ICHTHYOLOGY.—*The comparative food habits of the cyprinid fishes* Nocomis biguttatus *and* Nocomis micropogon *in western New York.*[1] ERNEST A. LACHNER, U. S. National Museum.

The comparative food habits of closely related Cyprinidae have received little study. The diet of our nongame fishes has generally been neglected, although it is an important factor in the maintenance of a large forage population. This study compares the food habits of the river chub, *Nocomis micropogon* (Cope), and the hornyhead chub, *Nocomis biguttatus* (Kirtland), during four months of late spring and summer. The type, quantity, and differences in food taken between these species in their various age groups and within the growing season are considered.

Cope (1869, p. 353) related the food of various species of cyprinids with the length of the alimentary canal. He listed the food of *Hypsilepis kentuckiensis* (*Nocomis biguttatus* or *N. micropogon*) as insects and crustaceans, along with other cyprinids, as *Exoglossum maxillingua* (LeSueur) and *Ericymba buccata* Cope, which have short alimentary canals, seven-ninths of standard length.

Forbes (1883, p. 76) placed *Nocomis biguttatus* in a group of Cyprinidae having short intestines and hooked pharyngeal teeth without grinding surfaces, and listed *Phenacobius, Semotilus, Ericymba, Rhinichthys,* and other genera with it. The food habits of 13 *Ceratichthys biguttatus* (*Nocomis* sp.), based upon an examination of the alimentary canals, are listed and compared with 14 other species of Cyprinidae (1883, p. 94). He found the diet to consist of one-fourth insects, "largely case-worms and other neuropterous larvae, another fourth being crustaceans (crawfishes), eaten, however, by only two of the specimens." The remainder of 54 percent (ratio in which the item was found) "was equally divided between algae and seeds of *Setaria* and other grass-like plants." He concludes: "The extraordinary amount of vegetation in the food of this fish is possibly related to the increased length of the alimentary canal," the measurements of which he gave as "the head and body being contained in the intestine about $1\frac{1}{4}$ times."

Evermann and Clark (1920, p. 363) record the diet of *Hybopsis kentuckiensis* (*Nocomis* sp.) to consist chiefly of worms, insect larvae, small crustaceans, and small fishes. Forbes and Richardson (1920, p. 169) have cited the same data as presented by Forbes (1883, p. 94). Although Breder and Crawford (1922) did not study the species concerned here, an interesting summary is presented on the food of related cyprinids. Greeley (1927, p. 60) found the fragments of 10 small clams (*Sphaerium*?) in *Nocomis biguttatus.* Hubbs and Cooper (1936, p. 50) list the larval stages of aquatic insects as the most important item of diet and smaller crustaceans, such as water-fleas, earthworms, and terrestrial insects, as probably eaten to some extent by *Nocomis biguttatus.* They cite that larger *biguttatus* eat some crayfish and that algae and other plants are taken but serve little value as food.

MATERIAL AND METHODS

The stomach contents of 607 specimens of *micropogon* and *biguttatus* were analyzed, 470 containing food. These specimens ranged in age from young of the year to 3-year-old adults and were collected in Sandy Creek, Lake Ontario drainage, Monroe County, N. Y. The dates of the collections, the number of specimens of the two species taken together, the number of stomachs examined in each age group, and the number containing food are given in Table 1.

Only the contents of the stomach were analyzed. These were removed and placed in a watch glass. The organisms were sorted, identified, and counted, and the volume of each was estimated. Only rarely were organisms found in the esophagus or mouth; these were included with the stomach contents. Although food was present in the intestinal tract while the stomach may have been empty, no attempt was made to identify this food other than for general information. Each specimen was aged by scale analysis which was recorded with the individual food description. The high correlation between age and size made it as reliable to compare the diet with age groups as with size groups, and was more convenient in tabulating the

[1] Received March 15, 1950.

TABLE 1.—DATA CONCERNING THE COLLECTIONS USED IN THE FOOD ANALYSIS OF TWO SPECIES OF NOCOMIS FROM SANDY CREEK, MONROE COUNTY, N. Y.

