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A survey of the food habits and distribution of the fishes of Tuckahoe Creek, Virginia, with special emphasis on Lepomis macrochirus Rafinesque

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A SURVEY OF THE FOOD HABITS AND DISTRIBUTION OF THE FISHES OF TUCKAHOE CREEK, VIRGINIA, WITH SPECIAL EMPHASIS ON *LEPOMIS MACROCHIRUS MACROCHIRUS* RAFINESQUE

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Introduction

An integral part of the ecological study of any organism is a good understanding of the food relationships. Basic studies of the distribution and ecology of common fresh-water fishes are necessary before a more detailed analysis can be made of the fishes in a particular area. Lagler (1956) states that food habit studies help determine population levels, rates of growth, and condition of the fishes. He also concludes that they serve as a partial basis for determining the status of various predatory and competing forms. Raney (1942) states that an intelligent fishery management program depends heavily upon information gained through food habit analyses.

In the present survey a study was made of the distribution and food habits of the fishes of Tuckahoe Creek, Virginia. Lepomis macrochirus (bluegill) was especially considered to determine if differences existed in the food when related to age, sex, size, season, and habitat. The treatment of the other fishes was dependent on the amount of data available which often warranted only a simple listing of the food.

Many food and distribution studies have been undertaken in the past. A relatively thorough search of the literature revealed, with few exceptions, that most were concerned with only a few species of fishes. Forbes (1888) gave an excellent account of the food of 87 species of fishes

in Illinois which were taken under different ecological conditions and at different times of the year. Later, Forbes and Richardson (1908) provided and exhaustive treatment of the food and habits of fishes from the same area. In a comparable work, Pearse (1918), completed a comprehensive study on the food of some fishes in certain Wisconsin lakes. Reigard (1915) reported on the ecology and food of the fishes of Douglas Lake, Michigan, emphasizing the fish communities in relation to the biology of the fishes. Sibley (1928 and 1929), and Pate (1933) investigated the food habits of fishes in New York, in a program supported by the New York Conservation Department. A detailed food study was made by Dendy (1946) on some fishes of Norris Reservoir, Tennessee. His paper was of particular value as a source of pertinent literature in the present study.

The food habits of the basses of the family Centrarchidae and the cold water salmonids have probably been studied more thoroughly than any other groups of fishes. Tester (1932) analysed the stomach contents of Micropterus dolomieu (smallmouth bass) from some Ontario waters. Surber (1941) studied the food habits of M. dolomieu in Virginia and West Virginia and found the Shenandoah River of Virginia to be especially productive. In Columbia Lake, Conneticut, Webster (1944), described the food habits of M. dolomieu and of interest was a discussion of statistics used in the interpretation of seasonal variations in the number of stomachs with food as opposed to those which were empty. Some basic factors con-

trolling the productivity of young M. salmoides (large-mouth bass) in Michigan ponds were considered by Cooper (1937). The food of trout in Fish Lake, Utah, was determined by Hildebrand and Towers (1927) and they concluded that the large amount of vegetation present in the lake was favorable to a high productivity of these forms. Hazzard and Madsen (1933) made a comparative study of the stomach contents of trout (largely Salmo leivisi) from lake and stream habitats of the Rocky Mountain regions in Wyoming and Montana. The transition of the diet in young specimens of Salmo trutta (brown trout) in central New York was reported by Raney and Lachner (1941). Similarily, Evans (1952) studied the food habits of S. trutta from the same approximate region and noted a high per cent of terrestial forms in the diet. This paper is especially good as a literature source of the food of trout. Leonard and Leonard (1949) analysed the food of Salmo gairdnerii (rainbow trout) and Salvelinus namaycush (lake trout) in Birch Lake, Michigan, and found that these fishes did not feed upon the abundant specimens of Leucichthys arteidi (cisco) as expected but fed primarily on aquatic insects and forage fishes. The seasonal fluctuations in the feeding of Salvelinus fontinalis (brook trout) in the Pigeon River, Michigan, were reported by Bensen (1954). Reimers (1957) conducted studies on the relation between stream food and trout survival in California. Allen (1941) compared the food habits of Salmo salar (Atlantic salmon) from two different river systems in England and Scotland.

Studies which involve fishes other than the centrarchid basses and salmonids are relatively few. Starrett (1950) in an extremely good paper reported on the food habits of 13 species of cyprinids in the Des Moines River, Iowa. In a study by Lachner (1950) the comparative food habits of the cyprinid fishes, Hybopsis biguttata (hornyhead chub) and H. micropogon (river chub), were analysed. Both Pfeiffer (1955) and Reed (1957) included food habit information in life history studies of Notropis rubellus (rosyface shiner); the former worked in New York and the latter in Pennsylvania. Outten (1957) reported on the food habits of N. coccogenis (warpaint shiner), and later (1958) on N. galacturus (whitetail shiner) and N. rubricroceus (saffron shiner). In an investigation of Phoxinus phoxinus (European cyprinid), Frost (1943), in England, included a good discussion of the food of the species in a natural history study. Several papers have been published which concern members of the family Esocidae. Of particular interest in the present investigation was the study by Raney (1942) of Esox niger (chain pickerel) in a small artificial lake in New York. He showed conclusively that a correlation existed between dietary items and the size of the specimens. Bailey and Harrison (1948) reported on the food of Ictalurus punctatus (channel catfish) as it was related to the various sized specimens. Reid (1950) gave a good account of the food and other ecological factors which were related to the centrarchid Pomoxis nigromaculatus (black crappie) in Orange Lake,

Florida. Diaber (1956) in a comparative study of the winter feeding habits of the percid Etheostoma flabellare (fantail darter) and the cottid Cottus bairdi (mottled sculpin) discussed some of the factors which maintained competition between the two at a low level.

Many of the previous studies have been concerned with the quantity of food material consumed and the workers therefore, have often employed a volumetric analysis. The present study; however, is not concerned with volume of food but rather with the number of fishes with food and the number of organisms taken.

Materials and Methods

One hundred and forty-three collections were made at six different stations between June 13 and December 22, 1958. A total of 31 species of fishes representing nine families was collected. Collections were made with either a six-foot or ten-foot seine of one-quarter-inch mesh size. The specimens were placed in 10 per cent formalin; large individuals were first slit along the right ventral body wall to insure adequate preservation of internal organs. To prevent mixing of collections, marked cotton bags were were used as containers at each station. This technique caused partial suffocation of the specimens which minimized the chance for regurgitation of food items. Webster (1942), while working on the food habits of Morone americana (white perch), also used a suffocation method to prevent regurgitation of food. Field data

were recorded and included the following: collection number, date, method of capture, air and water temperature in degrees C., turbidity, weather conditions, and the species collected. Also included were general descriptive data such as the presence of animals other than fish, the predominant flora, topographical features of the immediate area, and general characteristics of the stream other than listed above. The water flow was measured according to the method of Embody (1927). All hydrogen ion concentrations were measured by the method given by Suckling (1944). A preliminary survey of the creek was first made to determine the possible food organisms present. The angle of inclination of the creek banks was measured with the aid of a protractor. The terms which are used to describe bank inclination at the various stations are: flat -- zero to 29 degrees, moderately inclined -- 30 to 59 degrees, and steeply inclined -- 60 to 90 degrees.

Each collection was cataloged and placed in individual containers with 10 per cent formalin. Laboratory data for each specimen examined were recorded on separate sheets. The following measurements were made according to the procedure as outlined by Lagler (1956): specimens were weighed to the nearest 0.1 gm., standard length (from tip of snout to hypural) was recorded to the nearest mm., standard depth was measured to the nearest mm. at the point of greatest body depth. Sex was usually determined by gross examination of the gonads; however, with small fish it was often necessary to use either

a binocular stereoscopic or compound microscope. Age determinations were made by the standard scale method and by the vertebral method used by Hooper (1949). Where possible, eight specimens of a species were examined from each collection. To avoid bias due to size, individuals were selected as far as possible to include a specimen from each size range. The stomachs were removed by cutting the esophagus just behind the transverse septum and at the pyloric valve. As the catostomids and cyprinids do not possess a distinct stomach the alimentary tract in these forms was examined back to the first anterior loop of the intestine. Food items were separated as to type and counted. Usually the family was the lowest taxonomic catagory used in the recording of food items, but this choice depended upon many factors such as the retention of key characters and the size of the food items. Microscopic examination was often necessary to identify stomach contents, although the problem dealt primarily with macroscopic forms. Each fish examined was identified by a code number which corresponded to the laboratory data sheet. Microscopic items were not counted individually, but a particular group (i.e. diatoms) was counted once for each stomach if it was present. Such items as digested matter, unidentified insect parts, plant material, and miscellaneous items were considered as one item since an accurate count of these groups was beyond the limits of this problem.

In the preparation of tables only stomachs that contained items were used in the calculations. Statistical methods, where applicable, were used to check significant differences between means and followed Snedecor (1953). Abbreviations used in the tables to denote various food items were: (L) larva, (N) nymph, (P) pupa, (P,A) pupa and adult, (U.I.L.) unidentified insect larva, (U.I.N.) unidentified insect nymph, (U.I.P.) unidentified insect parts, (D.A.M.) digested animal matter, (D.V.M.) digested vegetable matter.

Description of the Area

Tuckahoe Creek, a tributary of the James River, is a typical lower piedmont stream comprised of short riffles and long deep pools (Map 1). The creek is 16 miles in length and has a drainage area which approximates 60 square miles. The headwaters are located in Goochland County; the lower half forms, in part, the Goochland-Henrico County line. With an elevation of 270 feet at the origin, the stream drops 150 feet to an elevation of 120 feet at the mouth. A gradient of 20 feet per mile occurs in the upper third of the stream but gradually decreases to five feet per mile in the lower reaches. Extensive open areas of cultivated fields and pastures occur in the drainage of the upper third of the creek, while the lower part is heavily wooded marsh land. The composition of the bottom changed from bedrock and sand-

gravel mixture upstream to mud, clay, and debris downstream. Turbid water, a characteristic of the creek, resulted from the heavy silt load. Slight acidity was indicated by the pH which ranged between six and six and one-half. The following is a brief account of the salient features of each of the six collection stations.

Station A. Located in a pasture, and with a length of about 200 feet, Station A was limited upstream by a pool three feet in depth and downstream by a bridge (Plate I). Average width was eight feet and average depth one-half foot. The bottom substrate of the stream was a mixture of sand, coarse gravel, and bedrock, with shifting sand in the pools. The banks were moderately inclined and undercut in many places. The flow averaged two cubic feet per second and, although it increased after rains, it soon returned to the average volume. Turbid conditions were noted about 20 per cent of the time. Water temperatures ranged from 30 degrees in August to six degrees in December. Several grasses which included Arthraxon hispidus, a rare grass in Virginia, and an occasional Platanus occidentalis (sycamore) formed the typical plant cover of the shore. Filamentous algae were prevalent on the rocky substrate and in the shallow pools.

Station B. The area collected was approximately 150 feet in length; bounded upstream by an abandoned mill dam which had deteriorated into a series of step falls and downstream

by a deep pool approximately five feet in depth (Plate II). The average width and depth measured 20 feet and two feet respectively. From the dam downstream the character of the bottom changed from bedrock to shifting sand. The banks, which were steeply inclined upstream, gradually changed to low and overhanging toward the lower limit of the area. A semi-isolated pool 15 feet in length with a depth approximating one foot was located on the south side of the creek. An average flow of eight cubic feet per second was recorded but considerable fluctuation occurred during the period of study. Turbid water conditions occurred approximately 60 per cent of the time. The highest water temperature recorded was 26 degrees in August; the lowest, three degrees in December. Lonicera japonica (honey suckle), Jussiaea decurrens (primrose willow), Cyperus sp. (sedges), and various unidentified grasses formed an abundant ground cover. Algae were common on the rocks and in the pools. While the dominant tree was Platanus occidentalis, others such as Liquidambar styraciflua (sweet gum) and Liriodendron tulipifera (yellow popular) shaded the stream.

Station C. The collection area was approximately 150 feet in length; limits upstream were determined by a bridge and downstream by a deep pool about five feet in depth (Plate III). The average width and depth measured approximately 15 feet and two feet respectively. Shifting sand comprised the bottom substrate and about one-half of the shore line. The remaining shore line consisted primarily of clay, was steeply inclined,

and in some places overhung the water. The measured flow averaged 12 cubic feet per second; however, the rate was greatly affected by the quantity of run-off water. The water was turbid, in varying degrees, about one-half the time. A range from 33 degress in July to five degrees in December was observed for the water temperature. The dominant plant species present were Lonicera japonica, several unidentified grasses, Cephalanthus occidentalis (button bush), Rhus sp. (sumac) and Salix fragilis (crack willow). Filamentous algae were plentiful in the pools.

Station D. The creek was difficult to collect in at this point as the depth of the channel ranged to five feet and made it virtually impossible for one man to haul a seine. The area collected approximated 200 feet in length and was limited upstream by marshy conditions and downstream by debris which formed an almost impassable barrier (Plate IV). Although the creek averaged 60 feet in width, the only accessable part was located on the east side of the main channel and averaged approximately three feet in depth. A small island near the middle of the station separated the main channel from a narrow vegetation-choked passage. Mud and decaying plant materials composed the major part of the substrate. Low marshy land, wet most of the collection period, formed the shore on both sides of the stream. Water flow which showed considerable fluctuation following periods of heavy rainfall measured 30 cubic feet per second. The water re-

mained turbid throughout the entire study irrespective of rainfall. Water temperatures ranged from 24 degrees in August to seven degrees in December. During the latter half of December a three-inch thickness of ice covered the station. Emergent plants commonly encountered were Polygonum hydropiper (water pepper), Nuphar advena (water lily) and several unidentified grasses. On the shores the dominant shrub was Cephalanthus occidentalis and the trees occurring in greatest number were Carpinus caroliniana and Betula nigra (river birch).

Station E. The area collected was about 150 feet in length; both the upstream and downstream limits were formed by deep debris-filled pools (Plate V). The average width measured 15 feet and the average depth three feet. The bottom substrate consisted of a combination of sand, clay, and debris. Relatively flat to moderately inclined banks lined the stream. An average flow of 30 cubic feet per second was recorded but considerable fluctuation correlated with rainfall occurred during the study. The water appeared turbid approximately 40 per cent of the time. Water temperatures ranged from a high of 25 degrees in July to a low of zero degrees in December. Ice covered the station during the low temperature period. Ground cover for the banks was virtually non-existent; however, trees were plentiful, with Quercus bicolor (swamp white oak), Betula nigra and Carpinus caroliniana predominating.

