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Macroscopic Fuana of a Small Brook

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MACROSCOPIC FAUNA OF A SMALL BROOK.

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INTRODUCTION.

The brief paper here presented is but the first of a series of studies which the writer proposes to work out concerning the ecological relations of the animal life of Johnson county. Johnson county has been chosen as the field for observations for several reasons, among which are its availability from Iowa City and the University buildings as a center, its wealth of diversified habitats, and the most excellent work already done by Professor Bohumil Shimek in the field of plant ecology, upon which all studies of animal ecology depend, as all animals ultimately depend upon plants for food.

Any piece of work must have a beginning. The animal life of the small brook was chosen as an opening wedge to the larger subject because the brook represents the earliest stages of the development of a permanent stream in the reduction of the purely terrestrial habitats to the ultimate sea level water habitat by the process of erosion. Such streams afford the most favorable opportunities for study during the spring months. A further reason for the choice lay in the fact that the particular stream which receives the attention of this study lies within a few minutes walk of the State University.

The writer does not hope to introduce any new or startling facts. The fauna of the typical small stream has been surveyed and recorded many times and the various habitats with their respective associations of species which it affords have received treatment in Shelford's Animal Communities of Temperate America. However, no extensive consideration of the animal life of the county could be considered complete without such a study and its present application to an Iowa stream may prove interesting to workers other than the writer.

THE STREAM.

The brook which is made the basis for this study lies within the city limits of Iowa City, although its valley lies outside the residence district. There are one farmhouse and three suburban

homes which might indirectly contribute sewage contamination to its waters. It forms the north fork of what was formerly known as Butcher's Run, due to the location of a slaughter house in its valley years ago, and it is virtually a tributary of that slightly larger stream. It joins Butcher's Run a few rods from the juncture of that stream with the Iowa river. The smaller north fork was chosen rather than Butcher's Run for the greater part of these observations because the latter has ceased to be normal owing to the encroachments of dwelling houses along the upper part of its course.

North Fork has a sinuous course for about one-third of a mile through partly wooded bluegrass pasture. Its valley forms the characteristic V of young streams. This valley secures its supply of ground water near its head in the form of seeping springs. For some distance below this point the stream is scattered through a semi-boggy, grassy area with a definite channel only at intervals. The upper part of its course runs through soil and has less well defined alternating rapids and pools than would be the case if the material were more heterogenous. The lower portion of its course shows in sharp definition the alternation of pools and rapids. Some of these pools were perhaps a rod in extent and showed a depth of over a foot (Plate XI, figure 1). The rapids show little of the loose stone, gravelly character so often encountered in small streams but are formed by the outcropping of solid shelves of stratified rock over which the water passes from one pool to the next (Plate XL, figure 2). Such rapids provide scant shelter and places of attachment for many of the common forms of rapid water life.

The bed of the stream was filled throughout with quantities of the decaying leaves which had fallen from the trees in forested portions of the basin and had been concentrated by the rains in the main stream beds. These, with the algae covering the rocks and generously distributed throughout the streams, afforded an unlimited food supply to all plant feeding forms.

On April 10 the stream was dry for a few rods at its mouth but showed running water elsewhere in its course. It is said to go completely dry for weeks at a time during the summer months.

ANIMAL ASSOCIATIONS OF THE BROOK.

The animal life of such a brook as that described lends itself to ready classification into special associations depending upon

the nature of the physical and vegetational features of the environment. For example the rich fauna of many of the larger pools consists of a surface film association, a bottom association, a free-swimming association and a marginal or transition zone association, etc. For convenience it has been deemed advisable to consider the life of this brook under two main heads, (1) the upper brook, and (2) the lower brook, with various subdivisions into associations where the data permit.

(1) The upper brook.

The upper part of the stream, as has been mentioned already, consists of a slowly moving shallow stream of water, with occasional clear cut channels, but for the most part creeping through semiboggy, grassy areas. The bottom was muddy throughout, covered with algae, and containing much decaying vegetable matter from last year's foliage.

The animal life here consisted of various Entomostracha, Planaria on the bottom, with Tipulid larvae as the prevalent larger form. Other undetermined dipterous larvae were taken. A few crayfish burrows were observed in the wet ground.

(2) The lower brook.

