

Sexual Dimorphism in Anal Fin of Brown Trout, *Salmo trutta*, and Close Relatives

In morphological studies on Salmonidae we observed an apparently undescribed type of sexual dimorphism in brown trout, *Salmo trutta*, and two closely related species. Sexual dimorphism is well marked in adults of many salmonid species, and especially in *Salmo* (Tchernavin, 1938; Vladykov, 1963; Morton, 1965; Breder and Rosen, 1966). However, in *Salmo* most manifestations of dimorphism are temporary and occur during the spawning season (Vladykov, 1931; Stoklosowa, 1966); others require morphometric studies to separate the sexes (Berg, 1948).

In brown trout and two close relatives we found that, through most of the life history, the anal fin was of two distinct shapes: falcate or notched in females and rounded or convex in males (Fig. 1). This character is externally visible, present on specimens collected at all times of the year, and evident on small fish. We examined many salmonid species and found anal fin dimorphism only in forms of brown trout, in Sevan trout, *Salmo ischchan*, and in Ohrid trout, *S. letnica* (Table I). We studied three specimens of Lake Garda trout,

TABLE I. Species of *Salmo* in which dimorphism of the anal fin was found adequate for determining the sex of specimens. All determinations were confirmed by inspection of the gonads. FL = fork length.

Species	Males		Females	
	No. of specimens	Range in FL (mm)	No. of specimens	Range in FL (mm)
Brown trout, <i>S. trutta trutta</i> Linnaeus	8	45-312	30	51-284
<i>S. trutta labrax</i> Pallas	2	113-222	12	100-265
<i>S. t. macrostigma</i> (Dumeril)	1	184	2	195-220
Sevan trout, <i>S. ischchan</i> Kessler	6	342-386	5	380-393
Ohrid trout, <i>S. letnica</i> (Karaman)	10	56-185	6	49-175

S. carpio, and found that the anal fin was falcate; examination of the gonads confirmed that the fish were females. No male specimens were available for study.

To test the dimorphism we separated the "males" and "females" on the basis of the anal fin and then examined the gonads to check the accuracy of the prediction. All specimens of brown, Sevan, Ohrid, and Lake Garda trout that we examined were correctly sexed by means of the anal fin.

We measured the lengths of the branched anal rays to determine which rays were responsible for the dimorphism. In brown and Sevan trout, the

depth of the notch (distance from the tip of the shortest branched ray to a line joining the tips of the longest anterior and posterior branched rays) in the female anal fin was compared with the horizontal diameter of the eye. These studies indicated that the notch in the female anal fin is caused by a greater difference in length between the intermediate (5 and 6) and the anterior and posterior branched anal rays in females than in males. In Sevan and brown trout the depth of the notch in females is $\frac{1}{6}$ (17%) of the horizontal diameter of the eye.

Although measurements of the branched anal rays and the notch verified the dimorphic nature of the anal fin, illustrations readily demonstrate that, in practice, measurements are unnecessary. The dimorphism is obvious in fishes over 150 mm fork length (Fig. 1, 2). In smaller specimens the dimorphism is not as distinct as in the larger fishes, but it is still evident (Fig. 3).

Sexual dimorphism of a similar nature has been reported in the anal fin of Hiodontidae (Kerswill, MS, 1937, p. 33; Hinks, 1943, p. 20). In this family however, the anal fin of the male is falcate and the distal margin of the anal fin in females is relatively straight; this is the opposite of the situation in the brown trout complex.

The existence of sexual dimorphism in the brown trout complex may have some systematic significance, especially in the problematical relationships of the Ohrid (Stankovič, 1960), the Sevan (Berg, 1948), and possibly the Lake Garda trout (D'Ancona and Merlo, 1958) to the brown trout. Moreover, sexual dimorphism is of great practical value in hatcheries, genetic studies, tagging operations, and other work. Valuable museum specimens can be readily sexed without mutilation.

Specimens of brown trout used in this study are from various locations in Europe and Canada; the Sevan trout are from Lake Sevan, USSR. Our specimens of Ohrid trout were raised in a fish hatchery in Minnesota, from eggs received from Lake Ohrid on the Yugoslavian-Albanian border.

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(FIG. 1-3 and REFERENCES on following pages)