Station F. The collection area was approximately 100 feet in length; both the upper and lower limits were determined by deep debris-filled pools (Plate VI). Near the upper end of the area an island separated the stream into two branches, each about 20 feet wide and two feet deep. The west branch formed the main channel, the east consisted of two connected pools. Sand, mud, and debris composed the bottom substrate. The banks were relatively flat to moderately inclined and undercut in several places, especially along the main channel. Water flow measured at the upper end of the island averaged 30 cubic feet per second. Heavy precipitation often caused the stream to overflow the banks and flood the surrounding area. Turbid water was noted approximately 75 per cent of the time. Water temperatures ranged from 25 degrees in July to zero degrees in December; icing conditions occurred in the latter part of December. The banks, composed of clay and practically devoid of ground cover, remained wet most of the collection period. Tree cover along the shore was dominated by Quercus bicolor, Betula nigra and Carpinus caroliniana.

Food habits and distribution of the centrarchid *Lepomis macrochirus*

Three hundred and fourteen stomachs were examined, of which 273 contained food material. The species was present at all stations, occurring most abundantly at Station B (Table 1). Although many different organisms were present in the diet only a few were consistent in occurrence (Table 2). The wide variety of food items indicated that L. macrochirus consumed what was

present and selectivity operated only in favor of an animal diet. Insects (65 per cent) and crustaceans (29 per cent) formed the major part of the diet. Dipteran larvae (mostly Tendipedidae) made up the highest mean number of items per all stomachs (4.6) and were contained in the most stomachs (45 per cent). Copepods (mainly Cyclops sp.) were next in occurrence with a mean of 2.1 and were found in 25 per cent of the stomachs. Fifty-five per cent of the total items were composed of two groups, dipteran larvae (38 per cent) and copepods (17 per cent). Turner (1955) in an analysis of 18 Kentucky farm ponds found chironomid larvae (Tendepedidae) to comprise the bulk of the food of all size ranges examined. Hemiptera (predominantly Corixidae) occurred in 29 per cent of the stomachs and ephemeropteran nymphs (many Hexagenia sp.) were taken in only five per cent of the stomachs but made up slightly more of the total items than Hemiptera. Cladocera (seven per cent) were consumed in approximately the same per cent of total items as ephemeropteran nymphs. Trichopteran larvae were eaten by seven per cent of the fish and Coleoptera were identified in 10 per cent of the stomachs. Of the coleopterans, the family Curculionidae was the most numerous, with several other families; Carabidae, Scarabaeidae, and Crysomelidae, occurring but a few times. All other groups listed in Table 2 are shown to have little importance in the diet of L. macrochirus. Plant material, found in 10 per cent of the stomachs, was composed predominantly of filamentous algae, bits of leaves, seeds, and plant stems. When the amount of plant material found in the present study is compared with

that of past studies by other workers it is found to form an exceedingly small part of the diet. Rice (1941) found plant material to comprise 40 per cent by volume of the food taken by this species in Reelfoot Lake, Tennessee. Chable (1947) concluded that plant material which was present in 50 per cent of the stomachs of L. macrochirus purpurescens was unimportant since it was undigested in the intestine. Although not within the limits of the present study, Gerking (1954) in a nutritional study stated that "it remains to be learned whether aquatic plants contribute significantly to the protein requirement of the bluegill".

Comparison by station. Tables 3 through 11 are concerned with the food of L. macrochirus; Tables 3 through 8 list the food items by station, and 9 through 11 contain only those items which were most abundant. Insects were by far the most abundant food class at all stations except A where Crustacea (Copepoda) formed the major item in the diet. Dipteran larvae (mainly Tendipedidae) were the most numerous insect item at all stations except at F where ephemeropteran nymphs predominated in per cent of total items (one stomach contained 179 specimens). Hemipterans were an important food at Stations A through D and made up a higher per cent of stomachs with items than did dipteran larvae at Stations A and C. Food items such as Coleoptera, Trichoptera, and Hymenoptera were of minor importance, their role in the diet varied among stations. Copepoda constituted the highest per cent of crustaceans utilized as food except at Station F where cladocerans were

abundant. Items other than those mentioned above occurred sporadically and less frequently.

The highest per cent of dipteran larvae (72 per cent of the total items) was found at Station D. This is probably correlated with the abundant vegetation at that station as tendipedids are primarily herbivores (Pennak, 1953). The group made up an extremely small part of the diet at Station A and was contained in fewer stomachs than were Hemiptera and Hymenoptera (Tables 9-10). This is especially interesting as tendipedids formed the bulk of the diet of the many specimens of Etheostoma olmstedi, the darter; however, the darters inhabited the swifter flowing water at A while L. macrochirus showed a preference for the small adjacent pools. Hemipterans (primarily Corixidae) were important items of the diet at Stations A, C, and D, and why this group was less important at the other stations is not readily explainable as they appeared to be plentiful at all stations. Hymenoptera (mainly Formicidae) were eaten in considerable numbers by L. macrochirus at the stations in the upper sections of the creek; however, only at Station A were they found in a high percentage of the stomachs (Table 10). Large numbers of ants were noticed in the surrounding pasture at A and the high occurrence at this station may be due to breaking of the ant infested bank by livestock as they moved into and out of the creek. Although present at all stations in large numbers, Gerridae (water striders) were consumed only by three fish, all at Station B; similarly, there were no Gyrinidae (whirligig beetles) eaten. Palaemonidae (shrimp) and young Astacidae

(crayfish) were also present at all stations; shrimp were especially abundant at Stations D and F; however, they were consumed only by three fish at D and one at F; only one crayfish was eaten and that was taken at Station C. From the data it can be seen that these forms were definitely not selected as food items by L. macrochirus. Copepods (58 per cent) were most abundant in the diet at Station A where they were probably concentrated in the small pools. At Station D copepods made up only four per cent of the total items, the lowest per cent that this form contributed to the food at any station (Table 9). The size of the fish was ruled out as a selection factor as fish at Station D approximated those of other stations where copepods were important dietary items. A more probable factor affecting copepods as an item in the diet was the extremely turbid water conditions at Station D which prevented the small organisms from being seen by the fish. This group was about equal in importance at Stations B, C, and E, while at Station F cladocerans along with copepods formed an important dietary item.

Comparison by age and size. Tables 12 through 20 are concerned with the food of L. macrochirus as related to age and size of the specimens. Fish ranged in age from young of the year through six years but specimens in age-groups V and VI are not included in the tables as there were only three of these. Insects which formed the major food item for all ages were represented most often by dipteran larvae which were consumed in the greatest quantity by age-groups 0 and I fish (48 and 53 per cent respectively), but were readily taken by all other age-groups as well (Table 12). While hemipterans were important in the diet of all ages they were of lesser import-

ance in the diet of age-groups 0 and I (Table 13). Hymenoptera were of importance in the diet of age-groups II and III where they formed 15 and 17 per cent of the stomachs with items, respectively (Table 16). Coleopterans which were completely absent from the diet of age-group 0 became a major item in the diet of age-groups III (30 per cent) and IV (63 per cent; Table 14). Trichopteran larvae were relatively unimportant in the diet but occasionally large numbers were found in a single specimen, e.g. two stomachs contained 26 larvae (Table 15). Although ephemeropteran nymphs were a minor item in all groups, one age-group III fish contained 179 specimens (Table 17). Table 18 shows copepods to compose an extremely important part of the diet in age-groups 0 and I (55 and 31 per cent, respectively) with a sharp decline in occurrence in older age-groups. Cladocerans were present in 16 per cent of the stomachs with items in age-group I and were of no significance in older fish (Table 19).

From the results it is indicated that the fish size and size of food are correlated; that is, small fish feed on small organisms, large fish on larger organisms. Dipteran larvae and copepods which barely escape microscopic description occurred in the largest per cent of stomachs in age-groups 0 and I while larger organisms, e.g. Coleoptera and Hymenoptera, were definitely more abundant in the diet of older fish. Although fishes and arachnids are not presented in the tables their presence in the diet of older fish as opposed to their absence in younger fish supports the correlation of fish size to the size of the food item. Conspicious because of their

minor role in the diet are the larger immature and adult insects (Megaloptera and Odonata; Table 2). This is explained on the basis of the relatively small size of the adult L. macrochirus present in the creek. Moffett and Hunt (1943) found that this species fed primarily on plankton and did not feed to any degree on insects until the fish approached 200 mm. in length. This was one third again as large as the largest specimen in the present study. While not easily discerned in the tables it was noted in the examination of the stomachs that young fish, age-groups 0 and I, generally had distended stomachs, while older specimens contained fewer items. From this it is assumed that younger fish feed more often than do the older ones.

Comparison by month. Tables 21 through 23 show a monthly comparison of the food items present in the diet of L. macrochirus. Of the insects, dipterans were consistently found in the most stomachs (Table 21) and with but few exceptions were the most abundant single food item (Table 22). Larvae (mainly Tendipedidae) formed the major part of the dipteran diet and were especially abundant from July through October. Apparently the abundance of tendipedids during the period was a result of increased hatches as it is difficult to explain such an occurrence on any other basis. Dipteran pupae and adults; however, were mostly Culicidae and as evidenced from the data reach their maximum importance in early fall. Over one-half of the ephemeropteran nymphs present in June were taken in one stomach. A similar phenomenon also increased the importance of trichopteran larvae in June. Members of the Hemiptera (primarily Corixidae) were

second in importance to Diptera as a consistent item in the diet. Their period of importance paralleled that of the dipteran larvae and reflects the abundance of this group during the summer months. Hymenoptera (primarily Formicidae) were taken in small numbers throughout most of the collection period. A late fall increase as shown in Tables 21 through 22 is not readily explainable.

Copepods were the most important non-insect item and were a prominent part of the diet. Their importance increased greatly toward the fall of the year when they replaced the declining number of insects as the most frequently taken item (Table 22). Of interest were similar findings of Moffett and Hunt (1943), in an analysis of the winter feeding habits of L. macrochirus in Cedar Lake, Michigan, who concluded that the species feeds but little during the winter months and that the diet is composed mainly of ephemeropteran nymphs and entomostracans. In the present study a slight trend was noted for empty stomachs to occur more often during the colder months; however, the December termination of the problem prevented an analysis of this phase.

Comparison by sex. There was no evidence of sexual dimorphism as related to the food habits of L. macrochirus. All of the other species were checked for this character and no important differences were noted. Whenever possible, the statistical "student t" test was applied to the average number of food items per sex at the 95 per cent level.

Other Centrarchidae

Lepomis gibbosus (Linnaeus). Pumpkinseed sunfish. Thirty-eight specimens were examined, 35 were found to contain food material. Stations B, C, and D were the only habitats in which the species was collected (Table 1). In this insectivorous form, dipteran larvae (mainly Tendipedidae) comprised 63 per cent of the total items and were identified in 57 per cent of the stomachs (Table 24). A small amount of plant material, composed of bits of leaves and grass, was present and is considered accidental. Mr. Robert Martin, Assistant Chief, Fish Division, Virginia Game Commission, Richmond, Virginia, mentioned the food of this species taken in a mountain lake of Virginia to be predominantly snails, whereas L. macrochirus from the same waters contained mainly insects and vegetative material (personal communication). In a volumetric food analysis of fishes from some Wisconsin lakes, Pearse (1918), found insects to form approximately 21 per cent, snails (26 per cent), large Crustacea (10 per cent), plants (26 per cent) with other items much less abundant. L. gibbosus, like most members of the genus Lepomis, is apparently an opportunist and feeds on those organisms most available.

Lepomis auritus (Linnaeus). Yellowbelly sunfish. Thirty-five specimens were examined and 25 individuals were found to contain food material. This was one of the few centrarchids taken at all collection stations (Table 1). Carnivorous in food habits, insects composed 88 per cent of the food items (Table 25). Many dipteran larvae were eaten by a few fish;

however, coleopterans (primarily Curculionidae) were also an important food source. Food habit studies on L. auritus were not available.

Chaenobryttus gulosus (Cuvier). Warmouth sunfish. Thirty-one stomachs were examined and 19 individuals were found to contain food items. The specimens were taken at Stations B and D in the heavily vegetated areas (Table 1). Insects comprised 58 per cent of all food items, crustaceans were next in occurrence at 17 per cent (Table 26). This was the only form which took an adult Libellulidae (dragonfly). Crustaceans consisted of four Astacidae (crayfishes) and two Palaemonidae (shrimp). An Aphredoderus sayanus (pirate-perch) and one unidentified centrarchid composed the fish items. The plant material was made up of bits of leaves and is thought to have been accidental in occurrence. Forbes and Richardson (1908) stated that this species fed predominantly on insects and fishes. Rice (1941) found crayfishes composed 99 per cent by volume of the diet at one period, but in a previous year only 46 per cent of the food was attributed to crayfishes. The present study agrees with both Rice and Forbes and Richardson as insects, crayfishes, and fishes were found in the the diet.

Enneacanthus gloriosus (Holbrook). Bluespot sunfish. Twenty-one specimens of this small sunfish were examined and 15 contained food items. All of the specimens were collected in deep pools in the lower-half of the creek (Table 1). Although for the most part indiscriminately carnivorous, the relatively

large number of crustaceans indicated some selection for these forms (Table 27). Crustaceans composed 55 per cent of the total items which accounted for the highest per cent of crustaceans consumed by a centrarchid. Dipteran larvae (mainly Tendipedidae) were the most often eaten item but comprised only 21 per cent of the total items. These results agree generally with those of Hildebrand and Schroeder (1928) as they reported the diet was made up mainly of Entomostraca with some insects, worms, and plant remains occurring in but a few stomachs. Published information on the food habits of E. gloriosus is scarce as little information was available.

Centrarchus macropterus (Lacepede). Flier. Nine specimens were collected from the lower three stations and seven contained food material (Table 1). In this insectivorous form, insects comprised 88 per cent of the total items. Although this was a small sample, when the Hemiptera (67 per cent; mainly Corixidae) are compared with the per cent of items of other fishes (highest Gambusia affinis; 34 per cent) the num- indicates that corixids constitute an important item in the diet of this form. Other food items were occasional in the diet (Table 28). No published information was available on the food habits of C. macropterus.