Date	Age in years	Number caught		Stomachs examined		Stomachs with food		Stomachs with food, in percent	
		1*	2*	1	2	1	2	1	2
July 19, 1939	0+	40	9	40	9	18	6	45.0	66.7
September 25, 1939	0+	39	118	38	118	31	94	81.5	79.5
June 10, 1940	1+	55	73	53	48	38	36	71.7	75.0
July 19 and August 5, 1939	1+	86	79	86	55	22	21	25.6	38.2
September 25, 1939	1+	58	41	58	41	43	28	74.2	68.3
July 19, August 5, and September 25, 1939 and June 10, 1940	2+ or older	24	40	24	37	9	24	37.5	64.9
Total	0+ to 2+	302	360	299	308	161	209	53.9	67.8

* Column 1 = *biguttatus;* Column 2 = *micropogon.*

data. A study of growth of the chubs will be published separately.

HABITAT DESCRIPTION

The area of Sandy Creek from which specimens were taken was approximately 1 to 10 miles above the mouth. The water is normally clear and white, with a normal flow of 50 to 100 cubic feet per second, and a slow to moderate current. The stream varies in width from 50 to 150 feet, through open grazing lands, partial willow growths, or heavier woodlands. The bottom composition is chiefly sandstone bedrock, and low gradient riffles of gravel and rubble are located about every 100 to 150 yards. Some pools are present up to 3 feet in depth, generally below the riffles. Water temperatures vary from 70° to 80° F. during the summer months. Probably the most characteristic feature of this stream is the dense growth, especially early in summer, of filamentous algae, chiefly *Cladophora.* It forms dense mats over the areas of quiet waters, and large strands are present in the riffles. Several species of *Potamogeton* are also present. The stream is smaller with less flow, and contains far more vegetation than is generally reported for a *micropogon* habitat (Hubbs, 1926, p. 29; Hubbs and Cooper, 1936, p. 26). Here *micropogon, biguttatus,* and *Notropis cornutus chrysocephalus* (Rafinesque) represent the most abundant species of fish fauna. All three were taken in about equal numbers by seining.

Throughout its range, it appears that *micropogon* is generally distributed in larger streams than is *biguttatus.* This is particularly true of their occurrence in the Allegheny River of western Pennsylvania. The young of *biguttatus* are commonly taken in algal and vascular-plant beds of more slowly flowing water, while the young of *micropogon* generally avoid such a habitat, appearing in the open and faster flowing water.

TYPE OF FOOD TAKEN

Eight orders of Insecta were represented in the diet of *biguttatus,* and ten orders in *micropogon.* Of the orders listed in Table 2, only the Homoptera, Lepidoptera, and Hymenoptera were terrestrial in origin. All other organisms were aquatic with the exception of several Carabidae among the Coleoptera. The following organisms were more specifically identified: The Neuroptera were represented by the family Sialidae, *Corydalis cornuta,* or dobson-fly larvae. Only one *Hexagenia* nymph (Ephemeridae) was found among the Ephemeroptera, all of the others being nonburrowing mayflies, mainly Baetidae. The Anisoptera, dragonflies, were the only Odonata found. The Plecoptera, stoneflies, were chiefly Perlidae. Of the Coleoptera, Hydrophilidae, Haliplidae (*Peltodytes cornuta*), Parnidae (*Psephenus,* the water penny), and a few ground beetles, Carabidae, were recorded. The caddis-worm, *Helicopsyche,* was the most numerous Trichoptera, and *Glossosoma, Molanna,* and *Brachycentrus* occurred in smaller numbers. Among the dipterous insects *Simulium,* black-fly larvae, and *Chironomus,* midge larvae, were abundantly found, with but a few other larvae such as *Limnophora* (Anthomyiidae). The dipterous pupae were mostly *Chironomus.*

In the invertebrates, other than insects, only a few water-mites, or hydrachnids, and

water spiders were taken. The Crustacea were chiefly Cladocera (water-fleas), Ostracoda, Amphipoda (scuds), Isopoda (sow-bugs), and Decapoda (*Cambarus propinquus*, crayfish). The Mollusca were mainly gastropods. *Physa heterostropha* was most commonly identified. *Sphaerium* and *Ferrissa* were also determined. Only one earthworm, *Lumbricus*, was found. Among the animal remains were fish tissue and scales and other undeterminable tissue. The organisms of the stomachs were generally in such a dismembered condition that many were identified to orders only. The plant material was mainly a filamentous algae, *Cladophora*, but smal quantities of other filamentous types oc curred. Seeds, stems, and leaves of vascular plants were found, and of these, *Anacharis* (water-weed), *Vallisneria*, and *Potamogeton* (pond-weed) were determined.

