FOOD HABITS OF RIVER CARPSUCKER AND FRESHWATER DRUM IN FOUR OKLAHOMA RESERVOIRS

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A total of 508 river carpsuckers and 230 freshwater drum, from Grand, Fort Gibson, Eufaula, and Texoma reservoirs, were examined for alimentary tract (stomach) contents. In carpsuckers, 2% of the stomachs were empty; volumetric composition of others was 68% organic detritus, 16.2% plant and animal detritus, and 14.2% entomostraca, chiefly ostracods and Copepoda. In drum, 30% of the stomachs were empty, while volume composition of others proved to be 80% fish, 9% crayfish, 8.6 organic matter, 1.1% mussels, 0.6% mayflies, 0.5% oligochaetes, and lesser amounts of chironomids, midges, and insect fragments. With some exceptions, qualitative variation among fish from different reservoirs was small. Monthly variation in certain food items of the carpsucker was associated with changes in volume of reservoir inflow.

This paper presents findings of the intestinal tract contents of 508 river carpsucker, *Carpiodes carpio* (Rafinesque), and the stomach contents of 230 freshwater drum, *Aplodinotus grunniens* Rafinesque, collected from four large mainstream impoundments: Grand, Fort Gibson, Texoma and Eufaula Reservoirs (Figure 1). The purpose of the study was to examine the biological basis for the productivity of these fishes and inter-relationships with some of the other commercial species.

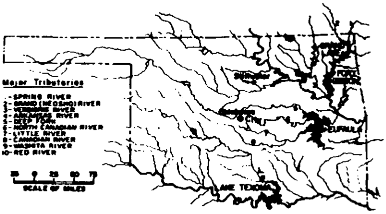

FIGURE 1. Oklahoma reservoirs (Grand, Fort Gibson, Eufaula and Lake Texoma) and their major tributaries where river carpsucker and freshwater drum were obtained for food habits study.

Generally few freshwater drum are taken by sport fishermen, but, traditionally, drum have been relatively important in the commercial fisheries of the Mississippi River (1), Lake Winnebago, Wisconsin (2), and large rivers and lakes in the northeastern United States and parts of Canada (3). During this study, river carpsucker and freshwater drum comprised 5.4 and 1.4%, respectively, of a 1,126,536 pound harvest of commercial fishes from four Oklahoma reservoirs, July 1967 through June 1968 (4). These two species have a lower economic value per unit weight than carp, buffalo, or flathead catfish. Between 1957 and 1970 freshwater drum comprised between 1.5 to 7.2% of the total estimated commercial harvest, and river carpsucker, 0.6 to 17.5% of the total harvest. The largest annual harvests of drum and river carpsucker between 1957 and 1970 were 34,761 and 158,662 pounds, respectively. In Grand Lake in the summer 1970, river carpsucker and freshwater drum comprised 1.8 and 11.0%, respectively, of a standing crop of 405 pounds per acre.

Details on morphometric characteristics of the four reservoirs and on standing crops of fish are reported elsewhere (5). Grand and Fort Gibson are impoundments of the Grand (Neosho) River in northeastern Oklahoma. Grand Reservoir is about 59,000 surface acres and Fort Gibson, downstream from Grand, is about 19,000 surface acres. Eufaula Reservoir, an impoundment of the North Canadian, South Canadian, and Deep Fork rivers, is in east-central Oklahoma, and has a surface area of 102,500 acres. Lake Texoma, an impoundment of the Red and Washita rivers, located in south-central Oklahoma, has 93,000 surface acres.

METHODS

Food habits of the river carpsucker were ascertained by examining the contents of the alimentary tract from the esophagus to

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the first loop of the intestine, hereafter termed "stomachs." Total volume was determined by aqueous displacement; individual categories were estimated as percentage of the total. Ten estimates were averaged to obtain a percentage composition for each item. Counts of individual organisms were made, in a 1 ml Sedgwick-Rafter counting cell, of ten 1 ml aliquots of the pooled tract contents for each month. The dietary spectrum was expressed as a percentage of the pooled monthly samples. Analyses of drum food habits were made of individual stomach contents which were identified and counted; total volume of the food items was measured to the nearest 0.1 ml by water displacement.