Micropterus s. salmoides (Lacepede). Three small specimens of this well known game fish were collected at Stations B and C (Table 1). One individual had eaten a corixid and a fish (Etheostoma olmstedi); another had consumed two un-

identified fishes and the stomach of the third specimen contained digested animal matter. The small population, as evidenced by the small sample, is probably the result of several factors such as few available spawning areas (bottom substrate mud or shifting sand), relatively few insects (based on stomach contents of other species), and pressures exerted by the large population L. macrochirus in food competition (Brand, 1954). These factors plus the presence of the predominant predator E. niger add up to a poor habitat for M. salmoides.

Pomoxis nigromaculatus (LeSueur). Only two specimens of this popular pan fish were collected, both from Station D. In one an odonate nymph was found and in the other the remains of a cyprinid. Reid (1950) reported that gizzard shad were the most important food item of the adult crappie except during the spring months of February, March, and April when their frequency was exceeded or equalled by Malacostraca.

Food habits and distribution of Cyprinidae

Notropis cornutus (Mitchill). Common shiner. One hundred and eighty-nine specimens of this common minnow were examined, of which 174 contained food items. Although adaptable to most habitats in the creek as is indicated by the distribution, over 90 per cent were collected in the upper-half of the creek. Station B with a shallow backwater area which provided an excellent habitat for young fish contained the greatest numbers of N. cornutus (over 50 per cent of the total;

Table 1). Omnivorous in food habits, plant and animal material was consumed in approximately the same frequency with seasonal selection apparently correlated with abundance of the food (Graph 1). The bulk of the plant food was composed of filamentous algae, diatoms, and desmids; insects contributed most to the animal diet (Table 29). June and November were the peak months for animal matter while plant food was highest in occurrence during August and December. Breder and Crawford (1922) in a seasonal dietary study of this and five other cyprinids near the District of Columbia found twice as much insect as vegetable material in N. cornutus with little food being consumed during the winter months. They implied that plant material was taken accidentally since it was unplasmolyzed. Reigard (1915) reported animal matter to consist of Entomostraca, insect remains, and bryozoans; plant matter, fragments of green leaves and possible digested algal remains. The latter suggests that plants may be of some nutritional value. The present study agrees more closely with the work of Reigard than that of Breder and Crawford.

Notropis rubellus (Agassiz). Rosyface shiner. Thirteen specimens of this small minnow were examined and nine were found to contain food items. Distributed through the middle section of the creek (Table 1), the form fed primarily on insects, and only one stomach contained vegetative material. The results of this limited sample agree with the data reported by Pfeiffer (1955) in a life history study of the species in New York and with Reed (1957) who studied the form in Pennsylvania.

Notropis analostanus (Girard). Satinfin shiner. Only six specimens of N. analostanus were collected and all were taken at Station F. The stomach contents of one specimen were composed of 109 ephemeropteran nymphs and four trichopteran larvae. Two others had consumed one plecopteran nymph each. No reference to the food habits of N. analostanus was found.

Hybopsis leptocephala (Girard). Carolina chub. Two hundred and forty-nine specimens of H. leptocephala, all from the upper three stations, were examined and 209 were found to contain food material. Although omnivorous, the species showed a definite preference for plant material as is shown in the results of a seasonal study (Graph 1; Table 30). Filamentous algae, diatoms, and desmids formed the bulk of the plant food, plant seeds were present in nine of the stomachs. July, September, and November were the peak months for the plant material; animal food was highest in September. At no time during the study did animal matter exceed plant food in the diet of this form. While literature concerning the food habits of H. leptocephala was not found, a good discussion of the food of related species H. micropogon and H. biguttata is given by Lachner (1950). He reports plant material, both filamentous algae and vascular plants, to form about 50 per cent of the volume of the stomach contents in older fish but states that this is probably incidental, taken accidentally in the capture of animal matter. Evidence in the present study indicates that plant material is specifically selected.

Semotilus corporalis (Mitchill). Fallfish. Twenty-three specimens of S. corporalis, the largest eastern minnow, were examined and 17 were found to contain food material, all of which was animal matter (Table 31). Insects comprised 73 per cent and fishes 17 per cent of the total items. Breder and Crawford (1922) reported 87 per cent of the food to be composed of insects; however, there was no mention made of fishes. Most of the specimens in this study were collected at Station C (Table 1).

Notemigonus crysoleucas (Mitchill). Golden shiner. Fifty-five specimens were examined, 43 of which contained food material. Typically a pool form, most of the fish were collected at Station D (Table 1). The diet of this omnivore was composed primarily of microscopic plants (37 per cent) and insects (21 per cent; Table 32). Pearse (1918) reported that 76 per cent of the diet of this species was Entomostraca. Forbes and Richardson (1908) stated that the diet varied according to the habitat. The results obtained by Pearse and those of the present study corroborates the findings of Forbes and Richardson.

Clinostomus v. vandoisulus (Valenciennes). Rosy dace. Twenty-six fish were examined and all but one were found to contain food items. The species was concentrated in the shallow pools in the upper-half of the creek (Table 1). Insects comprised the major part of the diet (55 per cent), other items, e.g. arachnids and vegetative matter, were occasionally present (Table 33). The relatively high occurrence of unidentifiable

insect parts is attributed to the action of extremely sharp pharyngeal teeth in this form. Breder and Crawford (1922) found insects to compose 88 per cent of the diet, only a trace of plant material was noted.

Rhinichthys a. atratulus (Hermann). Blacknose dace. Thirteen specimens were collected, nine of which were found to contain food material. All were taken at Station A in the swifter flowing water during the period of September through November. Although the sample was small the species appeared to be omnivorous in its food habits with microscopic plants and digested vegetative matter accounting for 64 per cent of the diet and the remaining part unidentified insect parts (Table 34). In a volumetric analysis by Breder and Crawford (1922) insects comprised 61 per cent of the food. Insects would have been a more important dietary item had the fish been taken earlier in the year.

Hybognathus nuchalis regius (Girard). Silvery minnow. Forty-six specimens were examined, only 24 of which contained food material. This minnow was collected at all stations except Stations A and E (Table 1). Microscopic items, e.g. diatoms, desmids, and filamentous algae, comprised an important part of the diet (41 per cent; Table 35). Seventy-five per cent of the stomachs contained partly digested vegetative matter which appeared to be made up wholly of microscopic organisms, as there was no evidence of vascular plant material. The present investigation agrees with the study made by Forbes and Rich-

ardson (1908) who stated that the food of this species was mud, filamentous algae, and diatoms.

Chrosomus oreas (Cope). Mountain redbelly dace. Seventy-three specimens were examined, 67 of which contained food material. Table 1 shows that this completely herbivorous species is an inhabitant of the smaller sections of the stream. Microscopic plants, e.g. diatoms, desmids, and filamentous algae, were found to form the bulk of the diet (Table 36). Fine grit was present in 54 per cent of the stomachs, an extremely high percentage which probably indicates that this species utilized microscopic organisms in the substrate food. Forbes (1888) also found this form to contain a high per cent of inorganic material but did not elaborate.

Food habits and distribution of Percidae

Etheostoma olmstedi (Storer). Two hundred and seventy-eight specimens were examined and 240 contained food material. Concentrated in areas with shifting sand bottoms, approximately one-half of all specimens collected were taken at Station A and over one-fourth at Station C (Table 1). About 86 per cent of the food consisted of insects of which almost 90 per cent was dipteran larvae (mostly Tendipedidae; Table 37). Dipteran larvae alone accounted for 75 per cent of the total food of this insectivorous fish. Forbes (1880) in an analysis of the food of the darters found 66 per cent of the diet of the

diet of the genus Boleosoma (Etheostoma) to consist of tendipedids. Food studies of a closely related form (Etheostoma nigrum) conducted by Hankinson (1908) and Pearse (1918) included tendipedid larvae as the most abundant item. Plant material (mainly filamentous algae) was present in only nine stomachs, which indicates that it was accidentally acquired. The data show that this form specifically selects tendipedid larvae, which is probably correlated with the small size of the fish (seldom exceeded 50 mm.).

Etheostoma f. fusiforme (Girard). Northern swamp darter. The only specimen collected was taken at Station D. The stomach contents included one ephemeropteran nymph and two tendipedid larvae. The food habits of this relatively scarce species has not been studied and the lack of specimens in the present investigation prohibits further comments.

Percina notogramma (Raney and Hubbs). Stripeback darter. Only four specimens of P. notogramma were collected and three stomachs contained plecopteran nymphs. The limited sample with a scarcity of food types restricts further discussion. No food habit information for this species was found.

Food habits and distribution of Esocidae

Esox niger (LeSueur). Sixty-four stomachs were examined and 42 contained food items. As would be expected, the species was collected in the pool areas of the lower collection stations,

A and B not providing a suitable habitat (Table 1). When the total sample was considered, disregarding size, insects were found to compose 41 per cent of the diet and fishes 34 per cent (Table 38). However, when arranged into two size groups (73 mm. or less; 74 mm. or greater) it was found that the smaller specimens fed primarily on insects (48 per cent) and fish only 30 per cent, while larger specimens fed on insects 16 per cent of the time but on fishes 63 per cent (Table 39). The size groups were tested by the chi-square method to ascertain if a difference existed in the numbers of insects and fishes included in the diet of each. A chi-square value of 4.21 was obtained, since this was significant at the 95 per cent level the food habits of the two groups were determined to be different. Raney (1942) with a larger sample and better size distribution showed quite conclusively that larger fish eat the larger food items, e.g. fishes and crayfishes, while smaller specimens are insectivorous. Hunter and Rankin (1939) did an excellent study of the food of Esox but unfortunately combined the data of two species E. niger and E. americanus, therefore invalidating any comparison of the present study with their work.

Food habits and distribution of Aphredoderidae

Aphredoderus sayanus (Gilliams). Pirateperch. One hundred and eleven specimens were examined but only 57 were found to contain food material, an extremely low per cent compared with

that of other fishes. An inhabitant of pools, the species was taken at all stations except A (Table 1). Insects composed 80 per cent of the food items, which agreed with the insectivorous habits of this form as described by Forbes (1888). Dipteran larvae (mostly Tendipedidae) occurred in the largest number of stomachs (35 per cent) and made up 53 per cent of the total items (Table 40). Forbes and Richardson (1908) found the diet composed mainly of tendipedid larvae with a smaller occurrence of water-bugs (Hemiptera), aquatic beetles, amphipods, mayfly nymphs, and fish. In a report on a new occurrence of A. sayanus in Ohio, Clark (1949) mentioned the food of eight specimens, included were insects and fish.

Food habits and distribution of Poeciliidae

Gambusia affinis holbrooki (Baird and Girard). Gambusia. Thirty-eight G. affinis were examined and 26 contained food material. Most of the fish were collected at Station C where they were congregated in small shallow pools (Table 1). Thirty-eight per cent of the stomachs contained Hemiptera (Corixidae) and 19 per cent fed on Diptera (Table 41). Barnickol (1941) in a food habit study of this species in Reelfoot Lake reported 14 per cent of the stomachs contained Diptera and seven per cent Hemiptera with some plant remains occurring in a few stomachs. Hildebrand (1921) studied the top minnow to determine if it could be used in mosquito control and although his results were not conclusive, the species

has been propagated and distributed for this purpose. Hunt (1952) in a report on the food of some fishes in the Tamiami Canal, Florida, found this form to be omnivorous but to show a preference for insects when they were available. The results of the present investigation show that the most available insects are eaten and that there is essentially no selection.

Food habits and distribution of Catostomidae

Moxostoma rhothoeca (Thoburn). Torrent sucker. Fifty-two specimens were examined and 47 were found to contain material. Typically an inhabitant of the swifter flowing streams of the upper piedmont in Virginia, the form also occurs in fast water regions of lower piedmont creeks. Station A with a riffle area, and B with a series of step falls provide the necessary environmental conditions. These were the only stations at which the species was collected (Table 1). Although insects were consumed occasionally, the greatest bulk of the food was plant material (80 per cent). Table 42 shows that a considerable number of stomachs (45 per cent) contained miscellaneous items comprised predominantly of fine grit. Unfortunately no information was found which concerned the food habits of M. rhothoeca, hence a comparison with specimens from other areas was not possible.

Erimyzon o. oblongus (Mitchill). Creek chubsucker. Sixteen specimens of this obliqued mouth sucker were examined, 13 of which contained material. Most of the specimens were collected

at Station B in the deeper water (Table 1). Few items were consumed, although, curstaceans and microscopic plants in the diet indicated an omnivorous mode of feeding (Table 43). Forbes (1888) mentioned the food of this form as Entomostraca, protozoa, rotifers, unicellar algae and a trace of chironomids.

Catostomus c. commersoni (Lacepede). White sucker. Thirty-four specimens, most from the upper-half of the creek, were examined and 31 individuals contained food material (Table 1). This pool form was found to feed primarily on microscopic plants and animals with plants occurring approximately twice as often (Table 44). Fine grit was identified in 68 per cent of the stomachs which reflects a bottom feeding activity. Reigard (1915) gives a good discussion of the actual feeding habits of this species. Forbes (1888) reported 42 per cent of the food was composed of molluscs and three per cent tendipedid larvae whereas Pearse (1918) found tendipedid larvae to make up 40 per cent of the diet and made no mention of molluscs. In a life history study by Stewart (1927) the most abundant food was tendipedid larvae (33 per cent) with other items occurring much less often.

Food habits and distribution of Ictaluridae

Ictalurus nebulosus (LeSueur). Brown bullhead. Five specimens, all from Station D, were examined and three contained food. The diet included the following items: three decopods (two Astacidae, and one Palaemonidae), one coleopteran (Curculionidae), three

megalopterans (sialid larvae), one ephemeropteran nymph and two fishes. Raney and Webster (1940) in New York found ostracods, cladocerans, and chironomids to be the main food in the diet of the young of I. nebulosus. Forbes and Richardson (1908) found bivalve molluscs, snails, and distillery diffuse to be abundant in the diet. Ictalurus spp. are often called "scavengers" and this fish will apparently feed on any available type food.

Ictalurus natalis (LeSueur). Yellow bullhead. Only two specimens were collected and the stomachs of both contained food. One individual was taken at Station C and the other specimen at Station D. The food items consisted of five decopods (three Astacidae, two Palaemonidae), two ephemeropteran nymphs, an annelid, a coleopteran and unidentified insect parts. These findings agree with those of Pearse (1922) and Rice (1941).