TABLE 2.—SUMMARY OF FOOD OF TWO SPECIES OF NOCOMIS COLLECTED JULY 19, AUGUST 5, SEPTEMBER 25, 1939, AND JUNE 10, 1940, FROM SANDY CREEK, N. Y.*

	biguttatus				*micropogon*			
Stomachs examined	299				308			
Stomachs with food	161				209			
ITEM	A†	B	C	D	A	B	C	D
Insecta	—	—	—	59.7	—	—	—	70.6
Neuroptera	—	—	—	—	2	1.0	1.0	0.2
Ephemeroptera	13	1.2	8.1	4.5	34	2.1	16.2	6.1
Odonata	1	1.0	0.6	0.4	—	—	—	—
Plecoptera	1	1.0	0.6	†	6	1.8	2.9	0.3
Hemiptera	5	1.2	3.1	0.5	5	1.4	2.4	1.2
Homoptera	—	—	—	—	1	1.0	0.5	‡
Coleoptera	—	—	—	2.3	—	—	—	4.4
Larvae	6	1.3	3.7	1.2	7	1.0	3.4	2.4
Adults	3	1.0	1.9	1.1	10	1.1	4.8	2.0
Trichoptera	—	—	—	32.4	—	—	—	26.3
Helicopsyche	51	11.0	31.7	25.5	39	6.2	18.6	17.2
Other Trichoptera	20	2.2	12.4	6.9	33	1.3	15.8	9.1
Lepidoptera	—	—	—	—	1	1.0	0.5	‡
Diptera	—	—	—	14.4	—	—	—	25.2
Chironomus larvae	41	9.4	25.4	10.0	42	5.0	20.1	7.6
Simulium larvae	8	4.5	5.0	2.2	36	13.4	17.2	10.0
Other larvae	5	1.8	3.1	1.9	7	1.4	3.4	6.2
Pupae	3	2.0	1.9	†	12	1.8	5.7	0.8
Adults	4	1.0	2.5	0.3	7	1.0	3.4	0.6
Hymenoptera	1	1.0	0.6	†	2	1.0	1.0	0.6
Insecta remains	35	—	21.8	5.2	52	—	24.8	6.3
Arachnida	1	1.0	0.6	‡	4	1.3	1.9	0.5
Crustacea	—	—	—	12.7	—	—	—	4.9
Cladocera	3	21.7	1.9	1.0	—	—	—	—
Ostracoda	14	9.2	8.7	4.0	2	6.5	1.0	0.5
Isopoda	1	1.0	0.6	‡	—	—	—	—
Amphipoda	2	1.0	1.2	1.1	—	—	—	—
Decapoda (*Cambarus*)	17	1.0	1.1	6.5	14	1.0	6.7	4.4
Crustacea remains	2	—	1.2	0.1	—	—	—	—
Mollusca	—	—	—	6.7	—	—	—	4.2
Gastropoda	18	1.4	1.1	4.5	11	1.8	5.3	3.9
Pelecypoda	6	1.7	3.7	2.2	2	2.0	1.0	0.3
Annelida	1	1.0	2.6	2.4	—	—	—	—
Animal remains	6	—	3.7	1.1	7	—	3.4	0.6
Plants	—	—	—	19.9	—	—	—	19.8
Filamentous algae	36	—	22.4	15.4	77	—	36.8	18.7
Vascular remains	14	—	8.7	4.5	24	—	11.5	1.1

* Specimens ranged in age from young of year to three-year old adults.

† A = Number of stomachs containing item; B = average number of items per stomach; C = percentage of stomachs containing item; D = percentage of volume of all food.

‡ = trace, less than 0.05.

COMPARATIVE FOOD HABITS

Food of young.—The food for early summer was determined by analysis of 40 specimens of young *biguttatus* taken on July 19, 1939, 18 containing food. Ostracods were present in 66.7 percent of the stomachs and formed 36.1 percent of the total volume of food. Three stomachs contained only ostracods and 35 were counted in one. Ephemeroptera nymphs, *Chironomus* larvae, and Cladocera each formed about 10 percent of the volume of all food. One stomach contained no other food except 25 Cladocera. Three stomachs contained algae, forming 13.8 percent of the volume. Six stomachs of 9 *micropogon* specimens taken had food, and the data are compared with *biguttatus* in Table 3.

