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Salsuginus yutanensis n. sp. (Monogenea: Ancyrocephalidae) from *Fundulus sciadicus* in Clear Creek of Eastern Nebraska

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SALSUGINUS YUTANENSIS N. SP. (MONOGENEA: ANCYROCEPHALIDAE) FROM *FUNDULUS SCIADICUS* IN CLEAR CREEK OF EASTERN NEBRASKA

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ABSTRACT *Salsuginus yutanensis* n. sp. (Monogenea: Ancyrocephalidae) is described from the gills of the plains topminnow, *Fundulus sciadicus* Cope, from Clear Creek in eastern Nebraska. *Salsuginus yutanensis* is distinguished from previously described species by having a shorter accessory piece and different hamulus proportions, especially in the relative lengths of deep and superficial roots. In addition, the angles between deep and superficial roots distinguish *S. yutanensis* from several congeners.

Previous studies have concerned the ecology of parasites of *Fundulus zebrinus* in Nebraska (Knight et al., 1980; Adams, 1986; Janovy and Hardin, 1988; Janovy et al., 1990). Ecological work has now been extended, in part, to another fish species, *Fundulus sciadicus* Cope, the plains topminnow, which occurs in disjunct populations occupying habitats quite different from those of *F. zebrinus.* An ancyrocephalid gill monogenean on *F. sciadicus* evidently is not the same species as that on *F. zebrinus,* and consequently it is described in the present paper.

MATERIALS AND METHODS

Fish were collected from backwater of 3 clear, spring-fed streams in Nebraska: Clear Creek, 5 km south and 3.3 km east of Yutan, Saunders County, Nebraska; Bull Ditch, 1.9 km north, and Cedar Creek, 3.2 km north, of Paxton, Keith County, Nebraska. Sixty fish ranging from 38 to 63 mm long and collected in July 1988 were examined. Gills were excised and placed in 1% chloral hydrate for up to 1 hr. Worms were removed with insect pin probes, fixed in alcohol–formalin–acetic acid, washed in 70% ethanol, and either cleared, and temporarily mounted in glycerin; cleared in glycerin and mounted in glycerin jelly; stained in acetocarmine or hemotoxylin, dehydrated, cleared in xylene, and mounted in Canada balsam; or dehydrated, cleared in xylene, and mounted in Canada balsam. Ninety-five specimens were studied, 45 of which were mounted temporarily in glycerin for measurement of sclerotized parts.

Measurements were taken according to the protocols of Murith and Beverley-Burton (1985). To assess morphological differences between dorsal and ventral hamuli of the same species and hamuli of various species, ratios, consisting of *d/c* and *x/y* (Janovy et al., 1989), and angle between deep and superficial roots were determined. Measurements are given in micrometers as means with ranges, standard deviation, and number of measurements in parentheses. Angles between superficial and deep roots of previously described species were determined from published figures. Drawings in Figures 1–7 were made with the aid of a camera lucida. A series of 1-way ANOVAs was performed to assess variation of measurements, ratios, and angles within and among collecting sites.

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DESCRIPTION

Salsuginus yutanensis

(Figs. 1–7)