Noturus i. insignis (Richardson). Eastern madtom. Three specimens were collected and all contained food material. From the distribution of the three specimens it is probable that the species is present throughout the creek; however, the sample size indicates a small population (Table 1). A tendipedid larvae, two plecopteran nymphs, insect remains, and unidentified fish remains were found in the stomachs. No reference to the feeding habits of this fish was found.

Food habits and distribution of

Umbridae

Umbra pygmaea (DeKay). Eastern mudminnow. Eight specimens were examined and five stomachs were found to contain food material. The distribution of this species, a typical sluggish water form, is given in Table 1. The stomachs, none of which were full, contained only animal matter (copepods and trichopteran larvae). Pearse (1918) listed the food of U. limi, a closely related form, as ostracods, amphipods, tendipedid larvae, earthworms, and plant remains. No published information was found which concerned the food of U. pygmaea.

Summary

Data were obtained from the examination of 1,773 fishes from Tuckahoe Creek, Virginia. Thirty-one species were collected with the aid of a seine and the following forms accounted for approximately 65 per cent of the total specimens taken: E. olmstedi, L. macrochirus, H. leptocephala, and N. cornutus. In the laboratory, stomach contents were separated as to type and identification of food items was made with the help of a binocular stereoscopic microscope. Where applicable, statistical methods were used to interpret the data. Lepomis macrochirus was investigated specifically, as it occurred throughout the creek in numbers which warranted more intensive study than other species. The more important results are listed below.

1. Many animal forms were present in the diet of L. macrochirus but only a few were consistent in occurrence. Insects formed the major food group with dipteran larvae consumed 45 per cent and hemipterans 29 per cent of the time. Crustaceans were the next most important group with copepods often eaten (25 per cent).
2. The data indicated that L. macrochirus fed on the most available food present, this often led to dietary differences among fish in different habitats.
3. A correlation was noted between the size of the fish and the food item, i.e. copepods were most abundant in young fish and coleopterans in larger specimens.
4. A monthly comparison of the food habits of L. macrochirus shows that insect food items apparently paralleled seasonal abundance. Crustacea (Copepoda) replaced the insects in the fall of the year as the insect population declined.
5. Insects comprised the major part of the diet of all centrarchids except E. gloriosus which contained a higher per cent of Crustacea (55 per cent) than insects (only 33 per cent). Coleoptera, along with dipteran larvae, were the most important food items in the diet of L. auritus, and dipteran larvae the most abundant item in the diet of L. gibbosus. Hemiptera accounted for the highest per cent of food items in C. macropterus and C. gulosus (67 per cent and 22

per cent respectively). Decopoda were also important in the diet of C. gulosus as they were found in 26 per cent of the stomachs.

6. The Cyprinidae demonstrated a wide variety of diets; all types of feeders present. N. cornutus was a true omnivore (feeding equally on plant and animal matter) while H. leptocephala, also an ominvore, was found to select a diet of plant material. Seasonal differences were observed in the diet of both forms.
7. Dipteran larvae were by far the most important item in the diet of the percid, E. olmstedi (78 per cent).
8. A. sayanus also fed primarily on dipteran larvae (53 per cent).
9. Specimens of E. niger less then 74 mm. in standard length were noted to eat insects more often (48 per cent as opposed to 16 per cent in larger fish) whereas larger specimens preferred a diet of fishes (63 per cent as opposed to 30 per cent in the smaller forms).
10. Although often acclaimed as a consumer of Culicidae larvae, G. affinis fed primarily on Hemiptera (39 per cent of the stomachs) during this study.
11. The Catostomidae were bottom feeders which consumed predominantly microscopic plants.
12. There was no indication of differences in food taken by any species of fish which could be attributed to sex.
13. The distribution of the fishes indicated that many forms had strong ecological preferences (Table 1).

Practically all of the Percidae, Catostomidae, and Cyprinidae (except N. crysoleucas and H. nuchalis) were taken from the upper section of the stream. The following forms were characteristically associated with the swifter flowing waters: C. oreas, R. atratulus, H. leptocephala, E. olmstedi, and M. rhothoeca. The Centrarchidae were concentrated in the deeper pool areas of the middle sections of the creek with L. macrochirus and L. auritus the only centrarchids collected at all stations. Specimens of A. sayanus and E. niger showed a preference for vegetated pool areas, neither of these fishes were taken from the uppermost parts of the stream. The Poeciliidae were taken largely from one shallow pool. Both the Umbridae and Ictaluridae displayed a discontinuous distribution in the creek.

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Map I. Map of collection area.

MAP I

TUCKAHOE CREEK

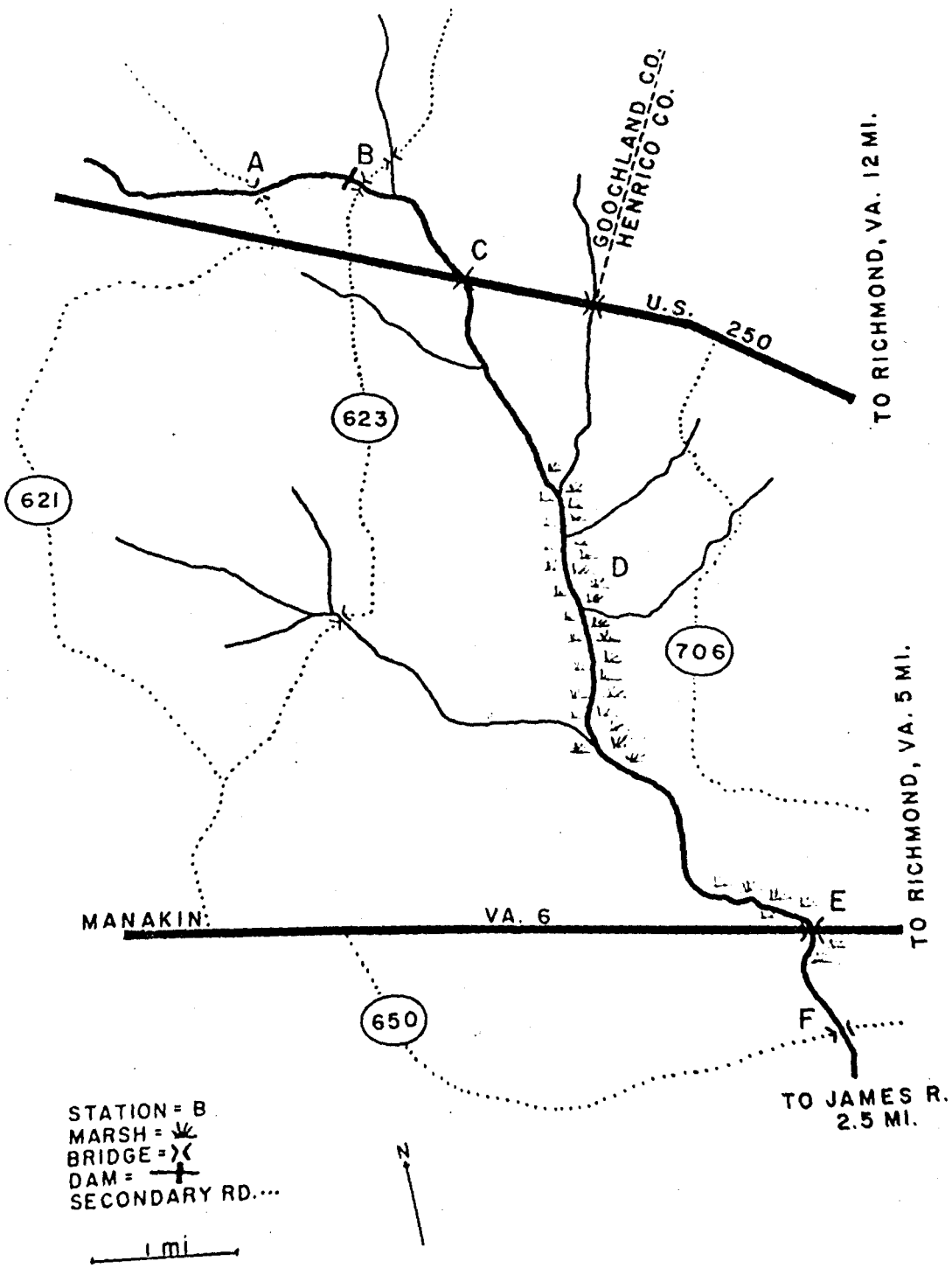


Plate I - Station A. Creek viewed downstream.

PLATE I

Plate II - Station B. Creek viewed upstream.

PLATE II

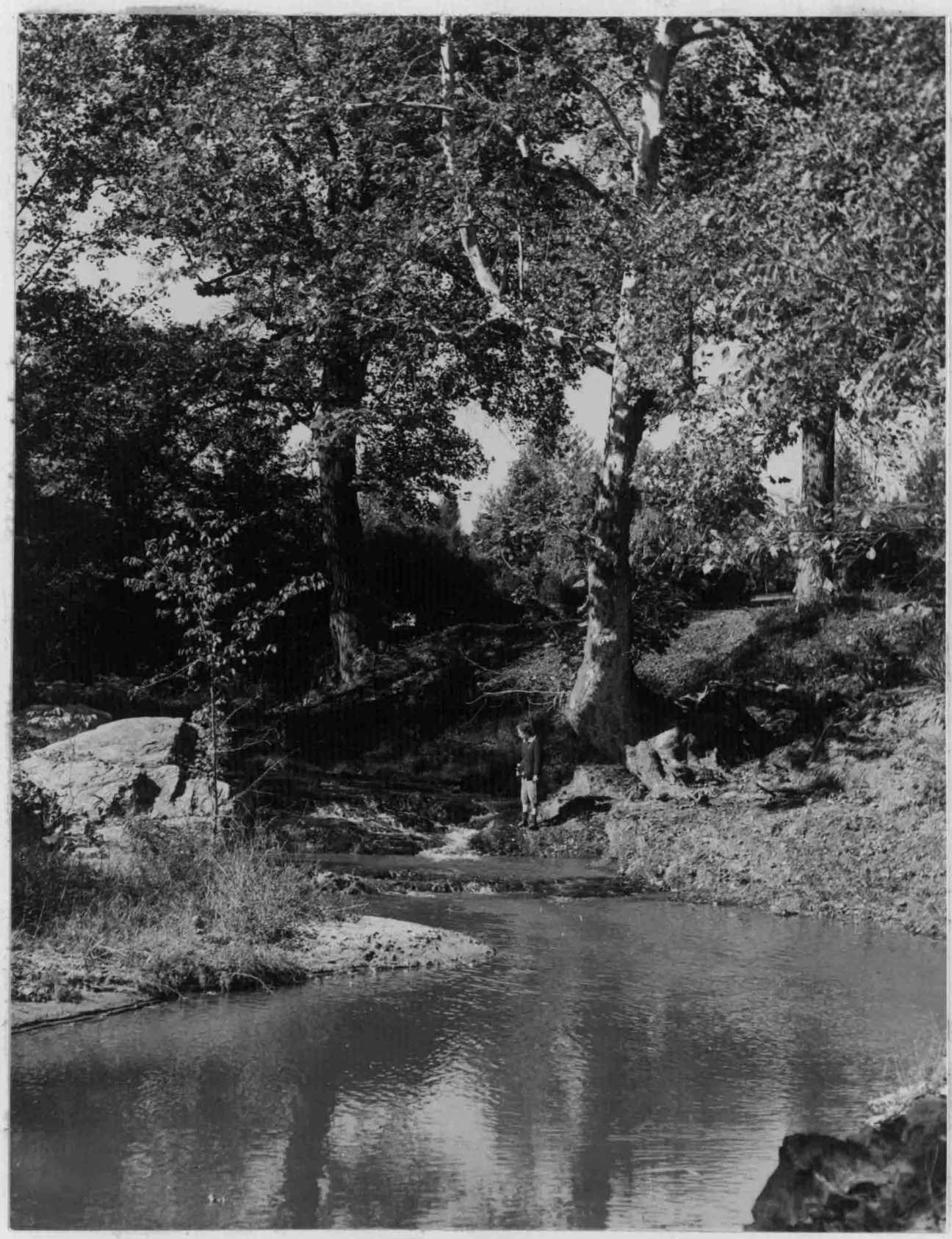


Plate III - Station C. Creek viewed downstream.

PLATE III

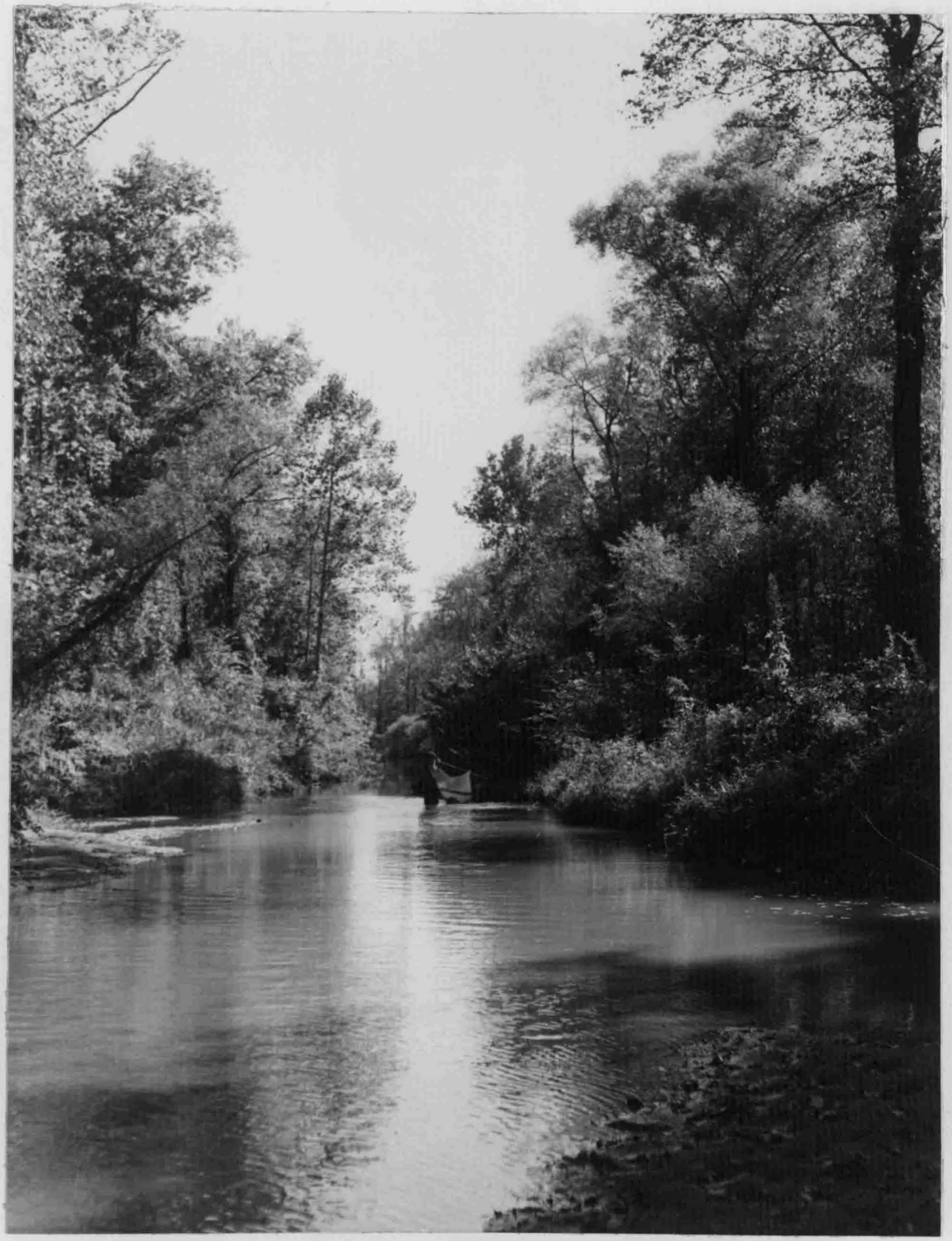


Plate IV - Station D. Creek viewed upstream.

