

T. L. Hankinson presented the following paper:

AN ECOLOGICAL STUDY OF THE FISH OF A SMALL  
STREAM.

In this paper I will attempt to set forth the nature of my studies of the fish life of the streams about Charleston, Ill., by considering some of the methods employed and the results obtained in investigating the fish of a particular stream, called by a few of us "Campus creek" because a portion of its water comes from the Normal School campus. Although more or less attention has been given to this stream for about six years, a systematic investigation of its fauna and flora has been

carried on for about three years. The work is but fairly begun; and this paper by no means represents a culmination point in the accumulation of facts concerning this body of water.

Campus creek meanders in a southerly and westerly direction through pasture and cultivated fields and thickets, keeping to the south side of its rather broad valley, which reaches a width of about a half mile near the mouth of the stream. The country along the sides of this valley is high and gently rolling morainal region. Like other streams about Charleston, Campus creek is a part of the Wabash system, its waters entering this river through the Embarras river and Kickapoo creek. To the latter stream it is a tributary. Campus creek has four principal branches, all of which flow in a southerly direction, entering the main stream on its north side. The different portions of this little system vary considerably as to direction and rate of flow, width of bed, depth of water, topography of bottom and shore, and biological conditions present. Throughout most of its course it is broken into a series of pools with intervening narrows or broad shoals. The average maximum depth of these pools seems to be about two feet, but a few have depths as great as three feet. The current is swift in narrows and about perceptible in pools. The water is very clear under ordinary conditions. The bottom is, for the most part, firm and light-colored, composed of various combinations of clay, sand, gravel, and cobble stones. Small boulders are not infrequent in the stream bed. In the deeper parts of pools, a thin, dark sediment, rich in humus, often covers the bottom. Dead leaves accumulate here, also, in many cases. The bank in most places is grassy, and the long blades often completely conceal narrow stretches of the stream. Many kinds of plants grow along the shore, but distinctly aquatic seed plants are scarce. The stream is rich in algæ, and these organisms are being studied by Mr. Transeau. Diatoms produce a brownish scum over submerged stones, sticks, and other objects as well as over some areas of the bottom soil. This scum is especially noticeable in early spring.

An attempt has been made to get a complete collection of

invertebrate animals from each collecting station along the stream, and notes on the habits of these forms are being made as well as upon fish, but at present no detailed report upon them can be made. Campus creek is a good crayfish steam. Amphipods and isopods are common in its headwaters and those of some of the larger tributaries. Snails of several kinds are numerous. Such aquatic insects as dragon-fly larvæ, damselfly larvæ, and caddice worms are abundant, and some interesting problems concerning these and other invertebrate forms have presented themselves. Of the species of aquatic vertebrates other than fish, no one is abundantly represented. Crickets frogs, *Acris gryllus* LeConte, leopard frogs, *Rana pi-piens* Schreber, and green frogs, *Rana clamitans* Latreille, are found in numbers in spring. Careful search has failed to reveal any amphibian eggs in any part of the stream, and tadpoles are scarce at all seasons. Only one turtle, a large snapping turtle, *Chelydra serpentina* Linnæus, has been seen by me about the creek. Water snakes, *Natrix sp.*, are now and then noted, and are especially common in late spring. The following water birds have been recorded by me from different parts of Campus creek system Carolina rail, *Porzana carolina*, king rail, *Rallus elegans*, Wilson's snipe, *Gallinago delicata*, spotted sandpiper, *Actitis macularia*, green heron, *Butorides virescens*, and American bittern, *Botaurus lentiginosus*.

Of the fifty-four species of fish found to my knowledge about Charleston, seventeen are represented in Campus creek. A list of these, using the names employed in the recent work on the Fishes of Illinois by Dr. Forbes and Mr. Richardson, is here given:

- Chub sucker, *Erimyzon sucetta oblongus* (Mitchell).
- Stone roller, *Campostoma anomatum* (Rafinesque).
- Black-head minnow, *Pimephales promelas* Rafinesque.
- Blunt-nosed minnow, *Pimephales notatus* (Rafinesque.)
- Horned dace, *Semotilus atromaculatus* (Mitchell).
- Golden shiner, *Abramis chrysoleucas* (Mitchell).
- Straw-colored minnow, *Notropis blennioides* (Girard).
- Silverfin, *Notropis whipplii* (Girard).
- Common shiner, *Notropis cornutus* (Mitchell).
- Blackfin, *Notropis umbratilis atripes* (Jordan).