The food of young *biguttatus* is compared with that of *micropogon* for late summer in Table 3, based on a collection made on September 25, 1939, in which 38 *biguttatus* were caught, 81.5 percent with food, and 118 *micropogon*, 79.5 percent with food. The mean standard length of the specimens of *micropogon* was 4.4 mm greater than that of *biguttatus*. The insect diet of *biguttatus* formed 89.0 percent of the total volume; that of *micropogon*, 83.2 percent. The main items of diet for *biguttatus* were a caddis-fly larva, *Helicopsyche*, 74.3 percent (column

TABLE 3.—FOOD OF THE YOUNG OF TWO SPECIES OF NOCOMIS FROM SANDY CREEK, N. Y.*

Date	July 19, 1939								September 25, 1939							
Species	*biguttatus*				*micropogon*				*biguttatus*				*micropogon*			
Mean S.L.† in mm	33.1				34.5				55.6				60.0			
Range of S.L. in mm.	27–37				30–38				36–67				43–74			
Stomachs examined	40				9				38				118			
Stomachs with food	18				6				31				94			
Stomachs with food (%)	45.0				66.7				81.5				79.5			
ITEM	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Insecta	—	—	—	31.4	—	—	—	83.3	—	—	—	89.0	—	—	—	83.2
Ephemeroptera	3	1.0	16.7	8.6	2	4.5	33.3	31.6	2	1.0	6.5	1.9	22	2.2	23.4	9.4
Plecoptera	—	—	—	—	—	—	—	—	—	—	—	—	5	2.0	5.3	0.5
Hemiptera	—	—	—	—	—	—	—	—	—	—	—	—	2	1.5	2.1	0.2
Coleoptera	—	—	—	—	—	—	—	—	—	—	—	1.9	—	—	—	4.7
Larvae	—	—	—	—	—	—	—	—	1	1.0	3.2	1.9	4	1.0	4.3	3.8
Adults	—	—	—	—	—	—	—	—	—	—	—	—	3	1.0	3.2	0.9
Trichoptera	1	1.0	5.5	5.9	3	1.0	50.0	35.0	—	—	—	6.1	—	—	—	33.7
Helicopsyche	—	—	—	—	—	—	—	—	23	8.8	74.3	56.9	352	6.3	37.3	26.9
Other Trichoptera	—	—	—	—	—	—	—	—	4	2.3	12.9	4.2	10	1.0	10.6	6.8
Lepidoptera	—	—	—	—	—	—	—	—	—	—	—	—	1	1.0	1.1	‡
Diptera	—	—	—	10.7	—	—	—	—	—	—	—	18.0	—	—	—	23.3
Chironomus larvae	4	3.0	22.2	10.7	—	—	—	—	9	7.5	29.0	11.7	22	5.1	23.4	6.5
Simulium larvae	—	—	—	—	—	—	—	—	4	2.5	12.9	6.1	23	13.4	24.5	14.3
Other larvae	—	—	—	—	—	—	—	—	—	—	—	—	3	2.0	3.2	0.9
Pupae	—	—	—	—	—	—	—	—	1	3.0	3.2	0.2	9	1.9	9.6	1.5
Adults	—	—	—	—	—	—	—	—	—	—	—	—	2	1.0	2.1	0.1
Insecta remains	4	—	22.2	6.2	1	—	16.7	16.7	10	—	32.2	6.1	35	—	37.2	11.4
Arachnida	—	—	—	—	—	—	—	—	—	—	—	—	2	1.5	2.1	‡
Crustacea	—	—	—	45.0	—	—	—	16.7	—	—	—	1.3	—	—	—	‡
Cladocera	3	21.7	16.7	8.6	—	—	—	—	—	—	—	—	—	—	—	—
Ostracoda	12	10.4	66.7	36.1	1	12.0	16.7	16.7	—	—	—	—	1	1.0	1.1	‡
Decapoda (*Cambarus*)	—	—	—	—	—	—	—	—	1	1.0	3.2	1.3	—	—	—	—
Crustacea remains	1	—	5.5	0.3	—	—	—	—	—	—	—	—	—	—	—	—
Mollusca	—	—	—	13.8	—	—	—	—	—	—	—	6.9	—	—	—	5.6
Gastropoda	4	1.0	22.2	13.8	—	—	—	—	6	1.3	19.4	5.6	4	2.3	4.3	4.8
Pelecypoda	—	—	—	—	—	—	—	—	1	1.0	3.2	1.3	2	2.0	2.1	0.8
Plants	—	—	—	9.8	—	—	—	—	—	—	—	2.8	—	—	—	11.0
Filamentous algae	3	—	16.7	9.8	—	—	—	—	6	—	19.4	2.8	29	—	30.1	10.5
Vascular remains	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1.1	0.5

* For explanation of A, B, C, and D, see footnote to Table 2.
† S.L. = standard length.
‡ See footnote to Table 2.