RESULTS

River carpsucker

General findings. Two per cent of the 508 river carpsucker stomachs were classified as empty (< 0.1 ml volume). The average volume of stomach contents (where contents were > 0.1 ml) was 1.0 ml, with a range from 0.14 ml for carpsuckers from Eufaula to 1.18 ml for fish from Fort Gibson. Average volume of food within the size range examined, fluctuated independently of average total-length or average weight.

Major tract constituents were organic detritus (average 68.0%), plant debris (15.7%), and entomostraca (15.2%). Diversity of food was relatively small; the only other items found were small quantities of algae, Trichoptera and Chironomidae. Absence of vascular plants, seeds, pelecypods, and *Chaoborus* distinguish the food of carpsucker from the carp (5). Larger benthos, such as mayflies or odonates, were absent. No terrestrial insects were found.

Entomostraca totaled 15.2% of stomach contents of river carpsucker, but inter-reservoir variation was remarkably large (Table 1). Ostracoda, volumetrically 7.1%, was the largest category of animal constituents. Cladocera was second (6.7%), and Copepoda third (1.42%). Abundance of Ostracods was 7.1% overall, exceeding Copepoda only in Grand Lake, and elsewhere the relative abundance of Copepoda and Cladocera exceeded that of the Ostracoda. In stomachs of Lake Texoma fish, the relative abundance of Copepoda was especially great; it comprised 10.1% of the

TABLE 1. *Food habits of river carpsucker from Eufaula, Grand, Texoma and Fort Gibson reservoirs, September, 1967 through August, 1968. Data are percentages of total volume of food in all carpsucker stomachs for each reservoir; figures in parentheses are average number of organisms per tract in fish containing contents > 0.1 ml.*

	Grand	Fort Gibson	Eufaula	Texoma	All reservoirs
Plant					
Algae	0.06	0.14	—	0.04	0.08
Fragments	—	45.17	—	—	15.72
Animal					
Entomostraca					
Copepoda	3.74	6.62	1.00	10.06	6.76
	(255)	(179)	(14)	(215)	(211)
Cladocera	0.52	3.28	1.00	0.57	1.42
	(64)	(80)	(7)	(23)	(522)
Ostracoda	19.43	1.14	—	0.10	7.05
	(1076)	(24)	—	(4)	(340)
Insects					
Trichoptera	—	0.02	—	—	0.01
		(1)			
Chironomidae	0.72	0.10	0.50	0.50	0.30
	(11)	(2)	(4)	(1)	(44)
Fragments	0.38	0.21	1.00	0.53	0.37
Detritus					
Organic	75.05	43.12	96.50	87.84	67.95
Inorganic	0.10	0.20	—	0.81	0.34
No. stomachs examined	155	153	14	186	508
Percentage empty (< 0.1 ml)	1.3	3.3	0	2.2	2.0
Avg. vol. (ml)/fish	1.14	1.18	0.14	0.85	1.03
Avg. total length (mm)	434	434	455	445	439
Avg. total weight (g)	1178	1268	1359	1404	1314

contents. Ostracoda were exceptionally abundant in fish from Grand Lake, where they made up 19.4% of the total volume of tract contents, as compared with 3.7 and 0.5% for Copepoda and Cladocera, respectively.

Ostracods were very abundant in carpsucker in Grand Lake, where average number per fish reached 9900 in October, and the overall mean was 1076.

Monthly Variation. Monthly fluctuations in number of individual food items or in average volume of certain food items in carpsucker were compared with volume (acre-feet) of inflowing water and surface temperature for Grand and Texoma reservoirs. Monthly variation was not reviewed for Lake Eufaula because of inadequate sample size, and the 153 carpsucker taken in Fort Gibson were collected only from October through March, too short a period in which to discern trends.

