

STUDIES OF THE BIOLOGY OF THE CHUBS (GENUS  
*NOCOMIS*, FAMILY CYPRINIDAE) OF NORTH-  
 EASTERN UNITED STATES

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The life histories of three species of chubs, namely *Nocomis biguttatus* (Kirtland), *Nocomis micropogon* (Cope), and *Nocomis leptocephalus* (Girard), found in the rivers and streams of eastern United States, were studied. The work was restricted mainly to a study of their description, age, growth and food habits, and the data are tabulated and figured in detail. The taxonomic history, distribution, abundance, and reproduction are also discussed.

Few data are available concerning the descriptive characters of the three species. Proportional measurements were made on 25 adult specimens of each species. Color descriptions of the breeding and nonbreeding adults are presented. A key to the species of *Nocomis* inhabiting eastern United States is given. Since each species has not been studied over its entire range, a tentative key is presented below :

KEY TO THE SPECIES OF *NOCOMIS* OF EASTERN UNITED STATES

1. Pharyngeal teeth in two rows, I, 4-4, I or I, 4-4,  $\alpha$ ; spot at base of caudal fin intense, large, round and distinct; predorsal scales more crowded, 19 to 27, average 22.5; more circumferential scales, 31 to 35, average about  $_{33}$ ; snout short, generally over 9 times in standard length, somewhat gently rounded; bony interorbital wider, 3.0 to 3.2 in head, average about 3.0; eye larger; barbel smaller; a light vermilion postocular spot; dorsal and anal fins orange; caudal fin of young red. Nuptial males with numerous tubercles, usually more than 45, antrorse, and located from internasal area to occiput, sometimes found on nape; occipital and interorbital swellings never developed; vermilion postocular spot very prominent; in life a mid-dorsal light line is developed from occiput to caudal fin about one-eighth inch wide, and the dark lateral band becomes intense and very conspicuous. *Nocomis biguttatus* (Kirtland). Hornyhead chub.
2. Pharyngeal teeth in a single row,  $_{4-4}$ ; spot at base of caudal fin not intense, at most, small and round, or diffuse and indistinct; predorsal scales less crowded, 16 to 23, average 20 or less; fewer circumferential scales, 27 to 32, average 31 or less; snout, when long, generally 8 times in standard length, or when short, blunt anteriorly; bony interorbital narrower, 3.0 to 3.7 in head, average more than 3.0; eye smaller; barbel larger; vermilion postocular spot absent; dorsal and anal fins generally olive-yellow; caudal fin of young amber. Nuptial males with fewer tubercles, usually under 40, erect, and located from internasal area to interorbital area, on snout and a few approach oc-

ciput ; occipital and interorbital swellings developed; mid-dorsal light line and intense dark lateral band not present or never observed in life a

a. Snout longer, in adults, averages about 8 times in standard length, somewhat pointed anteriorly; dorsal fin inserted farther forward, distance from end of hypural to origin of dorsal reaches nostril when measured forward from dorsal origin ; scales below lateral line more, 5 to 6, average 5.7; least suborbital into postorbital 1.7 to 2.0, average less than 2.0; preorbital in postorbital less, 1.0 to 1.1, average less than 1. ; suborbital into head length 3.5 to 4.<sup>2</sup>, average less than 4.0; caudal spot diffuse and faint; head longer and less deep ; body less deep ; lateral line less decurved. Nuptial males with tubercles located primarily on internasal area, on sides and front of snout, not approaching occiput.

*Nocomis micro pogon* (Cope). River chub.

b. Snout shorter, in adults, averages over 9 times in standard length, somewhat blunt anteriorly ; dorsal fin inserted more posteriorly, distance from end of hypural to origin of dorsal reaches eye when measured forward from dorsal origin ; scales below lateral line less, 4 to 5, average 4.6; least suborbital into postorbital 1.9 to 2.5, average more than 2.0; preorbital into postorbital more, 1.1 to 1.4, average more than 1.1; suborbital into head length 3.6 to 5.0, average more than 4.0; caudal spot round, small, fairly distinct ; head shorter and deeper ; body deeper ; lateral line more decurved. Nuptial males with tubercles located primarily on head between internasal and interorbital area, approach occipital area, and sometimes developed on sides and front of snout.

*Nocomis leptcephalus* (Girard). Carolina chub.

The species of *Nocomis* are widely distributed over eastern United States. Their local distribution and abundance vary considerably with factors of stream ecology and physiography. There is considerable overlap in the distribution of *biguttatus* and *micro pogon*. *Nocomis biguttatus* has its western limits from northern Arkansas and northeastern Oklahoma, northwest to Colorado and Wyoming and to eastern North Dakota, including the Red River ; eastward to the western portion of the Lake Ontario basin, the Hudson River drainage of New York, and the northern part of the Ohio River system. It occurs in the Great Lakes region, north to the Lake Superior and Green Bay drainages of Wisconsin and the Straits of Mackinac. *Nocomis micropogon* ranges from the Wabash River system and the Lower Peninsula of Michigan to the Lake Ontario basin, west of Rochester ; southward on the Atlantic slope from the Susquehanna system in New York to the James River system in Virginia, in the upper James River system of western Virginia, and on the uplands of the western Appalachian slope to the Tennessee River tributaries of Georgia and Alabama. *Nocomis leptcephalus* occurs on the Atlantic slope from the James River, Virginia,

southward, and in the upper New River system of western Virginia. The ranges of *leptocephalus* and *micro pogon*. likewise overlap in the James and New River systems.