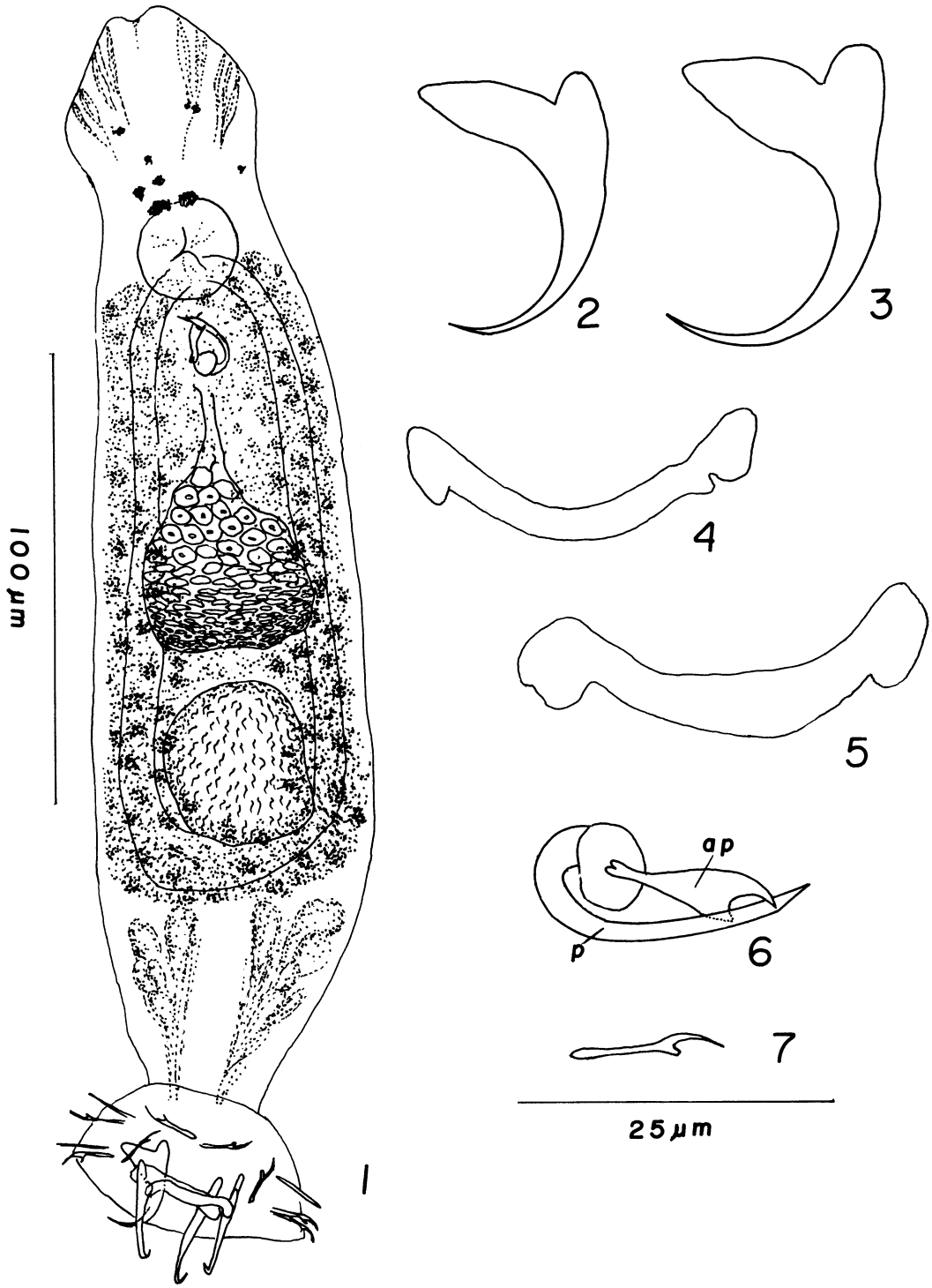
Diagnosis: Ancyrocephalidae with characters of the genus *Salsuginus* as defined by Murith and Beverley-Burton (1985). Body 309 (173–418, 54.9, 45) long by 84 (47–153, 23.3, 45) in maximum width (midbody); haptor 37 (25–52, 6.6, 45) long by 54 (30–75, 11.1, 45) wide; pharynx 30 (23–37, 4.1, 45) in transverse diameter. Both hamuli with long, thin curved blade and superficial root larger than deep root (Figs. 2, 3). Dorsal (Fig. 2) and ventral (Fig. 3) hamuli similar in shape, except that angle between deep and superficial root smaller in the dorsal hamuli than in the ventral. Standard hamular measurements (see Murith and Beverley-Burton, 1985): Dorsal a = 18 (16–20, 1.3, 45), b = 17 (15–19, 1.0, 45), c = 3 (2–5, 0.6, 45), d = 8 (6–9, 0.6, 45), e = 6 (5–7, 0.6, 45), x = 10 (8–11, 0.7, 45), y = 9 (8–10, 0.85, 45), d/c ratio mean (standard deviation, n) = 2.3 (0.4, 45), x/y ratio = 1.1 (0.1, 45); ventral a = 22 (20–24, 1.0, 45), b = 21 (19–23, 1.0, 45), c = 3 (2–4, 0.4, 45), d (7–11, 0.9, 45), e = 7 (5–8, 0.5, 45), x = 12 (11–13, 0.6, 45), y = 11 (9–12, 0.8, 45), d/c ratio = 3.3 (0.5, 45), x/y ratio = 1.1 (0.01, 45). Dorsal bar 22 (20–27, 2.0, 45) long by 3 (2–4, 0.3, 45) wide. Ventral bar 25 (22–30, 2.2, 45) long by 4 (3–5, 0.5, 45) wide. Larval hooks 12 (11–13, 0.3, 45). Penis tubular, 17 (15–19, 1.2, 43) long (straight line base to tip), distal aperture 2 (1–3, 0.1, 43) wide. Accessory piece 13 (12–14, 1.1, 43) long, terminal end with pointed branches distally and 2 small lobes proximally (Fig. 6).

Taxonomic summary

Type host: *Fundulus sciadicus* Cope, 1885, the plains topminnow.

Type locality: U.S.A., Nebraska, Saunders County, Clear Creek, 5 km south and 3.3 km east of Yutan.

Specimens deposited: One holotype (USNM No.



FIGURES 1–7. *Salsuginus yutanensis* n. sp. **1.** Whole worm, ventral view. **2.** Dorsal hamulus. **3.** Ventral hamulus. **4.** Dorsal bar. **5.** Ventral bar. **6.** Male copulatory structures. **7.** Larval hook. ap, accessory piece; p, penis.

81115) and 24 paratypes (USNM No. 81116) in the United States National Museum Helminthological Collection, Beltsville, Maryland. Twenty-five paratypes (UNSM No. 33103) in the H. W. Manter Laboratory, University of Nebraska State Museum, Lincoln, Nebraska.

