when received and had apparently been so for some time. Attempts to rehydrate them using trisodium phosphate (Pritchard and Kruse 1982) were unsuccessful. No internal details were visible in the 10 specimens examined. Some of the specimens collapsed under cover-slip pressure during mounting and several eggs were observed. These measured 80–96 \times 52–65 μm (mean 88 \times 57 μm). One specimen was prepared for SEM, but it was impossible to determine whether spines or spine-like structures were present.

Variables that differed significantly between the two groups (Table 1) were subjected to stepwise multiple regression. Two variables, egg number and the dimensions of the eggs collected from the feces, were not included. Six variables, body length, body width, pharynx width, and the lengths of the ovary, posterior testis, and the uterine eggs accounted for most of the variability ($R^2 = 0.94$) and these were retained for further analysis. MANOVA performed on the reduced data set revealed that the mean vectors of the two groups were significantly different (Wilks' $\lambda = 0.044$, $F_{1,421} = 127.85$, $P < 0.0001$), indicating that the two populations can be separated statistically using these variables. Subsequent discriminant function analysis revealed that egg length was the most important variable for separating the two groups. Egg length (Fig. 12) accounted for most of the variability between the samples (Wilks' $\lambda = 0.1330$), and 96% of the specimens in the sample



FIGS. 1 and 2. *Sphaeridiotrema pseudoglobulus* n.sp. from Quebec. Fig. 1. Holotype; 6-day-old specimen from an experimentally infected domestic duckling, ventral view. Fig. 2. Cirrus of a specimen from an experimentally infected blue-winged teal. FIGS. 3–5. *Sphaeridiotrema globulus* obtained from an experimentally infected domestic duckling from New Jersey. FIGS. 3 and 4. Typical 6-day-old specimens, ventral view. Fig. 5. Cirrus. FIGS. 6–8. *Sphaeridiotrema globulus* from lesser scaup from Maryland (USNM 75388). Fig. 6. Gravid specimen (USNM 75388 slide No. M 1286-1), dorsal view. Fig. 7. Gravid specimen (USNM 75388 slide No. M 1286-3), ventral view. Fig. 8. Cirrus (USNM 75388 slide No. M 1286-5).



FIGS. 9 and 10. Scanning electron micrographs of *Sphaeridiotrema pseudoglobulus* n.sp. Fig. 9. Paratype; acetabulum, showing minute spines. Scale bar = 50 μm . Fig. 10. Enlargement of portion of Fig. 9, showing spines. Scale bar = 250 μm . FIG. 11. Scanning electron micrograph of *Sphaeridiotrema spinoacetabulum* paratype (USNM 38908). Acetabulum, showing triangular spine-like structures around the edge. Scale bar = 10 μm .

could be correctly classified on this characteristic alone. Two specimens were misclassified among the 55 included in the original analysis. One Quebec specimen with eggs 103 μm long and one New Jersey specimen with eggs 108 μm long were classified incorrectly. When ovary length was included in the analysis, Wilks' λ decreased to 0.0661; however, the percentage of correct classifications did not improve significantly (McNemar's test; $P > 0.05$).

The analysis was repeated using an expanded data base that included egg measurements from those specimens from the original data set not included in the original discriminant function analysis, along with specimens of different ages and from different host species obtained in other experiments and from the museum specimens listed above. This increased the sample size to 217. An additional 10 cases were classified incorrectly. One Quebec specimen (eggs 101 μm long) and nine New Jersey specimens (one each from an experimentally exposed wild-stock mallard, a domestic duck, and a scoter (USNM 39557) and six specimens from scaup (USNM 75388)) were classified incorrectly. All but one (113 μm) had a maximum egg length of 108 μm and all but two specimens resembled those shown in Figs. 6 and 7. Those that differed (108 and 113 μm) each had one egg in the uterus. The eggs from the type specimens were classified in the same group as those from the New Jersey specimens.