Here the cutting of the stream through heretogenous material has developed well defined rapids and pools, each deserving of separate consideration.

THE RAPIDS.

The rapids of this stream are peculiar in that they consist almost wholly of stratified rocks over which the water drops, thus affording scant shelter and places of attachment for the more common forms inhabiting rapid water (Plate XL, figure 2). These stones were covered with algae and upon each shelf lay masses of decaying leaves.

No animal form was strictly peculiar to these rapids. The artificial burrows of Chironomous larvae occurred here in numbers, many with the larvae inside. Other forms such as Tipulid larvae, Stratiomys larvae and Hydrophilid beetles were taken from among the decaying leaves and from the crevices in the rocks. These were also found in the pools.

THE POOL ASSOCIATIONS.

The pools, with their large expanse of quiet water, of a depth not so great as to prevent the thorough influence of the sun's rays, permit the growth of an abundance of algae and other aquatic plants on the bottom and of semiaquatic plants at the margin. This richness of plant life and the variety of physical conditions make possible a division of the fauna into separate associations, such as already have been pointed out.

Surface film association.—Here the physical features of importance are the atmosphere as a direct supply of oxygen, and the surface tension of the water. The most characteristic form is the Water strider, which breathes the air directly, is enabled to support itself upon the surface film, and takes its food by preying upon other insects that have fallen into the water.

Many forms from the free-swimming association depend on the surface for breathing, coming up at intervals to renew their supply of oxygen. Tipulid larvae which live in the mud on the bottoms must take their oxygen from the air, thus establishing a connection between these two associations.

The bottom association.—Upon the bottoms of the pools has become concentrated the silt together with vegetable debris, composed in a large part in this instance of the decaying leaves. Living plants are attached here.

Dredgings from the muddy bottoms of such pools have brought to light such forms as flat worms (Planaria), pond snails, the larvae of Chironomous and Corethra, dragonfly larvae and water scavenger beetles (Hydrophilidae). Cranefly larvae (Tipulidae) also are found in numbers on the muddy bottom but their distribution is limited to the margins where the water is sufficiently shallow to allow them to reach the surface with the breathing apparatus located on their posterior extremities. Many of the free-swimming forms spend a part of their time on the bottom or upon the vegetation growing there. Examples of these forms are May fly larvae, mosquito larvae, larvae of Dytiscid beetles and adults of the same.

The free-swimming association.—The free-swimming association consists of these forms which spend much of their time moving about throughout the water and which have access to all parts of the pool although they may be taken in temporary connection with those forms of the other associations proper. The

larvae of the May flies and of the Dytiscid beetles form excellent examples of animals of this class which do not have to come to the surface for breathing. The immature stages of the Mosquitoes and the adult Dytiscid beetles both play an important part in this association but each of these is so constituted anatomically that it must rise to the surface at intervals to renew its supply of oxygen.

The transition zone association.—The transition zone association is characterized by those forms the distribution of which is limited to that area included in the margin of the brook—the edge of the water itself and the immediate banks of the stream. The vegetation of this region consists for the most part of semi-aquatic and mesophytic plants. A great abundance of vegetable debris is usually to be found. The mudflats occasionally found at the edge of the stream contain the burrows of Heterocerid beetles. Spiders crawl about on the vegetation and make excursions out over the water. Staphylinid beetles were taken from partly submerged decaying leaves. Frogs, while they may be found temporarily in any of the associations, must receive distributional classification with the transitional zone forms. Examinations of the stomach contents of *Rana pipiens* Sch., taken from Butcher's Run show that their food supply comes partly from forms that have aquatic habits during at least a part of their lifetime. The air above the brook at times fairly swarms with the adults of the May fly and Simulium or Buffalo gnats. Craneflies were taken from the vegetation near the edge of the water.

CATALOGUE OF THE FORMS TAKEN.

In the foregoing discussion of the various associations of animals afforded by the brook only such forms were mentioned as were considered particularly characteristic of each of those associations. The following is a catalogue of those forms of animal life taken in this rather superficial survey, with merely enough reference to their habits and life history to account for their presence in such a brook as that under observation. The table on page 373 presents much of the same data in condensed form.