Comparison of average volume of stomach contents and surface water temperature showed that the maximum monthly average volume occurred in October (Grand and Texoma reservoirs) when water temperatures were 22 to 23 C. In carp from these reservoirs, the largest average tract contents were encounterd in November and December when water temperatures were 9 to 11 C, as reported earlier (5).

Variations in monthly average volume of stomach contents in carpsucker showed neither a positive nor negative relationship to monthly average volumes of inflowing water. Maximum intake for all samples occurred in the October samples. Variations in volume of organic matter and total food volume were positively related, a finding which indicated that organic matter varied directly with total intake of food.

In Grand Lake, the maximum number of Cladocera in carpsucker occurred in November, when they averaged 336 per fish. Otherwise, occurrence of Cladocera was trivial to non-existent. In Texoma Reservoir, monthly variation of Cladocera per tract in carpsucker ranged from 1 to 46, and the maximum number, which occurred in March, coincided with the maximum inflow of water. Cladocera were quite abundant in Fort Gibson, where monthly averages ranged from 2 to 172 per stomach.

The maximum monthly average number of Copepoda found in river carpsuckers from all reservoirs was in those from Grand Lake, where 968 per fish were found in March. In fish from Fort Gibson and Texoma, the maximum average numbers of Cladocera occurred in November. Monthly variation in number of Copepoda in Grand Reservoir fish did not coincide with monthly variations in reservoir inflow.

TABLE 2. *Food habits of freshwater drum from Eufaula, Grand, Texoma and Fort Gibson reservoirs, September 1967 through August 1968. Data are percentages of total volume of food in all drum stomachs for each reservoir.*

	Grand	Fort Gibson	Eufaula	Texoma	All reservoirs
Animal					
Pelecypoda	—	—	9.56	13.95	1.10
Oligochaeta	0.63	—	—	—	0.47
Decapoda	—	28.41	51.75	0.93	8.95
Ephemeridae	0.14	3.50	—	—	0.58
Chironomidae	0.08	0.09	—	—	0.07
Chaoborinae	0.08	—	—	—	0.06
Insect fragments	0.11	—	0.56	—	0.14
Gizzard shad	67.86	50.65	—	45.12	57.91
Channel catfish	0.07	—	—	—	0.07
Drum	5.35	—	—	—	3.97
Fish remains	21.30	13.33	0.69	29.30	18.08
Detritus					
Unident. organic	4.38	4.02	37.44	10.70	8.60
No. stomachs examined	162	37	11	20	230
Percentage empty	27	32	9	55	30
Avg. vol. (ml) in stomachs with food	103	9.91	1.60	0.27	1.03
Avg. total length (mm)	322	297	254	300	310
Avg. total weight (g)	557	498	453	362	507

Freshwater drum

General findings. Composition of the stomach contents of 230 freshwater drum, averaging 310 mm (12.2 in) total length and 507 g (1.1 lb), was examined (Table 2). Total volumes of all food items for all reservoirs were used to obtain an overall average composition for the four reservoirs. In order of volumetric importance, food items were fish, crayfish, organic detritus, small clams (*Pisidium*), aquatic insects, and aquatic oligochaetes. Collectively, fish, principally gizzard shad and fish remains, comprised 80% of the total volume of all contents. Gizzard shad made up the major portion of the volumetric composition of drum stomach contents (45.1 to 67.9%) in all but those from Eufaula Reservoir, where, apparently, the sample was taken when drum were concentrating their feeding activity on infauna; their stomachs contained crayfish (51.8%), organic detritus (37.4%), and mussels (9.6%). All but four of 78 fish found in the stomachs of the total number (230) of freshwater drum examined occurred in drum from Grand Lake. In Grand Lake, 90% (74) of these ingested fish were gizzard shad, 6.7% were freshwater drum, and 3.3% were channel catfish. The four fish which occurred in drum from Fort Gibson and Texoma reservoirs were gizzard shad.