PLATE IV

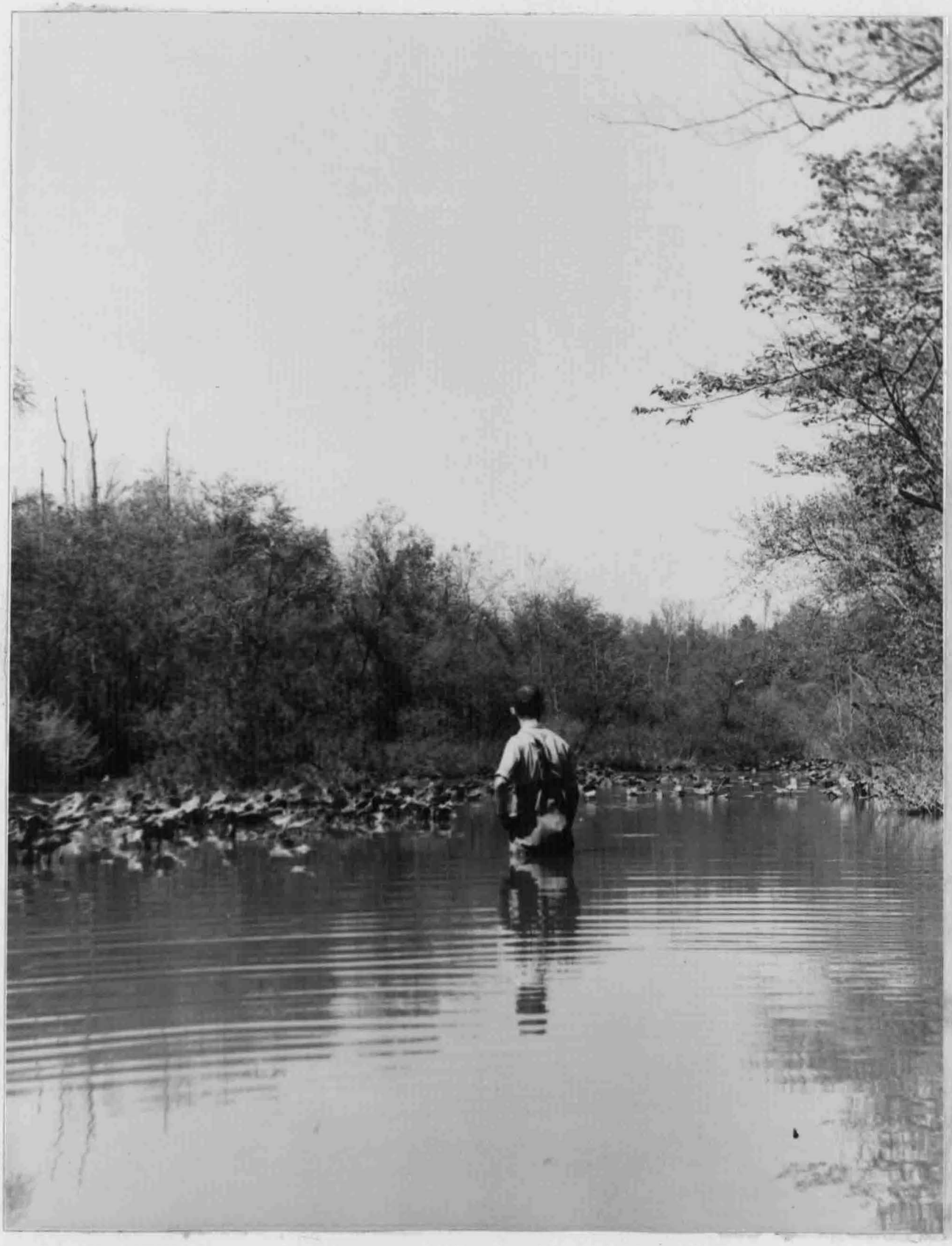


Plate V - Station E. Creek viewed downstream.

PLATE V

Plate VI - Station F. Creek viewed downstream.

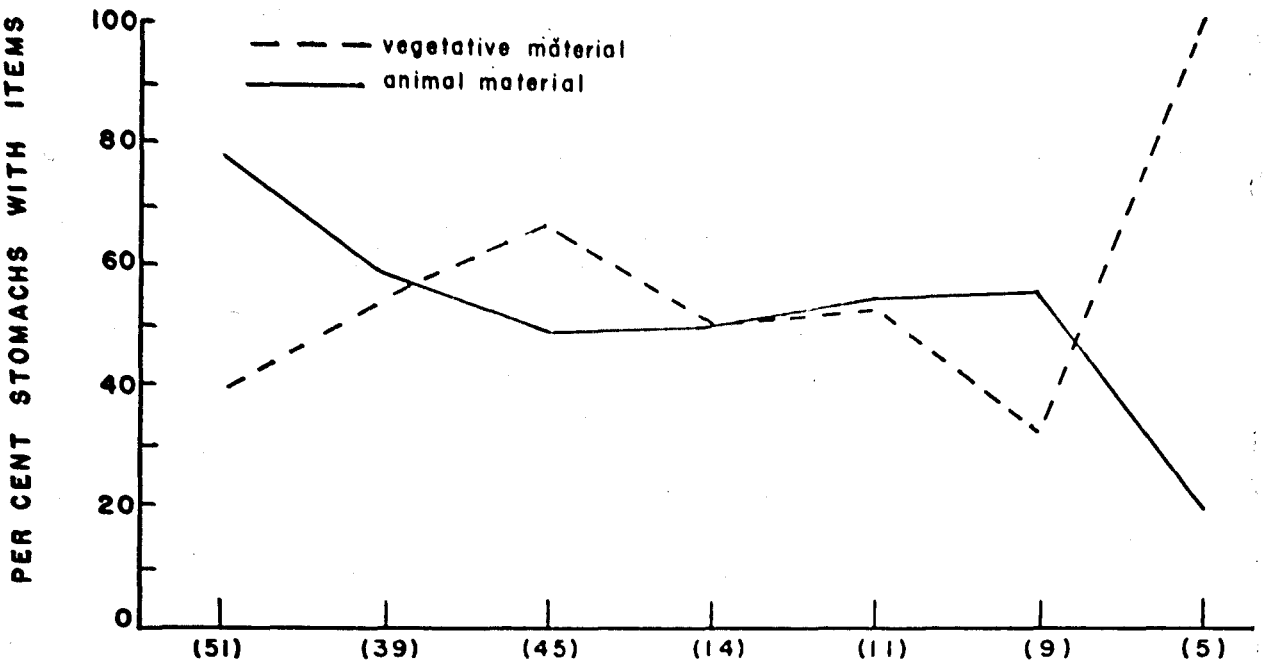
PLATE VI

Graph I - Graphical presentation of animal and vegetative material consumed by month with the total number of stomachs that contained food by month.

Fig. A. Notropis cornutus

Fig. B. Hybopsis leptocephala

GRAPH I


PER CENT STOMACHS WITH ITEMS
100
80
60
40
20
0
vegetative material
animal material
(51)
(39)
(45)
(14)
(11)
(9)
(5)

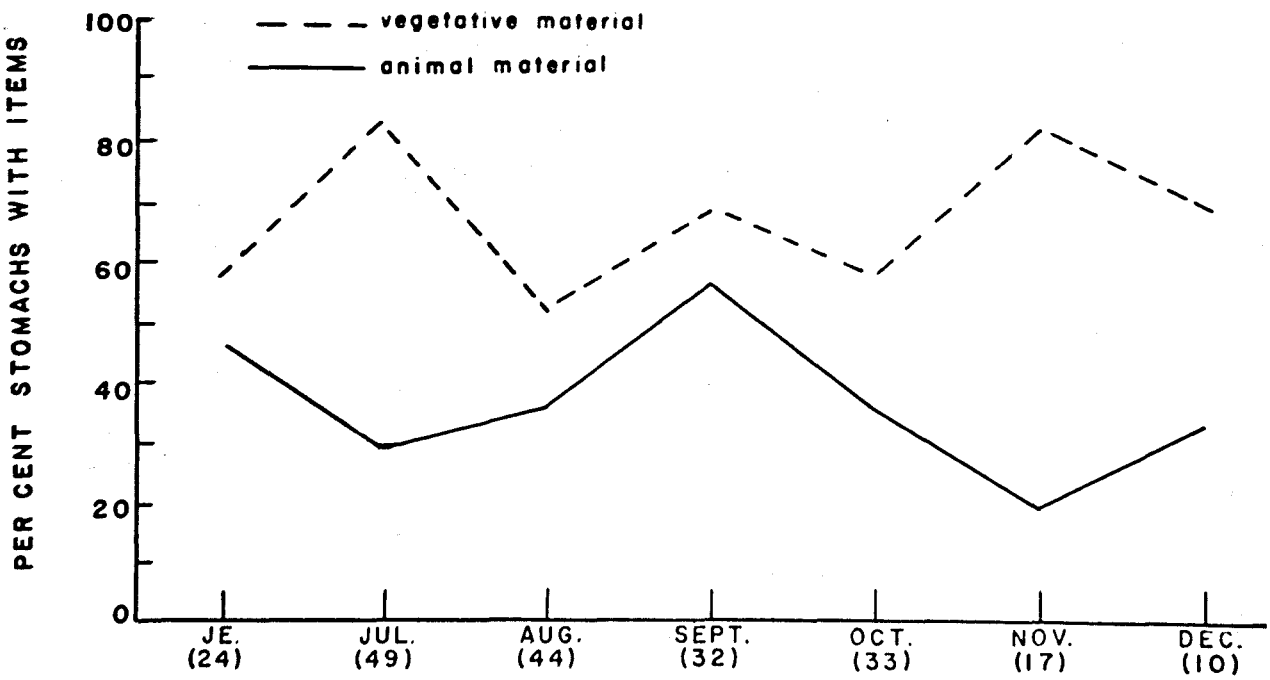

PER CENT STOMACHS WITH ITEMS
100
80
60
40
20
0
vegetative material
animal material
JE. (24)
JUL. (49)
AUG. (44)
SEPT. (32)
OCT. (33)
NOV. (17)
DEC. (10)

Table 1. The distribution of fishes taken from Tuckahoe Creek during the period of June through December, 1958.

Fishes	Station A	B	C	D	E	F	Tot.
Umbridae							
Umbra pygmaea	...	1	4	2	...	1	8
Esocidae							
Esox niger	...	...	15	28	8	13	64
Catostomidae							
Catostomus c. commersoni	7	16	10	1	...	...	34
Erimyzon o. oblongus	...	10	2	4	...	...	16
Moxostoma rhothoeca	26	21	...	...	...	...	47
Cyprinidae							
Notropis cornutus	46	108	46	15	1	1	217
Notropis rubellus	...	4	6	...	3	...	13
Notropis analostanus	...	...	...	...	...	6	6
Clinostomus v. vandoisulus	10	15	1	...	...	...	26
Chrosomus oreas	56	11	10	...	...	...	77
Rhinichthys a. atratulus	13	...	...	...	...	...	13
Hybopsis leptocephala	164	80	67	...	...	...	311
Hybognathus nuchalis regius	...	10	5	30	...	2	47
Notemigonus crysoleucas	...	12	...	44	1	5	62
Semotilus corporalis	3	...	16	...	...	4	23
Ictaluridae							
Ictalurus natalis	...	...	1	1	...	...	2

Table 1. continued

Fishes	Station A	B	C	D	E	F	Tot.
Ictalurus nebulosus	...	...	...	5	...	...	5
Noturus i. insignis	1	...	1	...	1	...	3
Anguillidae							
*Anguilla rostrata**	...	...	...	1	1	...	2
Poeciliidae							
Gambusia affinis holbrooki	...	1	31	6	...	...	38
Aphredoderidae							
Aphredoderus sayanus	...	27	40	27	10	10	114
Centrarchidae							
Lepomis m. macrochirus	15	133	70	96	16	41	371
Lepomis gibbosus	...	13	10	15	...	...	38
Lepomis auritus	7	7	9	5	3	4	35
Enneacanthus gloriosus	...	...	...	20	...	1	21
Pomoxis nigromaculatus	...	...	...	2	...	...	2
Centrarchus macropterus	...	...	...	5	1	3	9
Chaenobryttus gulosus	...	8	...	23	...	...	31
Micropterus s. salmoides	...	2	1	...	...	...	3
Percidae							
Etheostoma olmstedi	203	40	152	3	11	6	415
Etheostoma f. fusiforme	...	...	...	1	...	...	1
Percina notogramma	...	...	...	...	2	2	4
Total	551	520	496	333	57	99	2056