Platyhelminthes.—The flat worms were represented by the fresh-water Tricads in the form of *Planaria* sp. These were observed crawling about on the muddy bottom of the shallow stream near its source. They were also taken frequently in dredging the larger pools. At the time of the first observations, April 10,

they were found in great numbers, almost to the exclusion of other forms, in a pool near the mouth of the brook which had become isolated by the drouth. These worms receive their nourishment from the ooze, etc., on the bottom. Their food is necessarily microscopic.

Mollusca.—Pond snails, of two species,[1] *Physa gyrina* Say, and *Limnaea* sp?, constituted a great part of the individuals of the larger forms in the bottom associations. They were present in numbers, crawling about over the bottom and upon the growing vegetation as well. It is supposed that vegetable matter composes at least the principal part of the food of these snails. The eggs, in their masses of jelly, attached to the under surface of the decaying leaves, were found at almost every dredging.

Entomostracha.—These minute Crustaceans abound in varying numbers throughout the whole of the brook, although they belong primarily to the free-swimming association. Of these the Ostracoda were by far the most prevalent, the masses of green algae being fairly alive with them. A horde of the little animals was observed feeding on the soft parts of a dead snail, *Physa gyrina* Say.

Of the Copepoda, *Cyclops* sp?, was observed, though not in such great numbers as the individuals of the Ostracoda.

Arachnida.—Spiders of the Drassidae, the ground spiders, comprising several undetermined species, form a very important part of the transition zone association. They haunt the vegetation at the water's edge and sally forth upon the surface film of the water itself to prey upon drowning insects.

Insecta.—By far the greater number and variety of forms of animal life in the brook are those of insects. They dominate to a large measure the life in each of the associations. Five orders are represented, Ephemerida, Odonata, Hemiptera, Coleoptera, and Diptera.

Ephemerida—May flies.—The nymphs of the May flies abound in all of the quiet pools during the weeks of early spring. The nymphs of *Callibaetis* sp? and *Blasturus* sp? were taken in numbers by use of the dredge net on April 10 and April 17. These numbers had been very much reduced by April 24, due to the emergence of the imagos. On April 17 the subimagos were observed leaving the nymphal skins at the water and taking flight immediately. One of these when captured was recognized

[1]Determined by Prof. B. Shimek.

as belonging to the genus Callibaetis but the species was not determined. On April 24 these hovered above the water in great numbers, their long anal cerci acting as rudders to keep them facing the breeze in flight. The nymphs of these genera form prevailing factors in the free-swimming association. Their leaflike abdominal gills provide them with oxygen as they swim about or rest upon the vegetation. They are plant feeders.

Odonata—Dragonflies.—Nymphs of the dragonfly, *Gomphrus* sp.? were taken occasionally in dredging the muddy bottom with its leafy debris. These are practically confined to the bottom association. They are predaceous, feeding upon other insect forms and have been known to attack and devour tadpoles and other forms of similar size.

Hemiptera.—Two families of the Hemiptera were recognized, the Hydrobatidae and the Corisidae. Of the former, commonly known as the water striders, two species, probably *Gerris marginatus* Say, and *Gerris remegis*, were taken. These belong wholly to the surface film association. They move about over the water, supported by surface tension, with great freedom and agility. They are predaceous and prey chiefly upon other insects which have fallen into the water. Upon one instance the writer observed a strider seize a Simulium fly but a few seconds after it had touched the surface and proceed to transfix it with its beak to devour the body juices. Another specimen made a meal from a drowning May fly adult.

The Corisidae, or water boatmen, are free-swimming insects and form a part of the free-swimming association, although they come frequently to the surface and occasionally may be found floating. They are predaceous and for the most part feed upon other insects. Specimens of *Corisa* sp.? were taken from the larger pools.

Coleoptera—Beetles.—The observations made in this study involve beetles of four families: Dytiscidae, Hydrophilidae, Staphylinidae, and Heteroceridae.

1. Dytiscidae. The Dytiscids, or predaceous diving beetles, were represented by two species, *Acilius mediatus* Say and *Laccophilus fasciatus* Aube. These beetles move about with great rapidity through the water and form an important factor in the free-swimming association due to their predaceous food habits. They are obliged to rise to the surface occasionally to renew their supply of oxygen, taking a bubble of air down with them under

their wing covers. Dytiscid larvae of at least two species were taken. These also are predaceous and the writer observed one larva of a large species which had seized a larva of a Tipulid fly larger than itself and into which it had sunk its long mandibles. Another of the same species gave chase to a May fly nymph and persisted for several minutes until the greater fleetness of the pursued enabled it to escape its enemy.