Crayfish comprised 8.9% of the average stomach contents of drum from all reservoirs, but this figure was 28.4% for Fort Gibson and 51.7% for Eufaula. Organic detritus accounted for 8.6% of the volumetric contribution. The average volume of stomach contents of the drum was 1.0 ml for all samples having a volume greater than 0.1 ml; the range was from 0.9 ml for Lake Texoma to 1.6 ml for Eufaula.

Monthly variation. Generally, collections of drum were insufficient to examine for monthly variation trends relating to temperature or other variables. However, in Grand Lake (where fish with food in their stomachs were collected in ten of the eleven months from October, 1967 through August, 1968), drum stomachs containing fish and fish remains were encountered predominantly from October through March. Insects, mayflies, chironomids, and *Chaoborus* were the only foods found in May and June. The smallest quantities of food were present in the stomachs of drum collected in May and June, when suitable sized forage fish were scarce. However, the average food volume when freshwater drum were feeding on insects was considerably less than the stomach capacity of drum captured.

In Grand Lake, gizzard shad were most abundant in the fall and summer and least abundant in the winter, at which time freshwater drum fed intensively on winter aggregations of small drum. Drum were found in stomachs of freshwater drum only from Grand Lake; channel catfish were present only in freshwater drum from Grand and Fort Gibson reservoirs.

DISCUSSION

River carpsucker

Whereas, in this study, 2% of the river carpsucker stomachs were classified as empty, in the Des Moines River, Iowa study empty stomachs were found in 26% of 104 river carpsucker (6), and in a report of Lewis and Clark Lake, on the Missouri River, 1.2% of the stomachs of 121 adult river carpsuckers were said to be empty (7).

The large quantity (*ca.* 68%) of organic detritus in the stomachs of carpsuckers was presumably derived from the unconsolidated portion of the mud-water interface which Dalquest and Peters (8) called the surface film. Walburg and Nelson (7) also found that organic detritus comprised 69% of the volumetric composition of food in age I and older river carpsucker in Lewis and Clark Lake, South Dakota. In Lake of the Ozarks, carpsuckers were browsers which fed on periphyton associated with submerged rocks and debris (9). Benthic to epibenthic feeding on soft substrate accounts for the occurrence of a large quantity of fine organic debris in stomach contents and supports the characterization of the river carpsucker as a "mud-benthos" feeder (10). Food of river carpsucker in Canton Reservoir, Oklahoma was mainly unidentifiable organic matter derived from bottom ooze (11). Harlan and Speaker (12) characterized the food of carpsucker as predominantly unidentifiable organic matter (86%), plant matter (18%), and insect larvae (2%).

Brezner (9), using frequency of occurrence as a criterion, determined that the food of river carpsucker in Lake of the Ozarks was mainly "microorganisms" (desmids, filamentous algae, diatoms, and cladocerans), organisms which we designate as microbenthos. Brezner concluded that carpsuckers are not mud-feeders, but browsers feeding on the periphyton of submerged rocks and debris; the organic matter in their stomachs was composed of identifiable microorganisms, such as those listed above. Buchholz (6), also using frequency of occurrence, reported diatoms (71%), green algae (69%), bluegreen algae (55%), desmids (54%), dipterous larvae and pupae (41%), *Difflugia* (37%), rotifers (24%), and Copepoda (22%).

Dalquest and Peters (8) used percentage composition of the volume of food items as the basis for description of food habits of carpsucker in Lake Diversion, Texas. Eighty to 90% of the contents were identifiable only as organic debris, sand, mud or trash. In Lake Diversion, river carpsucker was not considered a browser of periphyton because "There are few rocks or other hard objects to support a large population of browsing fishes." The identifiable food items were found to be diatoms and other algae, protozoa, rotifers, entomostraca, tiny immature insects, and invertebrate eggs. Our data agree with Dalquest and Peters (8) on relative abundance of Ostracoda and Copepoda and the scarcity of Cladocera. Walburg and Nelson (7) reported Cladocera comprised 4% of the volume and Copepoda, 11%. Ostracods were of much greater volumetric importance in carpsucker than in carp (0.3%) (5) or smallmouth buffalo (0.5%) (13). Thus, our findings corroborate those of Dalquest and Peters and of Walburg and Nelson, who characterized river carpsucker as microbenthophagous, *i.e.,* a feeder on the microbenthos, including the finely divided particulate organic matter from the profundal substrate.