Etymology: The name *yutanensis* refers to the village, Yutan, near the type locality.

Remarks

Salsuginus yutanensis is similar to *Salsuginus thalkeni* Janovy, Ruhnke, and Wheeler, 1989, *Salsuginus angularis* (Mueller, 1934) Beverley-Burton, 1984, *Salsuginus spirae* (Williams, 1980) Murith and Beverley-Burton, 1985, *Salsuginus bermudae* Rand and Wiles, 1987, *Salsuginus bahamianus* (Hanek and Fernando, 1972) Murith and Beverley-Burton, 1985, *Salsuginus seculus* (Mizelle and Arcadi, 1945) Murith and Beverley-Burton, 1985, and *Salsuginus heterocliti* Murith and Beverley-Burton, 1985, in having dorsal hamuli smaller than ventral ones, and different from *Salsuginus umbraensis* (Mizelle, 1938) Murith and Beverley-Burton, 1985, and *Salsuginus fundulus* (Mizelle, 1940) Beverley-Burton, 1984, in which dorsal and ventral hamuli are approximately the same size. *Salsuginus yutanensis* differs from *S. angularis* and *S. heterocliti* in having proportionally shorter superficial roots in dorsal and ventral hamuli (d/c = 2.3 and 3.3 vs. 3.3 and 4.3 and 3.3 and 4.0, respectively), and from *S. seculus* in having proportionally shorter superficial roots in the dorsal hamuli (d/c = 3.3 vs. 5.0).

The new species differs from *S. seculus, S. spirae,* and *S. bahamianus* in having dorsal hamuli that are proportionally wider (dorsal x/y = 1.1 vs. 0.7, 0.7, and 0.8, respectively), and it differs from *S. bermudae* in having wider ventral hamuli than dorsal hamuli. *Salsuginus yutanensis* hamuli are dimorphic in that their sizes are significantly different and their d/c ratio is larger for the ventral hamuli (3.3 vs. 2.3) than for dorsal.

The angles formed by the deep and superficial roots consistently are greater in the ventral hamuli of *S. yutanensis* than in the dorsal hamuli, although ranges overlap (62–83° and 53–73°). This feature is in contrast to *S. thalkeni* and *S. fundulus,* in which the dorsal d/c angle is greater, and to *S. spirae* in which the ventral d/c angle is very much greater than the dorsal.

The accessory piece of the male copulatory apparatus has less pronounced proximal lobes than are observed for most of the other species. The accessory piece is also considerably shorter in this species than in all others except *S. fundulus* and perhaps *S. seculus.* The ranges of accessory piece measurements from all sites did not overlap those of *S. thalkeni.* As is common for this genus, the structure of the dorsal and ventral bars is quite variable in the extent of curvature and depth and position of grooves.

Analysis of variance revealed that there is considerable site-related variation in many of the morphometric characters. For example, hamulus length (a and b) varied significantly among 3 collection sites distributed over a 500-km distance, although all ranges overlapped broadly. However, shape of dorsal and ventral hamuli, as determined by ratios and root angles, and the relationship between dorsal and ventral hamuli generally were more constant despite variations in size.

DISCUSSION

Salsuginus systematics has relied heavily on sizes of hamuli and shapes of the accessory piece (Mizelle and Arcadi, 1945; Murith and Beverley-Burton, 1985; Rand and Wiles, 1987). In response to concerns of Rand and Wiles (1987), Janovy et al. (1989) suggested that ratios, angles, and meta-measurements be used to better assess morphological similarities and differences among the *Salsuginus* species. Rand and Wiles (1987) determined that 2 morphotypes of *S. bermudae* collected from *Fundulus bermudae* in 2 lakes could be distinguished using differences in accessory piece structure. They suggested that the different accessory pieces reflected environmental differences between lakes rather than biological speciation of the parasite groups. Worms collected from the gills of *F. sciadicus* from 3 sites in Nebraska in July 1988 showed extensive morphometric variation. However, use of other criteria such as ratios indicates that although sizes of sclerotized parts vary from site to site, proportions within and between dorsal and ventral hamuli are relatively constant. We suggest these variations are attributable to the influence of environmental conditions on development.

In general, the habitats of the 2 Nebraska *Fundulus* species do not overlap. *Fundulus zebrinus* occurs through the Platte River main stream, whereas *F. sciadicus* occurs in relatively isolated populations almost wholly restricted to ditches and small oxbows of spring-fed streams. Furthermore, the 2 species differ in feeding habits, *F. zebrinus* being a bottom feeder and *F. sciadicus* a top feeder. In addition, there is evidence that the 2 host species are not particularly closely related, and in fact, some authors consider *F. zebrinus* a member of a monotypic genus *Plancterus* (see Wiley [1986] for analysis of this problem). Thus there is no a priori reason to suspect that the *Salsuginus* species of the 2 Nebraska species of the genus *Fundulus* are the same, if Murith and Beverley-Burton (1985) are correct in their conclusions about host specificity in this genus of worms.

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