TABLE 4.—FOOD OF THE JUVENILES (SECOND SUMMER) OF TWO SPECIES OF NOCOMIS FROM SANDY CREEK, N. Y.

Date	June 10, 1940								July 19 and August 5, 1939								September 25, 1939							
Species	*biguttatus*				*micropogon*				*biguttatus*				*micropogon*				*biguttatus*				*micropogon*			
Mean S.L. in mm.	53.5				73.9				86.7				92.0				87.2				98.1			
Range of S.L. in mm.	38–76				55–91				65–106				79–110				69–109				82–133			
Stomachs examined	53				48				86				55				58				41			
Stomachs with food	38				36				22				21				43				28			
Stomachs with food (%)	71.7				75.0				25.6				38.2				74.2				68.3			
ITEM	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Insecta	—	—	—	71.9	—	—	—	53.2	—	—	—	63.1	—	—	—	65.4	—	—	—	47.9	—	—	—	26.3
Ephemeroptera	4	1.8	10.5	4.6	6	1.5	16.7	2.5	4	1.0	18.2	15.1	2	2.0	9.5	3.9	—	—	—	—	1	1.0	3.6	1.1
Odonata	1	1.0	2.6	1.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Plecoptera	—	—	—	—	1	1.0	2.7	0.4	—	—	—	—	—	—	—	—	1	1.0	2.3	†	—	—	—	—
Hemiptera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	1.2	11.6	2.0	2	1.5	7.2	2.9
Coleoptera	—	—	—	4.7	—	—	—	2.4	—	—	—	0.3	—	—	—	4.8	—	—	—	0.7	—	—	—	—
Larvae	1	1.0	2.6	0.4	1	1.0	2.7	1.0	—	—	—	—	—	—	—	—	2	1.5	4.7	0.7	—	—	—	—
Adults	2	1.0	5.3	4.3	2	1.5	5.6	1.4	1	1.0	4.6	0.3	1	1.0	4.8	4.8	—	—	—	—	—	—	—	—
Trichoptera	—	—	—	8.2	—	—	—	6.3	—	—	—	47.3	—	—	—	40.7	—	—	—	42.8	—	—	—	4.3
Helicopsyche	—	—	—	—	1	1.0	2.7	0.8	7	3.9	31.8	27.2	2	2.0	9.5	9.3	20	16.2	46.6	40.1	—	—	—	—
Other Trichoptera	6	2.2	15.8	8.2	5	1.2	13.9	5.5	5	2.2	22.7	20.1	8	2.6	38.1	31.4	3	1.0	7.0	2.7	5	1.4	17.9	4.3
Diptera	—	—	—	38.5	—	—	—	32.1	—	—	—	0.2	—	—	—	7.8	—	—	—	1.1	—	—	—	12.0
Chironomus larvae	21	13.6	55.2	25.4	12	7.1	33.3	11.4	2	1.5	9.1	0.2	2	2.5	9.5	1.9	5	3.6	11.6	0.4	5	1.4	17.9	6.3
Simulium larvae	3	8.3	7.9	4.3	11	13.9	30.6	18.2	—	—	—	—	2	11.0	9.5	4.5	1	1.0	2.3	0.2	—	—	—	
Other larvae	4	2.0	10.5	8.0	1	1.0	2.7	1.1	1	1.0	4.6	†	—	—	—	—	—	—	—	—	2	1.0	7.2	3.6
Pupae	1	1.0	2.6	†	3	1.7	8.3	0.7	—	—	—	—	—	—	—	—	1	2.0	2.3	†	—	—	—	—
Adults	2	1.0	5.3	0.8	2	1.0	5.6	0.7	—	—	—	—	1	1.0	4.8	1.4	2	1.0	4.7	0.5	2	1.0	7.2	2.1
Hymenoptera	—	—	—	—	1	1.0	2.7	0.7	—	—	—	—	—	—	—	—	1	1.0	2.3	0.2	1	1.0	3.6	3.6
Insect remains	15	—	39.4	14.1	10	—	27.8	8.8	1	—	4.5	0.2	2	—	9.5	8.2	5	—	11.6	1.1	4	—	14.3	2.6
Arachnida	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1.0	2.3	†	2	1.0	7.2	3.6
Crustacea	—	—	—	9.9	—	—	—	5.3	—	—	—	22.4	—	—	—	14.3	—	—	—	11.3	—	—	—	3.5
Ostracoda	2	1.5	5.3	†	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Isopoda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1.0	2.3	†	—	—	—	—
Amphipoda	2	1.0	5.3	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Decapoda (*Cambarus*)	2	1.0	5.3	4.7	3	1.0	8.3	5.3	6	1.0	27.2	22.0	3	1.0	14.3	14.3	5	1.0	11.6	11.3	1	1.0	3.6	3.5
Crustacea remains	—	—	—	—	—	—	—	—	1	—	4.6	0.4	—	—	—	—	—	—	—	—	—	—	—	—
Mollusca	—	—	—	2.4	—	—	—	—	—	—	—	9.6	—	—	—	0.6	—	—	—	7.5	—	—	—	3.9
Gastropoda	—	—	—	—	—	—	—	—	3	1.0	13.6	9.4	1	1.0	4.8	0.6	5	2.2	11.6	2.3	2	1.0	7.2	3.9
Pelecypoda	1	1.0	2.6	2.4	—	—	—	—	1	2.0	4.6	0.2	—	—	—	—	3	2.0	7.0	5.2	—	—	—	—
Annelida	1	1.0	2.6	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Animal remains	3	—	7.9	5.3	—	—	—	—	1	—	4.6	0.2	—	—	—	—	2	—	4.7	†	6	—	21.4	5.8
Plants	—	—	—	8.5	—	—	—	41.2	—	—	—	4.6	—	—	—	19.4	—	—	—	33.3	—	—	—	56.8
Filamentous algae	3	—	7.9	0.3	10	—	27.8	12.2	4	—	18.2	4.6	6	—	28.6	19.4	19	—	44.2	29.1	21	—	75.0	56.8
Vascular remains	6	—	15.8	8.2	17	—	47.2	29.0	—	—	—	—	—	—	—	—	4	—	9.3	4.2	—	—	—	—