Discussion

Host species, parasite age, and fixation techniques are known to affect the morphology and morphometrics of flukes. Despite controlling for these factors, consistent morphometric and

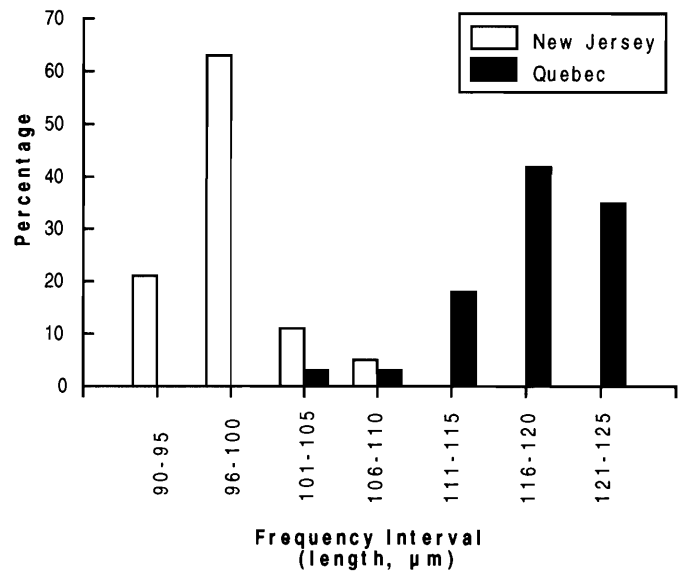


FIG. 12. Lengths of uterine eggs from 6-day-old specimens of *Sphaeridiotrema pseudoglobulus* n.sp. from Quebec compared with lengths of those from *S. globulus* from New Jersey reared experimentally in domestic ducklings.

morphological differences were observed between populations of *Sphaeridiotrema* reared from the Quebec and New Jersey sources. Specimens from the two sources can be distinguished most readily on the basis of egg length. Where the egg lengths overlap (100–110 μm), uterine and cirrus characteristics reliably separate most specimens. As egg dimensions are neither subject to host-induced variation (Watertor 1967; Kinsella 1971; Blankespoor 1974) nor influenced by fluke age (Thomas 1965; Blankespoor 1974; Kinsella 1971), they provide a reliable and easily obtained means for rapid identification in this instance.

As observed by Price (1934) and Burns (1961), the early descriptions of *S. globulus* are incomplete and are insufficient for specific diagnosis. The earliest measurements available for *S. globulus* are in the brief descriptions by Braun (1902) and Odhner (1913). Price (1934) provided an extensive set of measurements but no illustrations; Szidat (1937) provided a detailed illustration but few measurements. Parenthetically, it is a copy of Szidat's specimen that is shown in Yamaguti (1971; Fig. 1248), not one from Odhner (1913) as stated.

Comparison of the measurements from each experimental population with those given by Price (1934) (Table 1) reveals that either could be identified with his material if egg size is disregarded. It is unfortunate that Price (1934) did not provide an illustration of his material because reexamination of his specimens has revealed that they differ morphologically from those described by Szidat (1937). As presently conceived, *S. globulus* is a composite species based partly on the descriptions in Price (1934) and Szidat (1937). Information from both sources has been used for identification purposes (e.g., Hoeve and Scott 1988) and by authors defining new species of *Sphaeridiotrema* (Burns 1961; Diaz 1980). The New Jersey specimens are identical with those described by Price (1934); the Quebec specimens are identical with those described by Szidat (1937). The question thus becomes which species, if either, is *S. globulus* and what is the identity of the other?

Braun (1902) provided a brief description of *S. globulus* based, in part, on the type specimens. Braun (1902) reported that the eggs were 104 μm long. The egg lengths recorded

from the syntypes examined in this study approximate the length reported by Braun (1902) and, if shrinkage due to drying is taken into account, lie well within the range reported by Price (1934) and established for the New Jersey specimens. Braun (1902) also provided drawings of the cirrus. The cirrus is wider at the base than at the tip but lacks a conspicuous bulbous base. It thus resembles the cirrus seen in the New Jersey material and in Price's specimens. The similarity in egg size and cirrus structure strongly suggests that the specimens described by Price (1934) and the New Jersey specimens represent the original *S. globulus*.

Price (1934) was the first to implicate *S. globulus* as a pathogen of waterfowl. This was confirmed experimentally (Huffman and Roscoe 1989), and other reports of pathogenesis due to intestinal infections with *S. globulus* seem to involve this species. Where egg measurements of specimens associated with intestinal enteritis were reported (Testi 1962; Francalanci and Manfredini 1969; Campbell and Jackson 1977), all fell within the range characteristic of this species.