Black bullhead, *Ameiurus melas* (Rafinesque).  
 Silver-mouthed minnow, *Ericymba buccata* Cope.  
 Yellow bullhead, *Ameiurus natalis* (LeSueur).  
 Blue-spotted sunfish, *Lepomis cyanellus* Rafinesque.  
 Black-sided darter, *Hadropetrus aspro* (Cope and Jordan).  
 Johnny darter, *Boleosoma nigrum* (Rafinesque).  
 Rainbow darter, *Etheostoma caeruleum* Storer.

Of these only seven may be considered common and permanent inhabitants of the stream. These are, named in the order of their apparent abundance: stone roller, blunt-nosed minnow, horned dace, blue-spotted sunfish, black head minnow, silver mouthed minnow, and chub sucker. The following have been noticed common at particular times only: silverfin, common shiner, and black bullhead. Species that have been recorded in a very few instances and which are certainly very scarce in the creek are: straw-colored minnow, blackfin, yellow bullhead, and each of the three kinds of darters that have been seen in the stream. There are some species common in Kickapoo creek that I have never noted in Campus creek, although some of them, at least, probably come into it at times in the vicinity of its mouth. These are: hog-nosed sucker, *Catostomus nigricans* LeSueur, white sucker, *Catostomus commersonii* (Lacepede), red horse, *Moxostoma aureolum* (Le Sueur), sucker-mouth minnow, *Phenacobius mirabilis* (Girard), brindled stone cat, *Schilbeodes miurus* (Jordan), common top minnow, *Fundulus notatus* Rafinesque, and green sided darter, *Diplesion blennioides* Rafinesque. On the other hand, a few species seem to prefer Campus creek to the larger Kickapoo creek. These are the horned dace, black head minnow, chub sucker, and blue-spotted sunfish. Species found in numbers in both streams are: stone roller, blunt-nosed minnows, silver minnows, and silverfin.

The chief problem under consideration, concerning the fish, in this work on Campus creek and on other streams about Charleston is to determine the local distribution of each species, the type of habitat that it prefers and the way it is related to its surroundings. When these habitats are discovered, a successional study of them can be made. The rapidly changing



Fig. 3. Nesting habitat of stone roller.



Fig. 4. Nesting habitat of horned dace.

conditions in Campus creek due to freshets and other causes render the stream very favorable for such work.

To find these preferred habitats is difficult on account of the great variation in distribution of fish noted at different times. There are not only annual and seasonal fluctuations in numbers, but also daily and even hourly ones. Often they can be correlated with changing environmental conditions but in many cases, they can not be. An abundance of statistical data for each type of habitat is needed, but this is not easy to obtain even under the specially favorable conditions afforded by a small, clear creek like the one under consideration. Unless much precaution is taken in making direct observations, the proportions of species and individuals seen will be very different from those that actually exist for wary fish, like horned dace, hide, making the less shy fish seem to be the only ones present. Collections will not always give accurate information, for fish have different ways of responding to the presence of a net. Some go at once into the mud and beneath stones, and are easily missed, and the collection may contain only individuals that seek to escape by swimming. Often under very favorable conditions for collecting have I failed to get a single representative of a species which I knew, through observation, was present in the place where collecting was done. To obtain correct conclusions, therefore, concerning habitat preferences on the part of a species of fish, it seems necessary to get an abundance of data by every possible method during many seasons and obtained at all times of the day and year. These data for Campus creek are not yet at hand, so this paper will not attempt to set forth habitat preferences, but will deal with some of the more obvious environmental factors affecting the distribution of fish in Campus creek, which are: barriers, current, fish food, water temperature, and shore vegetation.

**BARRIERS.** Like most of the creeks about Charleston, there is a long stretch of shoal just above the mouth of Campus creek. This has a sandy bed with many ripple marks, and is usually dry in late summer and early fall, while the part of the stream above this area persists in its usual condition. This

forms an obstacle to fish when they are trying to come up the stream in the spring, except when the water is unusually high, and at such times fish are noticeably more numerous in the creek. Barriers in the form of leaf dams exist. There are accumulations of dead leaves against fallen limbs, brush, tree roots, fences, and the like, that are in the water. These dams often change the surface of the stream a foot or more in elevation, and fish can not get by them except at times of freshet. A little fall, about a foot in height in a piece of narrows, has been an obstacle to migrating fish in Campus creek during the last three springs; and it was interesting to watch them attempting to leap over the fall and to swim up it. Last year this fall seemed a perfect barrier till about the middle of April, when a period of high water obliterated it temporarily. After this time, stone rollers in large numbers were found nesting in the part of the stream above the fall, while prior to it they were only abundant and found spawning below it.