2. Hydrophilidae. Four species of the Hydrophilidae, water scavenger beetles, were taken, of four genera: [2]*Hydrobius fuscipes* Linn., *Helophorus lineatus* Say, *Philydrus cinctus* Say and *Cymbiodyta fimbriata* Say. While these beetles swim about freely their food habits as scavengers confine their activities to the debris-covered bottom and on this account they must be placed in the bottom association.

3. Staphylinidae. Two species of Staphylinidae, the short winged scavenger beetles, namely *Tachyporus jocosus* Say and *Stenus* sp? were taken from partly submerged masses of decaying leaves. These beetles are wholly terrestrial in their adaptations and must be included in the transition zone association.

4. Heteroceridae. The burrows of Heteroceridae, the variegated mud-loving beetles, were observed on some of the small mudflats formed by silt deposition along the course of the stream. These beetles are one of the most characteristic forms of life on the mudflat and hence become important members of the transition zone association. No specimen was taken.

Diptera.—By far the greatest number of species prevailed among the forms of Diptera in their aquatic immature stages. Representatives of five families were taken as follows: Culicidæ, Chironomidæ, Tipulidæ, Stratiomyiidæ and Simulidæ.

1. Culicidae—Mosquitoes. By far the most abundant forms of the Culicidae were the larvae of Culex which had made their first appearance in the pools in great numbers by April 17. Upon April 24 these had increased greatly in numbers and a very few had pupated. Microscopic materials are swept into the mouth and contain both plant and animal matter. These larvae belong to the free-swimming association although they are obliged to rise to the surface at intervals for breathing purposes.

Coretha sp? larvae were taken in small numbers on April 10, 17, and 24, and pupae were added on the latter date. These

[2]The species of beetles listed in this paper were determined by Prof. H. F. Wickham, of the State University.

forms are predaceous upon the smaller animals, such as Entomostracha, and have been known to feed upon May fly nymphs. Their transparency enables them to feed to great advantage without being exposed to the attacks of other forms. Their other habits are similar to those of Culex and they also are members of the free-swimming association.

A specimen of *Corethrella* sp? in the larval stage was taken from one of the pools. The habits of this genus as far as known are very similar to those of the two preceding genera.

2. Chironomidae—Midges. Larvae of the genus Chironomus were taken by dredging the pools on the various dates mentioned above. They were taken also on April 24 in their artificial burrows on the rock shelves which had been a part of the rapids during greater flow of water. These feed upon decaying vegetable matter and are confined to the bottom association although they occasionally swim about free from the bottom.

A few specimens of the genus Ceratopogon were taken in the larval stage April 17. These are free-swimming forms wriggling about for the most part among the aquatic plants near the surface. It is presumed that this genus is carnivorous in its food habits.

3. Tipulidae—Craneflies . Tipulid larvae were taken in numbers from the shallow, muddy bottomed upper part of the stream on April 24. They also occur abundantly near the edge of the pools partly buried in the mud. Their distribution in the pools is limited to those depths that will enable them to reach the surface to obtain air with the specially adapted posterior end. In some cases the little depressions, caused by surface tension, which mark the location of the breathing apparatus of the Tipulid larvae fairly dot the marginal waters of the pools. They feed on the decaying plant matter in the muddy bottom, and belong to the bottom association. A single adult was taken April 24 from the grass beside the brook, but the species has not been determined.

A single pupa, similar in most characters to the pupae of certain Tipulidae was taken from the rock shelf of the rapids April 24.

4. Stratiomyiidae—Soldier flies. Larvae of *Stratiomys* were taken from all of those places recorded for Tipulid larvae but in decidedly fewer numbers. These larvae crawl about over the bottom in shallow places with the posterior segments turned up-

wards to bring the breathing spiracle on the extremity of the body to the surface, or they swim about, coming to the surface at intervals where the water is deeper. They feed by sweeping microscopic organisms into the mouth. As a large portion of their time is spent on the bottom, and most of their feeding is done there, it seems best to include them in the bottom association.