C, percentage of stomachs containing the item, Table 3); midge larvae, *Chironomus*, 29.0; black-fly larvae, *Simulium*, 12.9; mayflies, Ephemeroptera, 6.5; snails, Gastropoda, 19.4; and filamentous algae, 19.4. Comparable data for *micropogon* were *Helicopsyche*, 37.3; *Chironomus*, 23.4; *Simulium*, 24.5; Ephemeroptera, 23.4; Gastropoda, 4.3; and filamentous algae, 30.1. Considering the other items listed, Table 3, one can only note minor differences in the food habits of the young collected in September. It is interesting that *micropogon* had eaten considerably more algae (see D, Table 3) than

had *biguttatus*, probably not to be expected if one considered the habitat preferences of the two species.

In September ten stomachs of young *micropogon* contained only *Helicopsyche*, of which 37 larvae and the snaillike cases appeared in a single stomach; this type averaged 6.3 per stomach when present. *Simulium* and *Chironomus* also frequently formed a single item of diet for an individual *micropogon* or *biguttatus*; 96 of the former were counted in one *micropogon* stomach and 36 of the latter in a single stomach of *biguttatus*. Six *micropogon* stomachs contained algae exclusively.

Food of juveniles, in second summer's growth; for late spring.—The food of juvenile *Nocomis* for late spring was based on the analysis of 53 *biguttatus*, 71.7 percent with food, and 48 *micropogon*, 75 percent containing food, collected June 10, 1940. The data are summarized in Table 4. The mean standard length of the *micropogon* sample exceeded that of *biguttatus* by 20.4 mm. The insect diet of *biguttatus* represented 71.9 percent of the total volume of all food taken, compared to 53.2 in *micropogon*. The common items of food for both species were Ephemeroptera, 10.5, 16.7 (percentage of stomachs containing item in *biguttatus* and *micropogon* respectively); Trichoptera larvae, 15.8, 16.6; *Chironomus* larvae, 55.2, 33.4; *Simulium* larvae, 7.9, 30.6; and *Cambarus*, 5.3, 8.3.