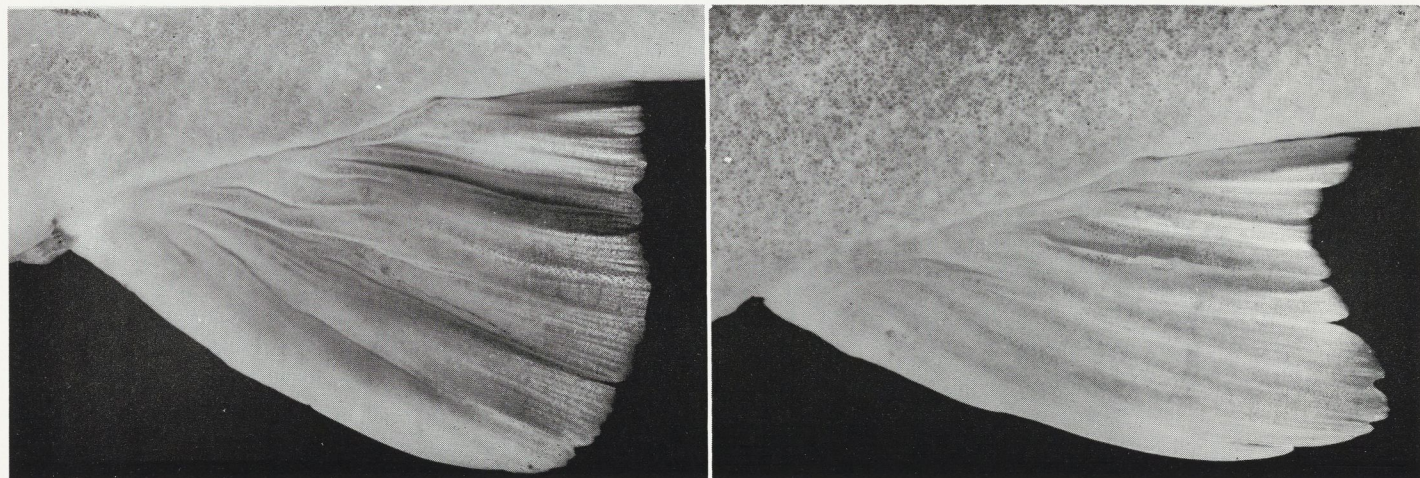


FIG. 1. Sexual dimorphism in anal fins of brown trout, *Salmo trutta*; left: male, 210 mm FL, anal fin length 26.5 mm; right, female, 213 mm FL, anal fin length 26 mm.



FIG. 2. Specimens of Sevan trout, *Salmo ischchan*, showing anal fin dimorphism; *above*, male, 342 mm FL; *below*, female, 380 mm FL.