Dalquest and Peters, however, believed that the organic debris, which they found to consist of infusoria, bacteria, and particulate organic matter, was not food. In our opinion there seems to be no basis for assuming river carpsucker cannot derive nourishment from the organic debris which is apparently obtained by feeding on the mud-water interface. We agree with Darnell (14) that organic detritus is an important source of organic imput to fish production.

The relative abundance of algae (0.08%), chironomids (0.30%), and trichopterans (0.01%) was very small in carpsucker of the Oklahoma reservoirs studied. Plant detritus was volumetrically important only in the case of river carpsucker from Fort Gibson and it did not obtain elsewhere. Plant matter, including algae and plant detritus, was not an important constituent in river carpsucker, probably because the size of plant fragments is too large for them to become a part of the surface film and filamentous algae were not abundant at the mud-water interface. The rarity of chironomids and absence of larger invertebrates indicate that either the fish select the larger food items or the nature of the feeding process does not permit deep penetration of the substrate and, therefore, items like oligochaetes are not consumed. *Chaoborus* was not found. Animal detritus was a minor stomach constituent. Due to lack of undigested fragments of sclerotized head capsules or other hard parts of animals, it is assumed that the diet of these fish rarely includes animals of that type. This observation offers another contrast between characteristics of the carpsucker and the carp. In the carp, animal fragments comprise 8.5% to 17.4% of the volume (5). The food of the carpsucker differs from that of the carp; the diversity of food is greater and the size of food is larger in the carp than in the river carpsucker. Carp are somewhat more omnivorous and, although consumers of organic detritus, *i.e.,* microbenthos, they consume seeds of terrestrial macrophytes (grasses and smartweed), multicellular algae, pelecypods, and *Chaoborus,* which are items lacking in the river carpsucker. Volumetrically, 9.1% of the alimentary tract contents of the smallmouth buffalo has been found to be Copepoda and 4% to 7%, Cladocera. A greater diversity of macrobenthos has been reported (6, 9) in river carpsucker than we found for these fish in four Oklahoma reservoirs. However, all previous studies indicated that the largest percentage, by volume, was of the smallest sized items.

Introduced European carp compete most closely with the river carpsucker and smallmouth buffalo which are native to the Arkansas and Red rivers. River carpsucker utilized, on the average, smaller food items than did either of the other species and its selectivity was greater. The major organic input into the diet of river carpsucker was particulate organic matter. The small average size of the food and the scarcity of macrobenthos characterized the river carpsucker as a microbenthophage. Dalquest and Peters (8) observed similarity between the diet of river carpsucker and of the bottom-feeding gizzard shad. River carpsucker is a selective profundal feeder but, within this relatively narrow range, it shifts from ostracods to copepods as a major food item depending on an availability of the items within the size range suitable for consumption.

Ostracods occurred in greater numbers in carpsucker in Grand Lake than in those of other reservoirs, but ostracods were more abundant in carp from Fort Gibson and Texoma than from Grand Lake. Differences in ratios of ostracods and Cladocera in carp and carpsucker apparently are related to differences in size selectivity. Species differences in habitat and use of food resources apparently reduce interspecies competition.

The imbibing mouth of carpsucker suggests a bottom feeder, but in the present study there is no evidence of indiscriminate polyphagy. Comparisons among diets of carp, river carpsucker, smallmouth and largemouth buffalo, and gizzard shad indicate adaptations related to selectivity by size of food and ability to utilize the diversity of organisms dwelling in profundal substrates. These adaptations and specializations reduce inter-specific competition and permit utilization of all food resources available in the reservoir. It also indicates a vastly more complex food web because these fish apparently compete with bacteria, infusoria, zooplankton, and macroinvertebrates for particulate organic matter.