Although Szidat (1937) was aware of the pathogenesis reported by Price (1934), he did not observe enteritis in ducklings he infected. Gagnon (1990) found lesions consisting of small denuded patches surrounded by enlarged microvilli, and vascular leakage, at sites where flukes were attached, but no evidence of hemorrhage or severe tissue damage in either domestic ducklings or blue-winged teal infected with metacercariae from Quebec sources. *Sphaeridiotrema* infections of the magnitude used by Gagnon (1990) (1–29 worms in domestic ducks; 47–89 worms in blue-winged teal) appear insufficient to cause serious pathogenesis in these hosts. The intensity of *Sphaeridiotrema* infections in ducks found dead (Hoeve and Scott 1988) is two orders of magnitude higher than that used by Gagnon (1990). This suggests that heavy infections of the Quebec form may indeed be fatal; however, the actual cause of the mortality is unknown. Hemorrhage and enteritis did occur in five domestic ducklings infected with 18–46 *Sphaeridiotrema* from New Jersey sources (unpublished data). The fact that there are two species known as *S. globulus* could account for the apparent discrepancies in the pathogenesis associated with this helminth.

The Quebec specimens (= *Sphaeridiotrema globulus* sensu Szidat 1937) do not resemble any of the species currently recognized in *Sphaeridiotrema*, and represent an undescribed species. A formal description is provided below.

Sphaeridiotrema pseudoglobulus n.sp.

Figs. 1, 2, 9, and 10 and Table 1 (under "Quebec specimens")

Synonym: *Sphaeridiotrema globulus* of Szidat, 1937 *nec Rudolphi*, 1814

Diagnosis

Psilostomidae Looss, 1900; Sphaeridiotrematinae Yamaguti, 1958. Description based on 44 whole mounts, 10 serially sectioned specimens, and 18 specimens prepared for SEM from experimentally infected domestic ducklings, and 7 specimens from experimentally infected blue-winged teal (cirri). All measurements are in micrometres (μm) unless specified otherwise. Measurements presented are the range, with the mean in parentheses. Standard deviations are provided in Table 1.

Body (Fig. 1) pyriform to oval, 0.9–1.38 (1.1) mm long \times 0.6–0.95 (0.78) mm wide; thick, globular in unflattened state. Body spines not observed. Oral sucker subterminal, oval, 120–182 (138) \times 125–216 (173). Acetabulum 240–480 (347) \times 366–475 (419), transversely oval, equatorial,

twice as large as the oral sucker and with minute spine-like structures present on rim (Figs. 9, 10). Spines usually unobservable by light microscopy but readily observed using SEM. Prepharynx present but generally only visible in sagittal sections. Pharynx muscular, 72–120 (96) long \times 67–120 (94) wide. Esophagus short. Ceca extending to posterior limits of vitellaria. Genital pore ventral, sinistral, pre-bifurcal, situated at level of pharynx near posterior margin of oral sucker. Cirrus (Fig. 2) aspinous, 120–149 (136) long, with bulbous base 48–67 (56) wide and narrower tubular portion (36–72 (53) long \times 17–27 (22) wide. Cirrus sac club-shaped, 252–384 (307) \times 45–84 (69), may extend posteriorly as far as the anterior margin of the acetabulum or slightly beyond. Seminal vesicle present. Testes spherical to oval, subequal, situated posterior to acetabulum. Testes median, overlapping anterior to posterior in half of the specimens and laterally in the rest. Anterior testis 120–288 (218) \times 168–360 (279), dorsal, oval to suboval; posterior testis 96–288 (160) \times 250–408 (349), usually much wider than long. Ovary 110–197 (140) \times 120–216 (173), spherical to oval, dorsal, median in 41% of the specimens, submedian in the rest, usually overlapping anterior testis. Mehlis' gland present. Laurer's canal not observed. Seminal receptacle not observed. Vitelline follicles large, extending in lateral bands from level of pharynx to, but not beyond, posterior testis. Vitellaria enclose ceca along most of their length. Uterus with few coils posteriorly, generally straight from level of acetabulum to genital pore. Distal portion of uterus modified as a metraterm. Eggs few, 5–15 (9), 103–125 (116) \times 62–84 (71).

Taxonomic summary

TYPE HOST: *Anas platyrhynchos*, domestic form.

SITE: Intestine.

TYPE LOCALITY: Rivière du Sud, Quebec, Canada.

OTHER HOSTS: Natural infections (reported as *S. globulus*) in *Aix sponsa*, *Aythya collaris*, and several *Anas* species in southwestern Quebec (Hoeve and Scott 1988). Gagnon (1990) infected *Anas discors* experimentally with metacercariae from *Bithynia tentaculata*.