* observed only

Table 2. The stomach contents of 273 specimens of Lepomis macrochirus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	81	28	0.30	2.9	10.3	2.5
Coleoptera (L)	3	3	0.01	1.0	1.1	0.1
Diptera (L)	1252	122	4.59	10.3	44.7	38.4
Diptera (P,A)	32	25	0.12	1.3	9.2	1.0
Ephemeroptera (N)	218	14	0.80	15.6	5.1	6.7
Hemiptera	198	78	0.73	2.7	28.6	6.4
Hymenoptera	63	24	0.23	2.6	8.2	1.9
Lepidoptera (L)	11	10	0.04	1.1	3.7	0.3
Megaloptera (L)	15	6	0.05	2.5	2.2	0.5
Odonata (N)	18	6	0.07	3.0	2.2	0.6
Orthoptera	9	3	0.03	3.0	1.1	0.3
Plecoptera	2	2	0.01	1.0	0.7	0.1
Plecoptera (N)	12	6	0.04	2.0	2.2	0.4
Psocoptera	3	1	0.01	3.0	0.4	0.1
Trichoptera (L)	117	20	0.43	5.9	7.3	3.6
U.I.L.	18	17	0.07	1.1	6.2	0.5
U.I.P.	56	56	0.21	1.0	20.5	1.7
Arachnida						
Araneida	12	10	0.04	1.2	3.7	0.4
Hydracarina	34	21	0.12	1.6	7.7	1.0
Crustacea						
Amphipoda	94	6	0.34	15.7	2.2	2.9
Cladocera	238	9	0.87	26.4	3.3	7.3
Copepoda	565	68	2.07	8.3	24.9	17.3
Decopoda	5	5	0.02	1.0	1.8	0.2
Isopoda	1	1	....	1.0	0.4	0.0*
Ostracoda	31	11	0.11	2.8	4.0	1.0
Gordioidea	4	4	0.01	1.0	1.5	0.1
Oligochaeta	1	1	....	1.0	0.4	0.0*
Gastropoda						
Pulmonata	12	6	0.04	2.0	2.2	0.4
Osteichthyes	15	11	0.05	1.4	4.0	0.5
D.A.M.	101	101	0.37	1.0	37.0	3.1
Plant material	26	26	0.10	1.0	9.5	0.8
Miscellaneous	13	13	0.05	1.0	4.8	0.4

* Less than 0.05 per cent

Table 3. The stomach contents of 14 specimens of *Lepomis macrochirus* collected at Station A and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	4	2	0.29	2.0	14.3	2.8
Diptera (L)	11	4	0.79	2.8	28.6	7.8
Diptera (P)	2	2	0.14	1.0	14.3	1.4
Ephemeroptera (N)	5	1	0.36	5.0	7.1	3.5
Hemiptera	6	5	0.43	1.1	35.7	4.3
Hymenoptera	9	5	0.64	1.8	35.7	6.4
U.I.L.	1	1	0.07	1.0	7.1	0.7
U.I.P.	8	8	0.57	1.0	57.1	5.7
Crustacea						
Cladocera	9	2	0.64	1.8	14.3	6.4
Copepoda	82	4	5.86	20.5	28.6	58.2
Isopoda	1	1	0.07	1.0	7.1	0.7
Gordioidea	1	1	0.07	1.0	7.1	0.7
D.A.M.	1	1	0.07	1.0	7.1	0.7
Miscellaneous	1	1	0.07	1.0	7.1	0.7

Table 4. The stomach contents of 80 specimens of *Lepomis macrochirus* collected at Station B and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	36	8	0.45	4.5	10.0	6.3
Coleoptera (L)	1	1	0.01	1.0	1.3	0.2
Diptera (L)	137	33	1.71	4.2	41.3	24.0
Diptera (P,A)	12	11	0.15	1.0	13.8	2.1
Ephemeroptera (N)	17	2	0.21	8.5	2.5	3.0
Hemiptera	22	10	0.28	2.2	12.5	3.9
Hymenoptera	16	7	0.20	2.3	8.8	2.8
Lepidoptera (L)	5	5	0.06	1.0	6.3	0.9
Odonata (N)	1	1	0.01	1.0	1.3	0.2
Orthoptera	6	1	0.08	6.0	1.3	1.1
Plecoptera	2	2	0.02	1.0	2.5	0.4
Plecoptera (N)	2	2	0.02	1.0	2.5	0.4
Psocoptera	3	1	0.04	3.0	1.3	0.5
Trichoptera (L)	5	3	0.06	1.7	3.8	0.9
U.I.L.	9	8	0.11	1.1	10.0	1.6
U.I.P.	16	16	0.20	1.0	20.0	2.8
Arachnida						
Araneida	5	4	0.06	1.2	5.0	0.9
Hydracarina	7	4	0.09	1.8	5.0	1.2
Crustacea						
Cladocera	21	3	0.26	7.0	3.8	3.7
Copepoda	156	22	1.95	7.0	27.5	27.4
Ostracoda	25	5	0.31	5.0	6.3	4.4
Gordioidea	1	1	0.01	1.0	1.3	0.2
Gastropoda						
Pulmonata	1	1	0.01	1.0	1.3	0.2
Osteichthyes	3	3	0.04	1.0	3.8	0.5
D.A.M.	41	41	0.51	1.0	51.3	7.2
Plant material	12	12	0.15	1.0	15.0	2.1
Miscellaneous	8	8	0.10	1.0	10.0	1.4

Table 5. The stomach contents of 64 specimens of Lepomis macrochirus collected at Station C and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	19	8	0.30	2.4	12.3	2.4
Coleoptera (L)	1	1	0.02	1.0	1.6	0.1
Diptera (L)	316	23	4.94	13.7	35.9	39.2
Diptera (P,A)	11	6	0.17	1.8	9.4	1.4
Ephemeroptera (N)	14	8	0.22	1.9	12.5	1.7
Hemiptera	83	28	1.30	3.0	43.8	10.3
Hymenoptera	30	7	0.47	4.3	10.9	3.7
Lepidoptera (L)	1	1	0.02	1.0	1.6	0.1
Megaloptera (L)	2	2	0.03	1.0	3.1	0.3
Odonata (N)	1	1	0.02	1.0	1.6	0.1
Orthoptera	3	2	0.05	1.5	3.1	0.4
Trichoptera (L)	74	8	1.16	9.3	12.5	9.2
U.I.L.	4	4	0.06	1.0	6.3	0.5
U.I.P.	14	14	0.22	1.0	21.9	1.7
Arachnida						
Araneida	5	4	0.08	1.3	6.3	0.6
Hydracarina	4	3	0.06	1.3	4.7	0.5
Crustacea						
Copepoda	191	15	2.98	12.7	23.4	23.7
Decopoda	1	1	0.02	1.0	1.6	0.1
Gordioidea	2	2	0.03	1.0	3.1	0.3
Oligochaeta	1	1	0.02	1.0	1.6	0.1
Osteichthyes	3	3	0.05	1.0	4.7	0.4
D.A.M.	22	22	0.34	1.0	34.4	2.7
Plant material	3	3	0.05	1.0	4.7	0.4
Miscellaneous	2	2	0.03	1.0	3.1	0.3

Table 6. The stomach contents of 66 specimens of Lepomis macrochirus collected at Station D and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	20	8	0.30	2.5	12.1	2.3
Diptera (L)	625	42	9.47	14.9	63.6	72.3
Diptera (P,A)	3	2	0.05	1.5	3.0	0.4
Ephemeroptera (N)	1	1	0.02	1.0	1.5	0.1
Hemiptera	86	34	1.30	2.5	51.5	10.0
Lepidoptera (L)	1	1	0.02	1.0	1.5	0.1
Megaloptera (L)	2	2	0.03	1.0	3.0	0.2
Odonata (N)	3	2	0.05	1.5	3.0	0.4
Trichoptera (L)	4	4	0.06	1.0	6.1	0.5
U.I.L.	4	4	0.06	1.0	6.1	0.5
U.I.P.	6	6	0.09	1.0	9.1	0.7
Arachnida						
Araneida	1	1	0.02	1.0	1.5	0.1
Hydracarina	4	4	0.06	1.0	6.1	0.5
Crustacea						
Amphipoda	5	3	0.08	1.7	4.5	0.6
Copepoda	36	14	0.55	2.6	21.2	4.2
Decopoda	3	3	0.05	1.0	4.5	0.4
Ostracoda	6	6	0.09	1.0	9.1	0.7
Gastropoda						
Pulmonata	9	4	0.14	2.2	6.1	1.0
Osteichthyes	9	5	0.14	1.8	7.6	1.0
D.A.M.	28	28	0.42	1.0	42.4	3.2
Plant material	8	8	0.12	1.0	12.1	0.9

Table 7. The stomach contents of 13 specimens of Lepomis macrochirus collected at Station E and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	1	1	0.08	1.0	7.7	1.5
Coleoptera (L)	1	1	0.08	1.0	7.7	1.5
Diptera (L)	12	2	0.92	6.0	15.4	17.4
Diptera (P,A)	2	2	0.15	1.0	15.4	2.9
Hymenoptera	3	2	0.23	1.5	15.4	4.4
Megaloptera (L)	11	2	0.85	5.5	15.4	15.1
U.I.P.	4	4	0.31	1.0	30.8	5.8
Arachnida						
Araneida	1	1	0.08	1.0	7.7	1.5
Hydracarina	9	4	0.69	2.2	30.8	13.0
Crustacea						
Amphipoda	1	1	0.08	1.0	7.7	1.5
Cladocera	3	1	0.23	3.0	7.7	4.4
Copepoda	15	2	1.15	7.5	15.4	21.7
D.A.M.	4	4	0.31	1.0	30.8	5.8
Miscellaneous	2	2	0.15	1.0	15.4	2.9

Table 8. The stomach contents of 36 specimens of *Lepomis macrochirus* collected at Station F and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	1	1	0.03	1.0	2.8	0.1
Diptera (L)	151	18	4.19	8.4	50.0	18.7
Diptera (P,A)	2	2	0.06	1.0	5.6	0.3
Ephemeroptera (N)	181	2	5.03	90.5	5.6	22.4
Hemiptera	1	1	0.03	1.0	2.8	0.1
Hymenoptera	5	2	0.14	2.5	5.6	0.6
Lepidoptera (L)	4	3	0.11	1.3	8.3	0.5
Odonata (N)	13	2	0.36	6.5	5.6	1.6
Plecoptera (N)	10	4	0.28	2.5	11.1	1.2
Trichoptera (L)	34	5	0.94	6.8	13.9	4.2
U.I.P.	8	8	0.22	1.0	22.2	1.0
Arachnida						
Hydracarina	10	6	0.28	1.7	16.7	1.2
Crustacea						
Amphipoda	88	2	2.44	44.0	5.6	10.9
Cladocera	205	3	5.69	68.3	8.3	25.3
Copepoda	85	11	2.36	7.7	30.6	10.5
Decopoda	1	1	0.03	1.0	2.8	0.1
Gastropoda						
Pulmonata	2	1	0.06	2.0	2.8	0.3
D.A.M.	5	5	0.14	5.0	13.9	0.6
Plant material	3	3	0.08	3.0	8.3	0.4

Table 9. A comparison by station of the 11 most abundant items present in the stomach contents of Lepomis macrochirus expressed as per cent of the total items at each station.

Items	Per cent of total items by station					
	A	B	C	D	E	F
Insecta						
Coleoptera	3	6	2	2	2	*
Diptera (L)	8	24	39	72	17	19
Diptera (P,A)	1	2	1	*	3	*
Ephemeroptera (N)	4	3	2	*	..	22
Hemiptera	4	4	10	10	..	*
Hymenoptera	6	3	4	..	4	1
Trichoptera (L)	..	1	9	1	..	4
Arachnida						
Hydracarina	..	1	1	1	13	1
Crustacea						
Amphipoda	..	..	..	1	2	11
Cladocera	6	4	..	..	4	25
Copepoda	58	27	24	4	22	11
All others	10	25	8	9	33	6

*Less than 0.05 per cent.

Table 10. A comparison by station of the 11 most abundant items present in the stomach contents of Lepomis macrochirus expressed as per cent of stomachs with each item at each station.

Items	Per cent of stomachs with item					
	A	B	C	D	E	F
Insecta						
Coleoptera	14	10	12	12	8	3
Diptera (L)	29	41	36	64	15	50
Diptera (P,A)	14	14	9	3	15	6
Ephemeroptera (N)	7	3	13	2	..	6
Hemiptera	36	13	44	52	..	3
Hymenoptera	36	9	11	..	15	6
Trichoptera (L)	..	4	13	6	..	14
Arachnida						
Hydracarina	..	5	5	6	31	17
Crustacea						
Amphipoda	..	..	..	5	8	6
Cladocera	14	4	..	..	8	8
Copepoda	29	28	23	21	15	31

Table 11. Frequency of occurrence by station of the 11 most abundant items present in the stomach contents of Lepomis macrochirus expressed with number and per cent of total.

Items		Station A	B	C	D	E	F
Insecta							
Coleoptera	No.	4	36	19	20	1	1
	%	4.9	44.4	23.5	24.7	1.2	1.2
Diptera (L)	No.	11	137	316	625	12	151
	%	0.9	10.9	25.2	49.9	1.0	12.1
Diptera (P,A)	No.	2	12	11	3	2	2
	%	6.2	37.5	34.4	9.4	6.7	6.7
Ephemeroptera (N)	No.	5	17	14	1	....	181
	%	2.3	7.8	6.4	0.5	....	83.0
Hemiptera	No.	16	22	83	86	....	1
	%	7.7	10.6	39.9	41.3	....	0.5
Hymenoptera	No.	9	16	30	....	3	5
	%	14.3	25.4	47.6	....	4.8	7.9
Trichoptera (L)	No.	....	5	74	4	....	34
	%	....	4.3	63.2	3.4	....	29.1
Arachnida							
Hydracarina	No.	....	7	4	4	9	10
	%	....	20.6	11.8	11.8	26.5	29.4
Crustacea							
Amphipoda	No.	....	....	....	5	1	88
	%	....	....	....	5.3	1.1	93.6
Cladocera	No.	9	21	....	....	3	205
	%	3.8	8.8	....	....	1.3	86.1
Copepoda	No.	82	156	191	36	15	85
	%	14.5	27.6	33.8	6.4	2.7	15.0
All others	No.	13	138	62	71	23	46
	%	3.7	39.1	17.6	20.1	6.5	13.0

Tables 12-13. A comparison of the occurrence of dipteran larvae and Hemiptera in the stomach contents of different age-groups of Lepomis macrochirus.