Freshwater drum

The percentage of empty stomachs in freshwater drum was lower than that in flathead catfish (49.2%) (15), longnose gar (*Lepisosteus osseus*) (50%), or shortnose gar (*L. platostomus*) (57%) (16) from these reservoirs. Diversity of food used by drum was greater than by flathead catfish or gar; greater diversity affords greater possibility for frequent intake of smaller quantities of food. This observation also supports a generalization that piscivorous fish feed less frequently. The lowest percentage of empty stomachs occurred in freshwater drum from Eufaula, where no fish were found in any freshwater drum stomach. In Lewis and Clark Lake, South Dakota, fish comprised only 2.8% and mayflies (*Hexagenia*) 70.7% of the volume, while 3.9% of the freshwater drum had empty stomachs (17). Generally, empty stomachs were more frequently encountered in environments where aquatic insects were less commonly used and where fish comprised the bulk of the volume. In Norris Reservoir, Tennessee, 55.3% of 282 freshwater drum collected in 1943 and 71.1% of 90 freshwater drum collected in 1944 had empty stomachs, even where aquatic insects occurred in 51.6% and 34.6% of all stomachs (18).

Most observers of the feeding chronology of freshwater drum note that very small drum feed predominantly on the entomostraca and change to a mixed diet dominated by small insects, usually either mayflies or chironomids, mollusks, and small fish (15, 18, 19, 20, 21). Large adult drum utilize the same items as well as larger forage fish and crayfish.

In Lake Erie, 70.4% of total stomach volume of 108 freshwater drum, averaging only 36 mm (range 14 - 110 mm), was entomostraca, largely *Cyclops* and *Leptodera* (20). Volumetrically, chironomids and mayflies contributed only 14.8% and 6.5%, respectively, and fish only 1.2%.

Daiber (19) found copepods in 54.6% of young-of-the-year freshwater drum, evidence supporting the earlier findings of Ewers (20), but *Hexagenia* and the amphipod *Gammarus* were also recovered from 67.3% and 35.3%, respectively, of the 601 freshwater drum (13 - 460 mm) Daiber examined. Crayfish and fish were not abundant in stomachs of adult drum in Lake Erie; estimates of their occurrence were 13.8% and 7.8%, respectively. Price (21) examined small and large freshwater drum in Lake Erie and found entomostraca in smaller drum, invertebrates in intermediate sized drum, and some fish in larger drum.

Swedberg and Walburg (22) examined the diet of 162 young-of-the-year drum from Lewis and Clark Lake where, it was learned, *Daphnia* and *Cyclops* made up 90% of the food consumed by fish 6 - 15 mm long. *Hexagenia* constituted 24%, chironomids 4%, and entomostraca 71% of the volume in stomachs of freshwater drum of 106 - 115 mm total-length. Entomostraca were used only by young freshwater drum, but before the end of the first summer these fish fed on mayflies and chironomids. In Lewis and Clark Lake, relative importance of chironomids, *Hexagenia* and entomostraca varied with site of capture. *Hexagenia* made up 22% of the stomach contents of freshwater drum captured from the flood plain, but only 1% of the contents from fish in the old river channel; chironomids accounted for 31% and 8% of the contents for the flood plain and river channel areas, respectively.

The principal forage fish of large adult freshwater drum in Oklahoma reservoirs is gizzard shad, which is also the major forage of longnose and shortnose gar (16), flathead catfish (15), and largemouth bass (23). Gizzard shad are used intensively by white bass and large channel catfish. Gizzard shad are dispersed vertically from near surface (epipelagic) to near bottom (profundal) and horizontally from littoral to pelagic habitats. Freshwater drum also ate smaller drum. Channel catfish occurred in stomachs of freshwater drum from Grand Lake, but no other game fish were found in the fish stomachs.