THE CURRENT. The direct effect of this on fish distribution in Campus creek has not been definitely made out. All the common species in the creek certainly prefer the deeper and quieter waters for permanent abodes, but many individuals come to the shoals from the pools at night and rest on the bottom where the water is swift. From observations made with a bicycle lamp in some of the streams about Charleston, including Campus creek, it appears that shoals constitute the chief nocturnal habitats for stream fish; the pools seem almost deserted at that time, and those shoals with rapidly moving water seem to be preferred, but more data are needed on this point. Stone rollers, with some exceptions, and also horned dace, go to the rapid and shallow water areas for spawning, usually just above the patches of riffles at the lower ends of pools. Male stone rollers, by pulling away the small stones of gravel bottoms, in the situations described, make little pits in which the females lay the eggs. These were very noticeable above many pieces of riffles in Campus creek last year, and these fish were seen working here from the last of March till after the middle of May. Some fish were found spawning

in very swift water of shallow riffles, where their bodies were out of water much of the time while working at the gravel. The only undoubted horned dace nest found in Campus creek was located in one of the tributaries of the stream in a narrow, shallow piece of swift water; but a number have been found in other streams in the region and all were located in a good current. Some silver-mouthed minnows were found spawning upon a sandy shoal where there was a moderate current last spring. The shoal with swift water seems to be least frequented by fish of all habitats in Campus creek except at night and by certain species at the spawning time. Its main function for fish appears to be that of a general highway connecting their diurnal dwelling places, the pools and deep narrows.

The current also has an indirect effect upon the distribution of fish by changing the bottom topography; for example, I noticed this winter that there is a broad shoal where a deep pool existed last fall; and in another place, where there was an extensive area of riffles used by stone rollers for nesting purposes last spring, there is now a deep pool. These changes will necessitate biotic changes involving fish as well as other organisms; and an opportunity will thus be afforded to observe directly the succession of forms inhabiting a particular part of the stream due to a change of environmental conditions. After a hard rain last April, the swift water completely denuded an area of gravel, which formed a piece of riffles used by many stone rollers for nesting purposes, and left in its place a shallow area a few inches deep, having a hard, blue clay bottom with a few pot holes and scattered cobble stones. Fish were found using these objects as places of concealment. Thus in a few hours one type of habitat was transformed into another, and each had a fish fauna different as to the species present and the way they reacted to their surroundings.

**Food.** This is undoubtedly a strong factor in determining the distribution of fish in Campus creek. Diatoms, entomostacans, and *Chironomus* larvæ are the chief objects that I have found by dissecting many examples of the common species.

Stone rollers, blunt-nosed minnows, and black head minnows feed largely on soil rich in diatoms. Chironomus larvæ and entomostracans formed the bulk of the food found in silver mouthed minnows and the blue-spotted sunfish. Some chub suckers had fed entirely upon soil and diatoms, and others upon entomostracans and Chironomus larvæ. The horned dace examined had a miscellaneous lot of insect fragments in their intestines including Chironomus larvæ and terrestrial insects. By further studies of the food of the fish of Campus creek, it is hoped that the distribution of the organisms used as food can be correlated with that of the species of fish that feed upon them.

TEMPERATURE. This effects the distribution of the fish in the stream indirectly and probably directly, but I have failed as yet to find any marked relation between temperature of water and fish distribution. They have been seen both active and inactive in winter when the water was near the freezing point. The largest number of fish ever seen by me in Campus creek was on January 28, 1906, when the water temperature was 6 degrees centigrade.

Some stone rollers taken at this time had their intestines filled with soil and diatoms. One winter I gave particular attention to a lot of fish that were remaining over winter in a pool in one of the tributaries of Campus creek, and I could see no relation between their behavior and the water temperature.

SHORE VEGETATION. As above stated, a grassy bank borders the stream almost everywhere, and this in many places overhangs the water due to the mat of soil and roots at its top edge, which resists erosion more than the portion below it. Under this shelf, fish and other aquatic animals like snails and various insects find a place of seclusion. From observations made on Campus creek it appears that fish are more often found where overhanging banks are present than at other places. Roots of trees also hold on to the soil, and often produce large overhanging banks; and where the roots are submerged, a habitat of a peculiar type is produced, for among them there is an intricate series of cavities in which fish often stay. The leaves

forming leaf dams and accumulations on the bottoms of pools, in which fish often conceal themselves, are contributed largely by the trees along the shore.

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