Table 12. Diptera Larvae

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent: Tot. stom. with item	Per cent: Tot. item	Per cent: Stom. with items
0 (32.0)	44	21	93	4.4	2.11	17	7	48
I (44.0)	113	60	577	9.6	5.11	49	46	53
II (62.7)	82	31	404	13.0	4.93	25	32	38
III (83.6)	23	8	175	21.9	7.61	7	14	35
IV (92.4)	8	2	3	1.5	0.38	2	1	25

Table 13. Hemiptera

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent: Tot. stom. with item	Per cent: Tot. item	Per cent: Stom. with items
0 (32.0)	44	8	15	1.2	0.23	10	8	18
I (44.0)	113	28	82	3.0	0.73	36	41	25
II (62.7)	82	29	61	2.1	0.74	37	31	35
III (83.6)	23	10	31	3.1	1.35	13	16	44
IV (92.4)	8	3	9	3.0	1.12	4	5	38

Tables 14-15. A comparison of the occurrence of Coleoptera and trichopteran larvae in the stomach contents of different age-groups of Lepomis macrochirus.

Table 14. Coleoptera

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent: Tot. stom. with item	Per cent: Tot. item	Per cent: Stom. with items
0 (32.0)	44	...	...	...	...	...	...	...
I (44.0)	113	3	3	1.0	0.03	12	4	3
II (62.7)	82	11	17	1.5	0.21	42	22	13
III (83.6)	23	7	29	4.1	1.26	27	38	30
IV (92.4)	8	5	28	5.6	3.50	19	36	63

Table 15. Trichoptera Larvae

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent: Tot. stom. with item	Per cent: Tot. item	Per cent: Stom. with items
0 (32.0)	44	3	22	7.3	0.50	15	19	9
I (44.0)	113	9	63	7.0	0.56	45	53	8
II (62.7)	82	6	6	1.0	0.07	30	5	7
III (83.6)	23	2	26	13.0	1.13	10	23	9
IV (92.4)	8	...	....	....	....	....	....	....

Tables 16-17. A comparison of the occurrence of Hymenoptera and ephemeropteran nymphs in the stomach contents of different age-groups of Lepomis macrochirus.

Table 16. Hymenoptera

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent		
						Tot. stom. with item	Tot. item	Stom. with items
0 (32.0)	44	3	6	2.0	0.14	13	10	7
I (44.0)	113	4	6	1.5	0.05	17	10	4
II (62.7)	82	12	24	2.0	0.29	50	38	15
III (83.6)	23	4	26	6.0	1.13	17	41	17
IV (92.4)	8	1	1	1.0	0.13	4	2	13

Table 17. Ephemeropteran Nymphs

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent		
						Tot. stom. with item	Tot. item	Stom. with items
0 (32.0)	44	3	23	8.0	0.52	21	11	7
I (44.0)	113	6	9	1.5	0.08	43	4	5
II (62.7)	82	4	7	1.8	0.09	27	3	5
III (83.6)	23	1	179	179.0	7.78	7	82	4
IV (92.4)	8	....	....	....	....	....	....	....

Tables 18-19. A comparison of the occurrence of Copepoda and Cladocera in the stomach contents of different age-groups of Lepomis macrochirus.

Table 18. Copepoda

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent		
						Tot. stom. with item	Tot. item	Stom. with items
0 (32.0)	44	24	246	10.2	5.59	35	44	55
I (44.0)	113	35	293	8.4	2.59	52	52	31
II (62.7)	82	8	22	2.6	0.27	12	4	10
III (83.6)	23	1	4	4.0	0.17	2	1	4
IV (92.4)	8	....	....	....	....	....	....	....

Table 19. Cladocera

Age-group and ($\bar{x}$ s.l.)	Tot. stom. with items	No. stom. with item	No. item	$\bar{x}$ no. per stom.	$\bar{x}$ no. per all stom. with items	Per cent		
						Tot. stom. with item	Tot. item	Stom. with items
0 (32.0)	44	7	219	31.3	4.98	78	92	16
I (44.0)	113	2	19	9.5	0.17	22	8	2
II (62.7)	82	....	....	....	....	....	....	....
III (83.6)	23	....	....	....	....	....	....	....
IV (92.4)	8	....	....	....	....	....	....	....

Table 20. A comparison of the age-groups (with mean standard length) of 273 specimens of Lepomis macrochirus.

Table 20. Lepomis macrochirus

Age-group and ($\bar{x}$ s.l.mm.)	No. stom. examined	No. stom. with items	Per cent stom. with items
0 (32.0)	45	44	97.8
I (44.0)	132	113	85.6
II (62.7)	98	82	83.7
III (83.6)	27	23	85.1
IV (92.4)	9	9	88.9
V (112.0)	2	2	100.0
VI (122.0)	1	1	100.0

Table 21. A monthly comparison of the eight most abundant items present in the stomach contents of Lepomis macrochirus expressed as per cent of the total stomachs that contained items.

	Total no. stomachs by month						
Items	Je. (18)	Jul. (28)	Aug. (73)	Sept. (47)	Oct. (51)	Nov. (42)	Dec. (14)
Insecta							
Coleoptera	5.6	17.9	11.0	19.2	3.9	7.1	....
Diptera (L)	5.6	46.4	52.1	42.6	43.1	38.1	28.6
Diptera (P,A)	50.0	7.1	4.1	12.8	21.6	....	7.1
Ephemeroptera (N)	5.6	7.1	5.5	4.3	3.9	2.4	14.3
Hemiptera	11.1	42.9	30.1	23.4	35.3	26.2	14.3
Hymenoptera	....	14.3	6.9	8.5	7.8	16.7	0.7
Trichoptera (L)	16.7	3.6	9.6	6.4	9.8	2.4	....
Crustacea							
Copepoda	22.2	10.7	4.1	10.6	9.8	14.3	21.4

Table 22. A monthly comparison of the eight most abundant items present in the stomach contents of *Lepomis macrochirus* expressed as per cent of the total items.

	Total no. items by month						
Items	Je. (466)	Jul. (247)	Aug. (646)	Sept. (573)	Oct. (770)	Nov. (430)	Dec. (128)
Insecta							
Coleoptera	0.2	2.8	2.6	4.2	3.6	0.9	....
Diptera (L)	8.2	53.4	61.9	61.9	30.6	20.0	8.6
Diptera (P,A)	0.4	0.8	0.6	1.4	1.9	....	0.7
Ephemeroptera (N)	38.4	1.2	0.8	0.7	0.3	0.9	16.4
Hemiptera	1.3	14.2	10.2	3.8	4.5	7.4	2.3
Hymenoptera	....	3.6	0.8	1.2	0.5	8.8	7.7
Trichoptera (L)	17.6	1.2	1.4	3.0	0.6	0.2	....
Crustacea							
Copepoda	6.2	5.3	5.4	14.3	19.1	43.7	53.1
All others	27.7	17.5	16.2	14.6	38.9	18.1	18.9

Table 23. A monthly comparison of the means of the eight most abundant items present in the stomach contents of Lepomis macrochirus.

Items	Total no. stomachs by month						
	Je. (18)	Jul. (28)	Aug. (73)	Sept. (47)	Oct. (51)	Nov. (42)	Dec. (14)
Insecta							
Coleoptera	0.1	0.2	0.2	0.5	0.5	0.1	....
Diptera (L)	2.1	4.7	5.5	6.9	5.1	2.0	0.8
Diptera (P,A)	0.1	0.1	0.1	0.2	0.3	....	0.1
Ephemeroptera (N)	9.9	0.1	0.1	0.1	0.1	0.1	1.5
Hemiptera	0.3	1.2	0.9	0.5	0.9	0.8	0.1
Hymenoptera	....	0.3	0.1	0.1	0.1	0.7	0.7
Trichoptera (L)	4.6	0.1	0.1	0.4	0.1	0.1	....
Crustacea							
Copepoda	1.6	0.5	0.4	1.7	2.5	4.5	4.9

Table 24. The stomach contents of 35 specimens of Lepomis gibbosus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with	Per cent Tot. items
Insecta						
Coleoptera	1	1	0.03	1.0	2.9	0.3
Diptera (L)	189	20	5.40	9.4	57.1	63.4
Diptera (P)	10	5	0.29	2.0	14.3	3.4
Ephemeroptera (N)	8	7	0.23	1.0	20.0	2.7
Hemiptera	5	4	0.14	1.2	11.4	1.7
Hymenoptera	1	1	0.03	1.0	2.9	0.3
Megaloptera (L)	7	2	0.20	3.5	5.7	2.3
Trichoptera (L)	21	2	0.60	10.5	5.7	7.0
Plecoptera	3	1	0.09	3.0	2.9	1.0
U.I.L.	5	5	0.14	1.0	14.3	1.7
U.I.P.	2	2	0.06	1.0	5.7	0.7
Crustacea						
Amphipoda	1	1	0.03	1.0	2.9	0.3
Copepoda	11	6	0.31	1.8	17.1	3.7
Ostracoda	4	2	0.11	2.0	5.7	1.3
Gastropoda	1	1	0.03	1.0	2.9	0.3
Osteichthyes	1	1	0.03	1.0	2.9	0.3
D.A.M.	18	18	0.51	1.0	51.4	6.0
Plant material	6	6	0.17	1.0	17.1	2.0
Miscellaneous	4	4	0.11	1.0	11.4	1.3

Table 25. The stomach contents of 25 specimens of Lepomis auritus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of items per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	31	5	1.24	6.2	20.0	15.4
Diptera (L)	108	3	4.32	36.0	12.0	53.7
Diptera (P)	1	1	0.04	1.0	4.0	0.5
Ephemeroptera (N)	5	5	0.20	1.0	20.0	2.5
Hemiptera	1	1	0.04	1.0	4.0	0.5
Hymenoptera	2	2	0.08	1.0	8.0	1.0
Lepidoptera (L)	2	2	0.08	1.0	8.0	1.0
Megaloptera (L)	4	2	0.16	2.0	8.0	2.0
Odonata (N)	2	2	0.08	1.0	8.0	1.0
Plecoptera (N)	3	3	0.12	1.0	12.0	1.5
Trichoptera (L)	6	3	0.24	2.0	12.0	3.0
U.I.L.	5	4	0.20	1.2	16.0	2.5
U.I.P.	6	6	0.24	1.0	24.0	3.0
Arachnida						
Araneida	1	1	0.04	1.0	4.0	0.5
Crustacea						
Cladocera	1	1	0.04	1.0	4.0	0.5
Copepoda	16	2	0.70	8.0	8.0	8.0
Osteichthyes	1	1	0.04	1.0	4.0	0.5
D.A.M.	3	3	0.12	1.0	12.0	1.5
Miscellaneous	3	3	0.12	1.0	12.0	1.5

Table 26. The stomach contents of 19 specimens of Chaenobryttus gulosus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	5	5	0.26	1.0	26.3	13.9
Ephemeroptera (N)	4	3	0.21	1.3	15.8	11.1
Hemiptera	8	3	0.42	2.6	15.8	22.2
Odonata	1	1	0.05	1.0	5.3	2.8
Odonata (N)	2	2	0.11	1.0	10.5	5.6
Orthoptera	1	1	0.05	1.0	5.3	2.8
Crustacea						
Decopoda	6	5	0.32	1.2	26.3	16.7
Osteichthyes	2	1	0.05	2.0	5.3	5.6
D.A.M.	6	6	0.32	1.0	31.6	16.7
Plant material	1	1	0.05	1.0	5.3	2.8

Table 27. The stomach contents of 15 specimens of Enneacanthus gloriosus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	18	9	1.20	2.0	60.0	20.9
Hemiptera	4	4	0.27	1.0	26.7	4.7
Megaloptera (L)	1	1	0.07	1.0	6.7	1.2
Odonata (N)	2	2	0.13	1.0	13.3	2.3
U.I.L.	3	3	0.20	1.0	20.0	3.5
Crustacea						
Amphipoda	2	1	0.13	2.0	6.7	2.3
Cladocera	1	1	0.07	1.0	6.7	1.2
Copepoda	28	3	1.87	9.3	20.0	32.6
Decopoda	1	1	0.07	1.0	6.7	1.2
Ostracoda	15	7	1.00	2.1	46.7	17.4
Gastropoda						
Pulmonata	1	1	0.07	1.0	6.7	1.2
D.A.M.	7	7	0.47	1.0	46.7	8.1
Nematoda	3	3	0.20	1.0	20.0	3.5

Table 28. The stomach contents of 7 specimens of Centrarchus macropterus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	3	2	0.43	1.5	28.6	3.1
Diptera (L)	6	2	0.09	3.0	28.6	6.1
Ephemeroptera (N)	1	1	0.01	1.0	14.3	1.0
Hemiptera	66	4	9.43	16.5	57.1	67.3
Lepidoptera (L)	2	1	0.29	2.0	14.3	2.0
Trichoptera (L)	1	1	0.01	1.0	14.3	1.0
U.I.P.	1	1	0.01	1.0	14.3	1.0
Insect eggs	6	1	0.09	6.0	14.3	6.1
Arachnida						
Araneida	1	1	0.01	1.0	14.3	1.0
Crustacea						
Copepoda	10	1	1.43	10.0	14.3	10.3
Miscellaneous	1	1	0.01	1.0	14.3	1.0

Table 29. The stomach contents of 174 specimens of Notropis cornutus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	16	12	0.09	1.3	6.9	3.5
Diptera	4	4	0.02	1.0	2.3	0.9
Diptera (L)	3	2	0.02	1.5	1.2	0.7
Ephemeroptera (N)	2	2	0.01	1.0	1.2	0.4
Hemiptera	2	2	0.01	1.0	1.2	0.4
Hymenoptera	41	18	0.24	2.3	10.3	9.0
Odonata (N)	1	1	0.01	1.0	0.6	0.2
Trichoptera (L)	3	3	0.02	1.0	1.7	0.7
Unidentified insect	4	4	0.02	1.0	2.3	0.9
U.I.L.	2	2	0.01	1.0	1.2	0.4
U.I.P.	53	53	0.30	1.0	30.5	11.7
Crustacea	1	1	0.01	1.0	0.6	0.2
Nematoda	1	1	0.01	1.0	0.6	0.2
Unidentified eggs	26	2	0.15	13.0	1.2	5.7
Graminae	1	1	0.01	1.0	0.6	0.2
Microscopic plants						
Desmids	19	19	0.11	1.0	10.9	4.2
Diatoms	69	69	0.40	1.0	39.7	15.2
Filamentous algae	71	71	0.41	1.0	40.8	15.6
D.A.M.	32	32	0.18	1.0	18.4	7.1
D.V.M.	69	69	0.40	1.0	39.7	15.2
Miscellaneous	32	32	0.18	1.0	18.4	7.1