5. Simulidae—Black flies. Adults swarmed about in such great numbers on April 17 as to make it uncomfortable near the stream. They resembled *Prosimulium pecuarum* Riley, but did not bite.

Vertebrata.—The vertebrates were represented by two species of common frogs, the Leopard frog, *Rana pipiens* Sch., and the common tree frog, *Hyla versicolor* LeConte. The Leopard frog makes the marshes and brooks its normal habitat while the little tree frog takes to the water only during the breeding season. The eggs of *Hyla* were taken from one of the pools on April 17. These hatched in three days when taken into the laboratory.

The stomach contents of two specimens of *Rana pipiens* Sch., taken April 24, tell the story of their food habits.

Specimen No. 1.	One May fly adult
	remains of six sowbugs
	one small terrestrial beetle
	one dipterous larva, probably Tipulid
	other unrecognizable material.
Specimen No. 2.	Larvæ of Carabid beetle
	one spider and remains of two others
	two sowbugs
	one snail, *Limnaea?*
	remains of one Myriopod
	three small beetles, remains of one other

The variety of these contents shows that the supply has come from both terrestrial and aquatic forms. The frog is therefore a most important member of the transition zone association.

TABLE OF FORMS TAKEN FROM THE WATER AND FROM THE TRANSITION ZONE OF THE BROOK, WITH INFORMATION AS TO THE PARTICULAR ASSOCIATION OF WHICH THEY FORM A PART, THEIR FOOD AND NUMBERS.

Animal	Association				Food				Numbers	
	Surface film	Bottom	Free swimming	Transition zone	Herbiverous	Predaceous	Scavenger	Microscopic organisms	Numerous	Few
Flatworms, *Planaria* sp?		+					+	+	+	
Ostracoda			+				+	+	+	
Copepoda, *Cyclops* sp?			+					+		
Mollusca, snails,										
Physa gyrina Say		+			+				+	
Limnaea sp?		+			+					+
Spiders, *Drassidae*				+		+			+	
May flies, *Blasturus* sp? nymph			+		+				+	
Callibaetis sp? nymph			+		+				+	
Dragon fly, *Gomphrus* sp? nymph		+				+				+
Water strider, *Gerris marginatus* Say?	+					+			+	
Gerris remegis?	+					+			+	
Water boatman, *Corisa* sp?			+			+			+	
Dytiscid beetles,										
Acilius mediatus Say			+			+			+	
Laccophilus fasciatus Aube			+			+			+	
Hydrophilid beetles,										
Hydrobius fuscipes L		+					+			+
Helophorus lineatus Say		+					+			+
Philydrus cinctus Say		+					+			+
Cymbiodyta fimbriata Say		+					+			+
Staphylinid Beetles,										
Tachyporus jocosus Say				+			+			+
Stenus sp?				+			+			+
Heterocerid Beetle				+					+	
Mosquitoes, gnats,										
Culex sp? larvæ			+					+	++	
Corethra sp? larvæ			+			+			+	
Corethrella sp? larvæ			+					+		+
Midges, *Chironomous* sp? larvæ		+			+		+		+	
Ceratopogon sp? larvæ			+			+			+	
Crane-flies,										
Tipulidae, larvæ		+					+	+	+	
Soldier-flies										
Stratiomyiidae, larvæ		+						+	+	
Frogs, *Rana pipiens* Sch. adult				+		+				+
Hyla versicolor le Conte, larvæ			+			+				+

CONCLUSIONS.

In the opinion of the writer the most significant facts brought to light by this study of the animal life of the brook are these: (1) the wonderful variety and complexity of the fauna in a habitat that does not remain constant throughout the year; and (2) the dovetailing interdependence of each species upon others in the environment, the number of individuals in each case depending primarily upon the food supply, which ultimately reverts to the amount of plant life.

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PLATE XL.

FIG. 1.—A large pool in the North Fork of Butcher's Run, Iowa City, Iowa. From this pool were taken specimens representing every form recorded from pools. Photograph taken April 17, 1915, by the author.

FIG. 2.—One of the characteristic rock shelf rapids of the North Fork of Butcher's Run, almost dry. Photograph taken April 24, 1915, by the author.