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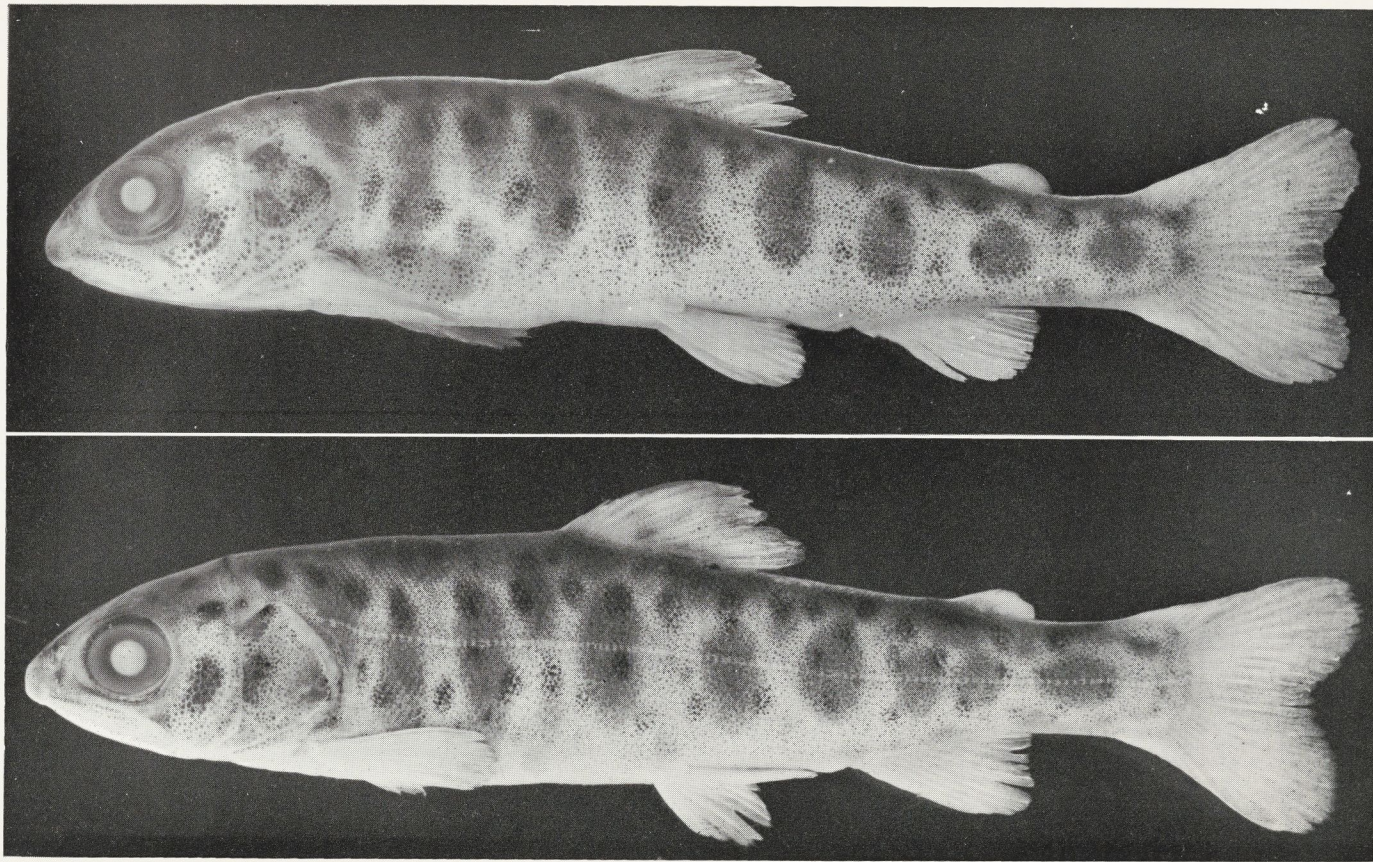
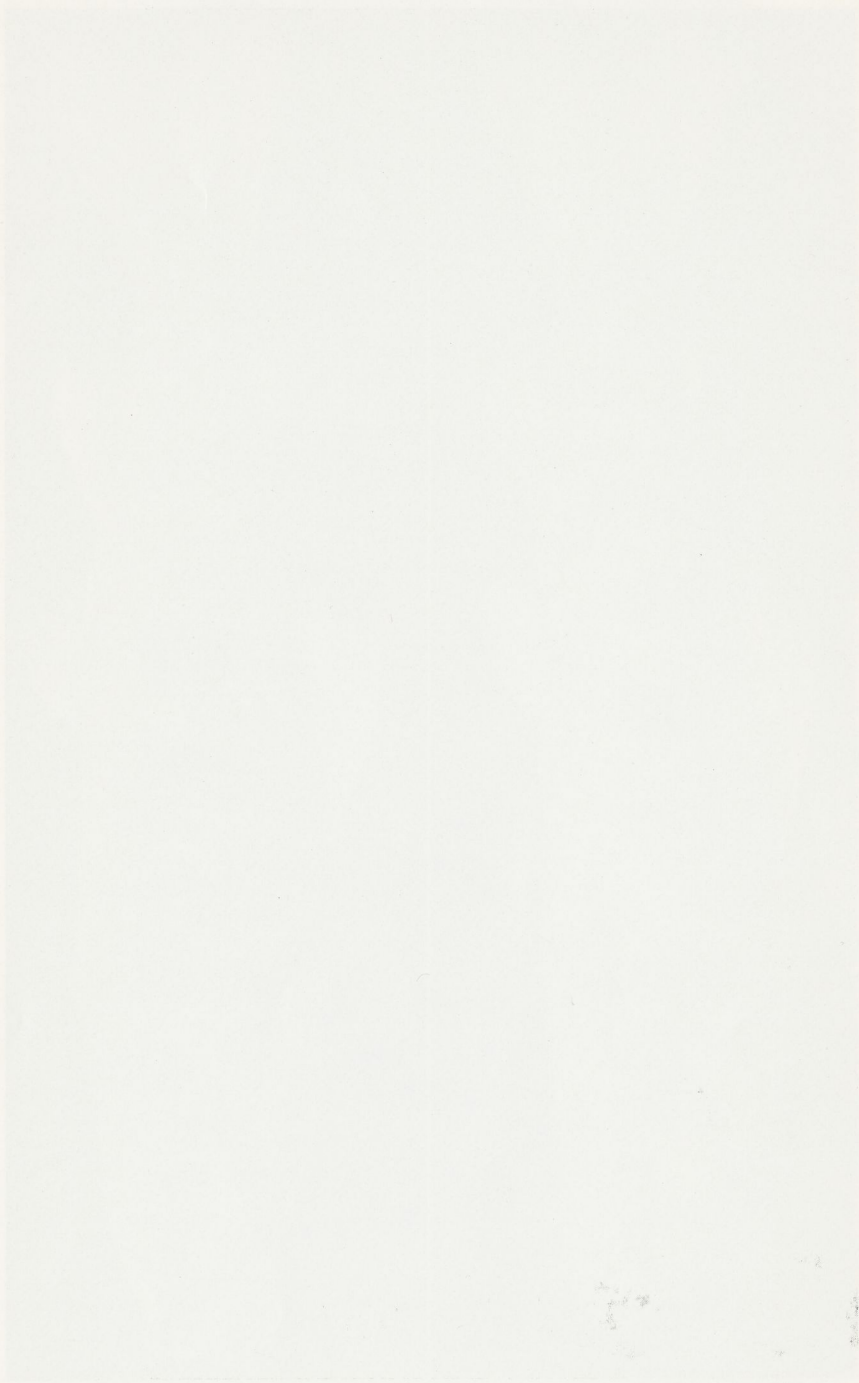


FIG. 3. Small specimens of Ohrid trout, *Salmo letnica*; the dimorphism is not as distinct as in large specimens but is still present; *above*, male, 57 mm FL; *below*, female, 60 mm FL.



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