The abundance varies throughout the range of the species. In certain streams of the Lake Ontario drainage of New York where *micro pogon*, *biguttatus*, and the central common shiner, *Notropis cornutus chrysocephalus*, occur together, they form the most abundant species of the fish fauna. *Nocomis leptocephalus* is generally common, especially in the sandy streams of the Piedmont of Virginia and North Carolina.

A conspicuous sight, generally above riffles, are the dome-shaped pebble nests of *Nocomis*, constructed during late April and May by the male. The eggs are deposited among the pebbles, which give some protection from scavengers. The nests are utilized as spawning sites by several other species of fishes. All three species of *Nocomis* are mature and spawn when three years old. Faster-growing individuals of both sexes of *biguttatus* are mature when two years old. The males of the three species mature at a greater length than the females.

Sexual dimorphism is very pronounced in the three species. The breeding males have well-developed tubercles on the head. Small tubercles are also present on the outer portions of the first 5 to 6 pectoral fin rays. Large swellings are developed on the occipital and interorbital areas of breeding males of *micropogon* and *leptocephalus*. The males develop bright breeding colors on the body, head, and fins. They attain a larger maximum size and grow more rapidly. The dorsal, anal, and paired fins are slightly larger in the males.

The sex ratio for all age groups in *biguttatus* was 1.0:1.3 (males : females) ; in *micropogon*, 1.0:0.9 ; and in *leptocephalus*, 1.0:2.3.

Age and rate of growth of the three species was determined by scale analysis of 1709 specimens collected from localities in New York, Pennsylvania, Virginia, and North Carolina. The annuli were formed with the resumption of growth, generally in late April or May. During periods of more rapid growth, June and July, the circuli were more widely spaced than during periods of slower growth, August and September. *Nocomis micropogon* attained the greatest age. One male of 454 specimens examined reached the age of five summers. One male and 12 females of 819 specimens of *leptocephalus* were in their fourth summer. Only one female *biguttatus* of 401 specimens attained the age of four summers. In each of the three species more females survived to the age of four summers. Neither sex of the four-summer age group formed more than 1.5 per cent of the population studied. The largest specimens recorded were : *micro pogon*, male, 188 m.m., standard length, female, 127 m.m. ; *biguttatus*, male, 124 m.m., female, 118 m.m. ; *leptocephalus*, male, 145 m.m., female, 102 m.m. *Nocomis micropogon* grew most rapidly and attained the greatest length. In *micropogon* from Sandy Creek, Lake Ontario drainage, Monroe County, New York, the males attained a mean standard length of 63 m.m. (46-75 m.m.),

103 m.m. (88-133 m.m.), and 138 m.m. (124-150 m.m.) at the end of the first, second, and third summers of life. Females reached 57 m.m. (43-68 m.m.), 94 m.m. (82-107 m.m.), and 111 m.m. (99-125 m.m.) for the same periods. Similar data for *biguttatus* are: males, 56 m.m. (37-67 m.m.), 90 m.m. (73-109 m.m.), and 123 m.m. (121-124 m.m.); females, 49 m.m. (37-59 m.m.), 86 m.m. (57-95 m.m.), and 106 m.m. (98-112 m.m.). In *leptocephalus* from the James River system, Virginia, the males attained a mean standard length of 47 m.m. (32-68 m.m.), 77 m.m. (59-104 m.m.), and 116 m.m. at the end of the first, second, and third years. Females reached 40 m.m. (28-61 m.m.), 62 m.m. (50-80 m.m.) and 86 m.m. In the three species the males grew more rapidly. This differential rate of growth was statistically significant at the end of the first year. The growth increment was somewhat greater during June and July than August and September. The annual increment in length for both sexes was greatest during the first year in *micropogon* and *biguttatus* and was greatly reduced the second and third years. In *leptocephalus* the annual increments were about equal through three years of life.

The study of food habits was based on stomach examination of 607 specimens (470 with food) of *micropogon* and *biguttatus*, that ranged in age from young of the year to three-year-old adults. These were collected in Sandy Creek, Lake Ontario drainage, Monroe County, New York, during July, August, and September, 1939, and June, 1940. Practically all of the animal food for both species was composed of aquatic Insecta, Crustacea, and Mollusca. The type of food taken by the two species was very similar. The items of diet most often encountered in the stomachs were *Simulium* (black-fly larvae), *Chironomus* (midge-fly larvae), *Heliocopsyche* (caddis-fly larvae), various Ephemeroptera (chiefly nonburrowing may-flies), and *Cambarus* (crayfish). Ostracods and Cladocera were eaten only by the young of the year during July. Only minor differences existed in the comparative amounts of animal food taken by each species. Filamentous algae, chiefly *Cladophora*, and vascular plants were eaten in large quantities. It is probable that much of the plant material was taken with the animal food. Other than the Cladocera food of the young during July, almost all food was benthotic. No notable difference was found in the type of food taken throughout the summer months.

#### SUBJECTS

Major: Ichthyology

First Minor: Zoology

Second Minor: Vertebrate Zoology

In charge of thesis: Professor E. C. Raney