A similar difference occurs with the plant material taken, as mentioned above for the young during September. In *biguttatus* only small amounts of filamentous algae were found, 7.9 percent of the stomachs containing algae, forming 0.3 percent of total volume of all food, compared to 27.8 and 12.2 percent for *micropogon*. The vascular plant remains showed the same trend: in *biguttatus*, 15.8, 8.2; *micropogon*, 47.2, 29.0.

Chironomids were taken in considerable numbers by *biguttatus*, 286 appearing in 21 stomachs, averaging 13.6 per stomach. As many as 78 were counted in a single specimen. Other comparative data concerning food items eaten are presented in Table 4.

Food of juveniles in midsummer.—Food studies of juvenile *Nocomis* for midsummer were based on 86 *biguttatus*, 25.6 percent with food and 55 *micropogon*, 38.2 percent containing food, collected July 19 and August 5, 1939. The data are summarized in Table 4. The high percentage of empty stomach is of interest and may be related to the observed "schooling" habits of both species during midsummer in Sandy Creek. The specimens of these two collections were taken only in several seining hauls through the pools, up to 3 feet in depth, below low gradient riffles. The chubs were easily observed for the school was compact. This habit is somewhat contrary to the general reports of others and was not observed during June and September in Sandy Creek. In June they are generally distributed in riffles, shallow pools and also about the heavy algal growth of the more slowly flowing water. They usually caught in small numbers, four or five appearing in a good seine haul. In September their habits are more secretive and solitary, especially the larger adults. One or two may be taken from under a slab rock, and numbers are caught only by much seining.

There was little difference in the insect diet of the two species. In *biguttatus* it was 63.1 percent of the total volume; and in *micropogon*, 65.4. Ephemeroptera nymphs and *Helicopsyche* and other trichopterous larvae were the common forms. A notable reduction of *Chironomus* and *Simulium* as food items was noted, their sum being 0.2 in *biguttatus* and 6.4 in *micropogon*, in percent of volume of all food. Many more crayfish, *Cambarus*, appeared than in the younger specimens of June. In *biguttatus*, crayfish were found in 27.2 percent of the stomachs totaling 22 percent of the food by volume, and in *micropogon* similar figures were 14.3 and 14.3 percent. Filamentous algae were again consumed in greater amounts by *micropogon*. It was present in 18.2 percent of the stomachs of *biguttatus* and 28.6 in *micropogon*, forming 4.6 percent of the food volume in the former and 19.4 in the latter. Those stomachs with food contained smaller amounts, and the average number of items per stomach (Table 4, column B) was lower.

Food of juveniles late in summer.—A summary of the food of juvenile *Nocomis* for late summer is also presented in Table 4. A reduction of insect food was noted in both

species, insects constituting 47.9 percent of food volume in *biguttatus* and 26.3 percent in *micropogon*. Greater amounts of filamentous algae were taken, such algae appearing in 44.2 percent of stomachs in *biguttatus* (29.1 percent of volume), and in 75 percent of stomachs of *micropogon* (56.8 percent of volume). *N. biguttatus* had eaten many *Helicopsyche*, this food item appearing in 46.6 percent of stomachs, and representing 40.1 percent of the volume of all food. Twenty stomachs averaged 16.2 of these caddisfly larvae, and as many as 68 were counted in one individual. No *Helicopsyche* were included in the diet of *micropogon*.

Food of adults, two years old or more.—The summer food of the larger and older specimens is presented in Table 5. The classification "adult" is for convenience in terminology. Some of the "juveniles" of September (Table 4) were mature fish. Chubs more than 2 years old formed but a small part of the total population sampled, representing 8 percent of 302 *biguttatus* and 11 percent of 360 *micropogon* specimens. Fewer insects were eaten by this group. *N. biguttatus* had 12.2 percent of the volume of all food composed of insects and *micropogon* 32.5 percent. No order of insects predominated. *Cambarus* was more commonly eaten appearing in 33.3 percent of the stomachs of *biguttatus* and 29.2 percent in *micropogon*. Plant material composed a large part of the volume of all food, forming 55.6 percent in *biguttatus* and 44.1 in *micropogon*.