OTHER LOCALITIES: Local marshes near Montréal and Lac Saint-Pierre, Quebec, Canada; Kurischer Haff, Germany (Szidat 1937).

SPECIMENS: *Sphaeridiotrema pseudoglobulus*. National Parasite Collection, Canadian Museum of Nature (CMNP), Ottawa, Ontario, Canada K1V 7P1. Holotype: CMNP1992-0030; 6-day-old specimen from experimentally infected *A. platyrhynchos*. Paratypes: $n = 10$, CMNP1992-0031 and the Helminthological Collection, United States National Museum, U.S. Department of Agriculture, Beltsville, Maryland (USNM), $n = 5$, USNM 82575. Additional specimens from experimentally infected *Anas discors* showing cirrus ($n = 2$), CMNP1992-0032, 0033. *Sphaeridiotrema globulus*. Voucher specimens (6 days old, from experimentally infected *A. platyrhynchos*), $n = 6$, CMNP1992-0034; $n = 6$, USNM 82576. The type specimens of *S. globulus* (dry specimens, 7 slides and 1 SEM stub) were returned to Berlin.

Remarks

Four species, *Sphaeridiotrema spinoacetabulum* Burns, 1961, *Sphaeridiotrema macrocotyla* (Macy and Bell, 1968), *Sphaeridiotrema newmillerdamensis* Diaz, 1980, and *Sphaeridiotrema monorchis* Lin and Chen, 1983 are currently known from birds.

Sphaeridiotrema spinoacetabulum, described from experimentally infected domestic ducks, is a pathogenic species that

infects the ceca rather than the intestine. Burns (1961) separated *S. spinoacetabulum* from *S. globulus* on the basis of adult morphology (as described by Price 1934) and the morphology of the cercariae (as described by Szidat 1937). There is extensive overlap between the measurements reported for *S. spinoacetabulum* and for *S. pseudoglobulus*. However, despite the fact that the specimens were also from domestic ducklings and were slightly older, the maximum dimensions of most structures in *S. spinoacetabulum* either approximated or were less than the mean size found in the new species. Minute spine-like structures occurred on the acetabulum of *S. pseudoglobulus* (Figs. 9, 10); however, these are not comparable to the triangular plate-like spines on *S. spinoacetabulum* (Fig. 11). The differences in the acetabular spines, the generally smaller organ sizes, and the differences in location and pathogenesis of flukes in domestic ducklings, along with the differences reported in the life cycle stages (Burns 1961), are sufficient to separate the two species.

Sphaeridiotrema newmillerdamensis was described from experimentally infected ducks and canaries (Diaz 1980). The oral sucker and acetabulum are approximately the same size and both the anterior part of the body and the margins of the acetabulum are densely spinous. Neither condition occurs in *S. pseudoglobulus*. The maximum dimensions of the acetabulum, ovary, cirrus sac, and testes in *S. newmillerdamensis* do not exceed 100 μm and are much smaller than those in *S. pseudoglobulus*. Normally, only a single egg is present in the uterus of *S. newmillerdamensis* and the eggs (79–83 \times 57–60) are much smaller than those of *S. pseudoglobulus*. Kanev and Vassilev (1984) included *S. newmillerdamensis* as a synonym of *S. globulus*. In view of the small size of the reproductive organs and the differences observed in body spination compared with that of the specimens of *S. globulus* described here, it is apparent that this synonymy should be rejected.

Macy and Bell (1968) erected the genus *Astacatremulata* for the species *macrocotyla*, separating it from *Sphaeridiotrema* by the presence of a larger, sac-like acetabulum, a genital pore located posterior to the intestinal bifurcation, a bipartite cirrus sac, testes arranged obliquely rather than tandemly, and a median ovary located laterally to the anterior testis. In addition, the metacercariae encyst on substrates external to the snail host and are not infective to ducklings (Macy and Bell 1968). The differences in the life cycle alone are sufficient to distinguish *S. macrocotyla* from the other species of the genus, and the validity of its inclusion in *Sphaeridiotrema* by Yamaguti (1971) is questionable.

Sphaeridiotrema monorchis has a single testis, according to Lin and Chen (1983), and is readily distinguishable from *S. pseudoglobulus* on this basis.

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