Of eight commercial species examined from these reservoirs (16), only freshwater drum and the two species of gar contained relatively large quantities of mayflies. In Fort Gibson, mayflies comprised 3.5% by volume of freshwater drum stomach contents. Only pieces of mayflies were found in carp, but no trace of mayflies was noted in carpsucker, flathead catfish or buffalo. Mayflies comprised 1.7% of the food volume in longnose gar in Fort Gibson and 4.4% of the food volume in shortnose gar in Lake Texoma (16).

Adult freshwater drum are commonly characterized as molluscophagous (24, 25) because they do eat snails and freshwater mussels, which are crushed with flattened molariform teeth (modified pharyngeal teeth) in the buccal cavity. In the present study, pelecypods comprised 1.1% of the total food volume of drum in all reservoirs, but in Eufaula and Texoma reservoirs pelecypods made up 9.6 and 13.9%, respectively, of the total volume. Most other investigators (17, 18, 19, 26) have not found that freshwater drum consume many gastropods or pelecypods, but availability may have limited consumption. In Wheeler Reservoir in northern Alabama, drum < 10 inches long (age groups I-IV) fed predominantly on diptera larvae (*Chaoborus* and Chironomidae), whereas fish > 10 inches (age groups V-XIII) fed predominantly on Asiatic clams (*Corbicula*) and gizzard shad (27).

Oligochaetes occurred in freshwater drum from Grand Lake, a fact worth recognition because oligochaetes did not occur in carp (5), river carpsucker, smallmouth and bigmouth buffalo (13). We assumed the absence of oligochaetes in carp was due to carp feeding only in the superficial layers of substrate. Obviously, freshwater drum were penetrating the substrate to a depth much greater than did carp as indicated by the abundance in drum of crayfish and pelecypods, and the occurrence of burrowing mayflies (*Hexagenia*) and chironomids.

This study did not include feeding chronology, but gill net selectivity resulted in a catch of fairly uniform size (254-322 mm total length). For freshwater drum of the size examined, fish as food was much more important in Oklahoma reservoirs (comprising 80% of stomach volume) than reported for Lake Erie (19, 20), Lake Winnebago (2), Iowa lakes (26), or Lewis and Clark Lake (17). In the last lake, fish comprised only 2.8% of the volume but *Hexagenia* contributed 70.7% of the volume. Although difficult to compare with the present study because the data were reported as frequency of occurrence, Dendy (18) found freshwater drum that, in 1943, in Norris Reservoir ate mostly aquatic insects (51.5% of 126 freshwater drum with one or more items), whereas fish or fish remains were present in only 26.2% of the drum. Entomostraca were present in 22.2% of stomachs containing food, but they probably accounted for only a small percentage of the biomass. In 1944, Dendy found aquatic insects in 54.6% of 26 stomachs, and fish and fish remains in 53.8% of the fish. Priegel (2) reported that *Chironomus plumosus* accounted for 88.3-99.3% of the total food volume of 672 adult freshwater drum in Lake Winnebago, Wisconsin during April, July and October, while leeches accounted for 0.5 to 10.5% of the volume, and fish only 0.2%. In Lake Polygon, Wisconsin *C. plumosus* accounted for 99.8 to 100% of the total food volume.

Clemens (28) examined stomach contents of freshwater drum in two Oklahoma reservoirs shortly after impoundment. In Tenkiller Reservoir collections commenced in the river channel as water levels were first rising and in Fort Gibson Reservoir collections were made the year after impoundment. Stomach contents of freshwater drum 4-11 inches, collected in Fort Gibson with rotenone, by percentage frequency of occurrence were 71.6% fish, and invertebrates, 62.1%. Thirteen freshwater drum, 14-17 inches, collected in Tenkiller Reservoir, contained fish, 15.4%, mayflies, 92.3%. Terrestrial invertebrates were not found in freshwater drum stomachs in either reservoir.

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