The vegetable matter ranked second only to insects in volume of all food taken for all age groups. It was probably taken secondarily, through the acquisition of animal food. The intestinal tract usually contained undigested filamentous algae. The raptorial dentition of both species does not suggest a vegetable diet, nor does the short length of the intestines, which is probably similar in both species (for five adults, length of distended intestine into standard length: *biguttatus*, range 1.2–1.4, average 1.3; *micropogon*, range 1.0–1.4, average 1.2).

TABLE 5.—FOOD OF THE ADULTS (2 YEARS OLD OR MORE) OF TWO SPECIES OF NOCOMIS COLLECTED JULY 19, AUGUST 5, SEPTEMBER 25, 1939, AND JUNE 10, 1940, FROM SANDY CREEK, N. Y.

	biguttatus				*micropogon*			
Mean S.L. in mm	99.8				122.6			
Range of S.L. in mm	88–118				93–150			
Stomachs examined	24				37			
Stomachs with food	9				24			
Stomachs with food (per cent)	37.5				64.9			
ITEM	A	B	C	D	A	B	C	D
Insecta	—	—	—	12.2	—	—	—	32.5
Neuroptera	—	—	—	—	2	1.0	8.3	4.6
Ephemeroptera	—	—	—	—	1	1.0	4.2	0.2
Hemiptera	—	—	—	—	1	1.0	4.2	4.2
Homoptera	—	—	—	—	1	1.0	4.2	0.2
Coleoptera	—	—	—	8.9	—	—	—	11.9
Larvae	1	2.0	11.1	8.9	2	1.0	8.3	4.3
Adults	—	—	—	—	4	1.0	16.7	7.6
Trichoptera	—	—	—	3.3	—	—	—	7.1
Helicopsyche	1	10.0	11.1	2.2	1	17.0	4.2	4.0
Other Trichoptera	1	6.0	11.1	1.1	2	2.5	8.3	3.1
Diptera	—	—	—	—	—	—	—	4.3
Chironomus larvae	—	—	—	—	1	2.0	4.2	0.1
Other larvae	—	—	—	—	1	1.0	4.2	4.2
Crustacea								
Decapoda (*Cambarus*)	3	1.0	33.3	32.2	7	1.0	19.2	13.5
Mollusca								
Gastropoda	—	—	—	—	4	2.0	16.7	9.4
Animal remains	—	—	—	—		—	4.2	0.8
Plants	—	—	—	55.6	—	—	—	44.1
Filamentous algae	1	—	11.1	11.1	11	—	45.8	33.8
Vascular remains	4	—	44.5	44.5	6	—	25.0	10.3

This is in agreement with Breder and Crawford (1922) and contrary to Forbes (1883 p. 89). A general summary of the numbers of individual food items consumed for all age groups of both species is presented in Table 2.

SUMMARY

1. The study of food habits was based on stomach examination of 607 specimens (470 with food) of *Nocomis micropogon* and *N. biguttatus*, that ranged in age from young to 3-year-old adults, and ranged in size from 27 to 150 mm in standard length.

2. Practically all the animal food for both species was composed of aquatic Insecta, Crustacea, and Mollusca.

3. The types of food taken by the two species were very similar. The organisms most frequently encountered in the stomachs were *Simulium*, *Chironomus*, *Helicopsyche*, various Ephemeroptera, and *Cambarus*. Ostracoda and Cladocera were eaten in appreciable numbers only by the young of the year during July.

4. Only minor differences existed in the comparative amounts of animal food taken by each species.

5. Filamentous algae, chiefly *Cladophora*, and vascular plants were taken in large quantities. It is probable that much of the plant material was taken with the animal food.

6. Almost all food was benthotic, other than the Ostracoda and Cladocera food of the young.

7. More stomachs were found empty during the midsummer months of July and August compared to those collected in June and September. Stomachs containing food at midsummer had less food by numbers or volume, compared with stomachs examined for June or September. This reduced feeding may be related to a schooling habit which was observed; perhaps food was not available to all *Nocomis* in the compact school.

8. Aquatic insects provided most of the food for the young and smaller juveniles of both species. Crayfish were eaten in greatest quantities by the larger and older juvenile and adult chubs. Plant material, chiefly filamentous algae, formed almost one-half of the volume of the stomach contents of the older juveniles and adults.

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