Table 30. The stomach contents of 209 specimens of Hybopsis leptocephala collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	9	8	0.04	1.1	3.8	3.4
Coleoptera (L)	1	1	0.01	1.0	0.5	0.2
Diptera (L)	18	13	0.09	1.4	6.2	3.4
Diptera (P,A)	6	5	0.03	1.2	2.4	1.1
Ephemeroptera (N)	1	1	0.01	1.0	0.5	0.2
Hymenoptera	2	1	0.01	2.0	0.5	0.4
Lepidoptera (L)	1	1	0.01	1.0	0.5	0.2
Odonata (N)	1	1	0.01	1.0	0.5	0.2
Orthoptera	3	3	0.01	1.0	1.4	0.6
Plecoptera (N)	2	2	0.01	1.0	1.0	0.4
Trichoptera (L)	3	3	0.01	1.0	1.4	0.6
Trichoptera (P)	1	1	0.01	1.0	0.5	0.2
Unidentified insect	1	1	0.01	1.0	0.5	0.2
U.I.L.	6	6	0.03	1.0	2.9	1.1
U.I.P.	13	13	0.06	1.0	6.2	2.4
Crustacea						
Cladocera	1	1	0.01	1.0	0.5	0.2
Copepoda	1	1	0.01	1.0	0.5	0.2
Decopoda	1	1	0.01	1.0	0.5	0.2
Nematoda	1	1	0.01	1.0	0.5	0.2
Microscopic plants						
Desmids	41	41	0.20	1.0	19.6	7.6
Diatoms	94	94	0.45	1.0	44.9	17.5
Filamentous algae	84	84	0.40	1.0	40.2	15.6
Plant seeds	27	9	0.13	3.0	4.3	5.0
D.A.M.	21	21	0.10	1.0	10.1	3.9
D.V.M.	113	113	0.54	1.0	54.1	21.0
Miscellaneous	85	85	0.41	1.0	40.7	15.8

Table 31. The stomach contents of 17 specimens of Semotilus corporalis collected from June through November, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	5	4	0.29	1.2	23.5	16.7
Diptera	1	1	0.06	1.0	5.9	3.3
Hemiptera	1	1	0.06	1.0	5.9	3.3
Hymenoptera	9	3	0.53	3.0	17.7	30.0
Odonata (N)	1	1	0.06	1.0	5.9	3.3
U.I.P.	5	5	0.29	1.0	29.4	16.7
Osteichthyes	5	4	0.29	1.2	23.5	16.7
D.A.M.	3	3	0.18	1.0	17.7	10.0

Table 32. The stomach contents of 43 specimens of Notemigonus crysoleucas collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	3	2	0.07	1.5	4.7	3.2
Diptera (L)	1	1	0.02	1.0	2.3	1.0
Hemiptera	2	1	0.05	2.0	2.3	2.1
Hymenoptera	3	2	0.07	1.5	4.7	3.2
U.I.L.	2	2	0.05	1.0	4.7	3.2
U.I.P.	8	8	0.19	1.0	18.6	8.4
Arachnida						
Araneida	1	1	0.02	1.0	2.3	1.0
Crustacea						
Cladocera	1	1	0.02	1.0	2.3	1.0
Copepoda	3	1	0.07	3.0	2.3	3.2
Microscopic plants						
Desmids	6	6	0.14	1.0	14.0	6.3
Diatoms	17	17	0.40	1.0	39.5	17.9
Filamentous algae	12	12	0.27	1.0	27.9	12.6
D.A.M.	11	11	0.26	1.0	25.6	11.6
D.V.M.	16	16	0.37	1.0	37.2	16.8
Miscellaneous	9	9	0.21	1.0	20.9	9.5

Table 33. The stomach contents of 25 specimens of Clinostomus vandoisulus collected from July through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom..	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	2	2	0.08	1.0	8.0	3.8
Diptera	1	1	0.04	1.0	4.0	1.9
Diptera (L)	5	3	0.20	1.7	12.0	9.4
Hymenoptera	1	1	0.04	1.0	4.0	1.9
Thysanoptera	1	1	0.04	1.0	4.0	1.9
Trichoptera (L)	1	1	0.04	1.0	4.0	1.9
U.I.L.	3	3	0.12	1.0	12.0	5.7
U.I.P.	15	15	0.60	1.0	60.0	28.3
Arachnida						
Araneida	3	3	0.12	1.0	12.0	5.7
Crustacea						
Copepoda	1	1	0.04	1.0	4.0	1.9
Unidentified eggs	5	1	0.20	5.0	4.0	9.4
Microscopic plants						
Diatoms	2	2	0.08	1.0	8.0	3.8
Filamentous algae	2	2	0.08	1.0	8.0	3.8
D.A.M.	7	7	0.28	1.0	28.0	13.2
D.V.M.	2	2	0.08	1.0	8.0	3.8
Miscellaneous	1	1	0.04	1.0	4.0	1.9

Table 34. The stomach contents of 9 specimens of Rhinichthys atratulus collected from September through November, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
U.I.L.	5	2	0.56	2.5	22.2	20.0
U.I.P.	1	1	0.11	1.0	11.1	4.0
Microscopic plants						
Desmids	1	1	0.11	1.0	11.1	4.0
Diatoms	6	6	0.67	1.0	66.7	24.0
Filamentous algae	4	4	0.44	1.0	44.4	16.0
D.A.M.	1	1	0.11	1.0	11.1	4.0
D.V.M.	5	5	0.56	1.0	55.5	20.0
Miscellaneous	2	2	0.22	1.0	22.2	8.0

Table 35. The stomach contents of 24 specimens of Hybognathus nuchalis collected from June through November, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Microscopic plants						
Desmids	1	1	0.04	1.0	4.2	2.0
Diatoms	15	15	0.63	1.0	62.5	29.4
Filamentous algae	5	5	0.21	1.0	20.8	9.8
D.V.M.	18	18	0.75	1.0	75.0	35.3
Miscellaneous	12	12	0.50	1.0	50.0	23.5

Table 36. The stomach contents of 67 specimens of Chrosomus oreas collected from June through November, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Microscopic plants						
Desmids	24	24	0.36	1.0	35.8	12.9
Diatoms	48	48	0.72	1.0	71.6	25.8
Filamentous algae	19	19	0.28	1.0	28.4	10.2
D.V.M.	59	59	0.88	1.0	88.1	31.7
Miscellaneous	36	36	0.54	1.0	53.7	19.4

Table 37. The stomach contents of 240 specimens of Etheostoma olmstedi collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Coleoptera	1	1	0.01	1.0	0.4	0.1
Coleoptera (L)	7	6	0.03	1.2	2.5	0.7
Diptera (L)	802	184	3.34	4.4	76.7	77.6
Diptera (P)	8	8	0.03	1.0	3.3	0.8
Ephemeroptera (N)	16	12	0.07	1.3	5.0	1.5
Hemiptera	4	4	0.02	1.0	1.7	0.4
Plecoptera (N)	5	4	0.02	1.2	1.7	0.5
Trichoptera (L)	17	13	0.07	1.3	5.4	1.6
U.I.L.	23	17	0.10	1.4	7.1	2.2
U.I.P.	4	4	0.02	1.0	1.7	0.4
U.I.N.	1	1	0.01	1.0	0.4	0.1
Crustacea						
Cladocera	2	2	0.01	1.0	0.8	0.2
Copepoda	46	15	0.19	3.1	6.3	4.5
Ostracoda	3	3	0.01	1.0	1.3	0.3
Nematoda	7	7	0.03	1.0	2.9	0.7
D.A.M.	56	56	0.23	1.0	23.3	5.4
Plant material	9	9	0.04	1.0	3.8	0.9
Miscellaneous	22	22	0.09	1.0	9.2	2.1

Table 38. The stomach contents of 42 specimens of Esox niger collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	1	1	0.02	1.0	2.4	1.4
Ephemeroptera (N)	1	1	0.02	1.0	2.4	1.4
Hemiptera	5	5	0.12	1.0	11.9	6.9
Odonata (N)	3	3	0.07	1.0	7.1	4.1
Plecoptera (N)	13	1	0.31	13.0	2.4	17.8
U.I.L.	2	2	0.05	1.0	4.8	2.7
U.I.P.	5	5	0.12	1.0	11.9	6.9
Crustacea						
Copepoda	1	1	0.02	1.0	2.4	1.4
Decopoda	8	7	0.19	1.1	16.7	11.0
Osteichthyes	25	19	0.60	1.3	45.2	34.2
D.A.M.	6	6	0.14	1.0	14.3	8.2
Miscellaneous	3	3	0.07	1.0	11.9	4.1

Table 39. A comparison of the food of Esox niger in relation to different size groups expressed with number and per cent of the total specimens of each group.

Size range in mm.	No.	Frequency of occurrence of stomachs with item		
		Insecta	Osteichthyes	Crustacea
38-73	23	11 (48)*	7 (30)	2 (9)
74-217	19	3 (16)	12 (63)	5 (26)

* Per cent
Chi-square value of 4.21 significant at 95 per cent level.

Table 40. The stomach contents of 57 specimens of Aphredoderus sayanus collected from July through December, 1958, and based on the mean number of item per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomach with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	121	20	2.12	6.1	35.1	53.3
Diptera (A)	2	2	0.04	1.0	3.5	0.9
Ephemeroptera (N)	17	11	0.30	1.2	24.6	7.5
Hemiptera	11	9	0.19	1.2	15.8	4.8
Megaloptera (L)	8	7	0.14	1.1	12.3	3.5
Odonata (N)	2	1	0.04	2.0	1.8	0.9
Plecoptera (N)	6	2	0.11	3.0	3.5	2.6
Trichoptera (L)	4	4	0.07	1.0	7.0	1.8
U.I.L.	4	4	0.07	1.0	7.0	1.8
U.I.P.	6	6	0.11	1.0	10.5	2.6
Crustacea						
Amphipoda	13	8	0.23	1.6	14.0	5.7
Copepoda	8	4	0.14	2.0	7.0	3.5
Decopoda	3	3	0.05	1.0	5.3	1.3
Ostracoda	1	1	0.02	1.0	1.8	0.4
Arachnida						
Hydracarina	1	1	0.02	1.0	1.8	1.8
Osteichthyes	1	1	0.02	1.0	1.8	0.4
D.A.M.	16	16	0.27	1.0	28.1	7.1
Plant material	3	3	0.05	1.0	5.2	1.3

Table 41. The stomach contents of 26 specimens of Gambusia affinis collected from June through November, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (P,A)	5	5	0.19	1.0	19.2	14.2
Hemiptera	12	10	0.46	1.2	38.5	34.3
U.I.L.	1	1	0.04	1.0	3.9	2.9
U.I.P.	5	5	0.19	1.0	19.2	14.3
Microscopic plants						
Filamentous algae	2	2	0.08	1.0	7.7	5.7
D.A.M.	7	7	0.27	1.0	27.9	20.0
Miscellaneous	3	3	0.11	1.0	11.5	8.6

Table 42. The stomach contents of 47 specimens of Moxostoma rhothoeca collected from July through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	6	6	0.13	1.0	12.8	4.2
Hymenoptera	1	1	0.02	1.0	2.1	0.7
U.I.L.	1	1	0.12	1.0	2.1	0.7
Microscopic plants						
Desmids	6	6	0.13	1.0	12.8	4.2
Diatoms	36	36	0.77	1.0	76.6	25.4
Filamentous algae	28	28	0.60	1.0	59.6	19.7
D.V.M.	43	43	0.91	1.0	91.5	30.3
Miscellaneous	21	21	0.45	1.0	44.7	14.8

Table 43. The stomach contents of 13 specimens of Erimyzon oblongus collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Crustacea						
Cladocera	3	1	0.23	3.0	7.7	11.3
Copepoda	1	1	0.08	1.0	7.7	3.9
Nematoda	2	2	0.15	1.0	15.4	7.7
Plant seeds	1	1	0.08	1.0	7.7	3.9
Microscopic plants						
Diatoms	4	4	0.31	1.0	30.8	15.4
D.A.M.	2	2	0.15	1.0	15.4	7.7
D.V.M.	8	8	0.62	1.0	61.3	30.8
Miscellaneous	5	5	0.38	1.0	38.5	19.2

Table 44. The stomach contents of 31 specimens of Catostomus commersoni collected from June through December, 1958, and based on the mean number of items per all stomachs, the mean number of each item per stomach, the per cent of total items and the per cent of stomachs with each item.

Items	Tot. no. items	No. stom. with items	$\bar{x}$ no. items per all stom.	$\bar{x}$ no. item per stom.	Per cent Stom. with item	Per cent Tot. items
Insecta						
Diptera (L)	15	3	0.48	5.0	9.7	14.2
Diptera (P)	1	1	0.03	1.0	3.2	0.9
U.I.P.	2	2	0.06	1.0	6.5	1.9
Crustacea						
Cladocera	17	6	0.58	2.8	19.4	16.0
Nematoda	2	2	0.06	1.0	6.5	1.9
Graminae	1	1	0.03	1.0	3.2	0.9
Microscopic plants						
Desmids	6	6	0.19	1.0	19.4	5.7
Diatoms	14	14	0.45	1.0	45.2	13.2
Filamentous algae	8	8	0.25	1.0	25.8	7.6
D.A.M.	1	1	0.03	1.0	3.2	0.9
D.V.M.	18	18	0.58	1.0	58.1	17.0
Miscellaneous	21	21	67.77	1.0	67.7	19.8

Vita

David Andrew Flemer was born December 20, 1934, at Lancaster, Pennsylvania. He attended public school in Westmoreland County, Virginia and was graduated from Oak Grove High School in 1953. In the fall of 1953 he entered the College of William and Mary and graduated in June, 1957, with the B. S. degree. In September, 1957, he was admitted to the Graduate School of the University of Richmond as a candidate for the M. S. degree in biology which he received in August, 1959. While at Richmond he married Alice Weir in August, 1958. He assisted in classes of human anatomy and general biology and also worked in the vertebrate museum. During the period 1958 to 1959 he held a Williams Fellowship. He has been accepted to the Rutgers University Graduate School where he plans to do work leading to the Ph.D. degree in zoology.