

GEOGRAPHICAL VARIATION OF *NOTEMIGONUS*
CRYSOLEUCAS—AN AMERICAN MINNOW

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The golden shiner is one of the most distinctive and best known of all the American minnows. It is usually abundant in sluggish streams and weedy ponds from New Brunswick, Ontario and North Dakota southward to Florida and Texas. Under favorable conditions it reaches a length of about one foot, and a weight of about a pound and a half, but in small ponds it is more or less dwarfed, breeding at the age of one or two years. Thus in the San Diego River of California, which is reduced during the dry season to a chain of small disconnected pools, the golden shiner, although it has become abundant since its introduction, is so greatly dwarfed that the largest adults I was able to obtain are scarcely more than three inches long to the base of the caudal fin. Most of these fishes in the San Diego River become mature at the end of their first year, and do not acquire, or acquire only in part, the peculiarly deep body which is characteristic of the adult as usually found in its native waters¹. I have also examined mature dwarfed examples from Texas, Iowa and Ohio, but these specimens, although small, have usually acquired the deep form of the larger adults. This dwarfing is one instance of the great adaptability of the golden shiner.

Excluding a doubtful form, *Notemigonus crysoleucas* is the only species in its genus. It has been recognized,² however that the species is divisible into two intergrading subspecies: *crysoleucas* proper, from the greater part of the wide range of the species, and *boscai*, from the South Atlantic States and Florida. The variations and inter-relationships of these two subspecies, in the different parts of their range, form the main theme of the present paper.

¹In discussing *Semotilus bullaris*, Dr. Kendall has recently stated (Bull. Bur. Fish., 35, 1918, p. 511): "Small adult fish resemble young of the larger fish, being silvery and having a dark stripe along the side". Similar neotenic relations, as is well known, prevail in the Salmonidae.

²First by Jordan and Meek (Proc. U. S. Nat. Mus., 8, 1885, p. 15).

According to current descriptions, *boscii* differs from *crysoleucas* in the larger scales; in the brighter colors of the breeding male, ad in the greater length of the anal fin. The variation to which these characters are subject has been studied in some detail.

1. *The Size of the Scales*

In 56 counts of the number of transverse rows of scales in specimens of *boscii* from Florida and South Carolina, an extreme variation of from 42 to 53 rows was found, the mode of variation being about 46 rows. In 127 counts of the transverse scale rows of specimens from the given range of *crysoleucas* proper, the mode of variation is at 47 rows instead of 46; the extremes of variation (from 42 to 53 rows) as determined for *boscii*, were found to hold also as the usual extremes for typical *crysoleucas*, although two specimens showed a higher number (in one case 55, in the other 57, on one side only). These figures indicate that there is no wide geographical variation in the size of the scales of *Notemigonus crysoleucas*.

In both *crysoleucas* and *boscii* the lateral line is frequently variously incomplete.

2. *The Colors of the Breeding Male*

In the southeastern form, *boscii*, the males in the spring are described as assuming bright colors, caused chiefly by the development of red color on the lower fins. In typical *crysoleucas*, however, the lower fins are usually marked with orange in the breeding fishes (of both sexes), and these fins are occasionally red.³ No data is available on the intergradation of the two forms in respect to coloration.

³Dr. Tarleton Bean (Bull. Am. Mus. Nat. Hist., 9, 1897, p. 344) described as a race of *crysoleucas*, a fish from Central Park, New York City, characterized by the "permanent vermilion color" of the lower fins. He apparently was dealing however with examples of an introduced European species, *Scardineus erythrophthalmus*.

3. *The Number of Rays in the Anal Fin*

The longer anal fin of *boscai*, containing more rays than that of *crystoleucas* proper, is the most important of the characters which distinguish the two forms. Within the species, including the two subspecies, the variation in the number of branched rays in the anal fin is from 8 to 17, more than one hundred per cent. A variation of five rays, which is unusually wide when the number is so low, occurs normally in a single lot from a single locality. Thus, in a series from Saginaw Bay, Michigan, the rays vary from 8 to 12; from Dewey Lake, Michigan, 10 to 14; from the Huron River basin, Michigan; from Pikeville, Indiana, 9 to 13; from Lake Monroe, Florida, 13 to 17.

The most interesting aspect of this variation in the number of branched rays of the anal fin is not its wide extent, but rather the geographical distribution of its variants. This is indicated in the two following tables.

Tables showing the geographical variation in the number of branched rays of 465 specimens of Notemigonus crysoleucas.

branched rays of 487 specimens of Notemigonus crysoleucas.

Branched annal rays	Localities (states)
8 9 10 11 12 13 14 15 16 17	{ North Dakota, Wisconsin, Michigan, Ontario, Nova Scotia, Iowa, Northern Mis- souri, Illinois, Indiana, Ohio.
1 7 42 203 119 23 2.....	
.....2 12 17 7.....	{ Texas, Louisiana, Arkansas, Oklahoma, Southern Mis- souri, Virginia, Maryland, Delaware, Pennsylvania.
.....4 12 23 14 1	
	{ South Carolina, Georgia, Alabama, Florida.

Estimated modal numbers of branched anal rays

Regions

11	Red River of the North
11	North Dakota
11	Wisconsin (Lake Pepin)
11	Michigan
11	Northern Illinois
11	North central Ohio
11½	Iowa and northern Missouri
11½	About southern end of Lake Michigan
12	Indiana
12	Western Ohio
13	Southern Missouri
13	Texas
13	Arkansas
13	Maryland and Potomac River
13½	Southern Virginia
14	Alabama
14½	South Carolina
15	Florida

It thus appears that, as regards the number of anal rays, the most important distinctive feature, *crysoleucas* blends into *boscai*, the number of rays becoming gradually more numerous from the northwest to the southeast. How gradual this intergradation really is, can be emphasized by considering the conditions in Illinois and the adjacent states. In Indiana I find the number of anal rays to vary from 9 to 14, twelve occurring most frequently. In Michigan, in northern Illinois, and in the states to the west of Illinois, I find the variation to be from 8 to 13 instead of 9 to 14; the number 11, rather than 12 occurring most frequently. It seems rather surprising that the golden shiners of Indiana should present this slight racial difference when compared with others from the Illinois River basin, but the difference is in agreement with the more southern facies of the fauna just southeast of Lake Michigan. About the southern tip of Lake Michigan the modal number is between 11 and 12.

Among stream fishes, the distribution of species and variants is usually correlated, not with latitude or area, as in the case of terrestrial animals, but rather with the extent of the stream basins themselves: for the history of the streams and the history of the stream fishes are intimately connected. The case of the golden shiner forms one of the apparent exceptions to this general law, for in *Notemigonus* the distribution of the variants seems to be correlated with area and perhaps with temperature, rather than with the stream basins. A closely similar case appears to occur among the sun-fishes, and others will probably be demonstrated when our freshwater fishes are more extensively studied.
