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SEASONAL CHANGES IN BOTTOM FAUNA OF AN OZARK HEADWATER STREAM (CLEAR CREEK, WASHINGTON COUNTY, ARKANSAS)

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ABSTRACT. The physico-chemical features of Clear Creek, a headwater stream in Northwestern Arkansas, did not differ much from those described for limestone area streams in other parts of the U.S. The bottom fauna was dominated by insects. Of the fifty-three species (or groups) forty-four are insects. Differences in relative composition between upstream and downstream stations were observed. The rather low fall standing crop gradually increased until in late winter at which time the maximum occurred. This large standing crop was then abruptly reduced by the erosional effects of flood waters. Following flooding, the relative composition of the standing crop was altered, apparently as a direct result of certain members being able to better withstand the erosional conditions.

Only two studies of bottom fauna from streams of the Ozark physiographic province have been made, both from Missouri. The first, made by Sullavan (1929) on the Niangua River in Southern Missouri, was qualitative and confined to a single period in the summer. Most of his determinations were to family or genus and, in most instances, the descriptions are so generalized that one cannot determine whether the organisms were pool or riffle inhabitating. O'Connell and Campbell's (1953) study was more precise with an adequate account of sampling stations. However, their identifications were to family only and quantitative treatment consisted of percentage composition and average of the total with no indication of variability of results. Also their study was confined to summer months. Both Sullivan (1929) and O'Connell and Campbell (1953) examined moderately large streams.

This paper presents the results of a six month (October, 1948, to March, 1949) bottom faunal study of the riffles in a headwater Ozark stream, Clear Creek.

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Physiographic Features of the Stream

The stream valleys of the Ozark region exhibit two phases of development, which grade into each other wihotut sharp distinction. The simpler phases, an open trough bordered by hills and without rock ledges adjacent to the stream but with residual cherts generally covering the valley and flooring of the stream, is usually shown in the upper portion of the stream with the Canyon phase and its extensive meanders found on the lower stream (Adams and Ulrich, 1905). Clear Creek conforms generally to the first phase described. It is a primary tributary of the Illinois River which originates on the northern base of the Boston mountains in Arkansas and flows northward, then westward into the Plateau region of the Ozark uplift of Arkansas then on into Oklahoma. The small, clear stream which is fed by intermittent sheet wash from the adjacent hills and by springs, consists of narrow, shallow pools with numerous riffles interspersed. The riffles are usually formed by accumulations of roughly angular fragments of chert or occasionally by ledges of chert. The rifffle materials are mostly gravel with some rubble as classified by Roelf's (1944) system.

Materials and Methods

Seven riffles within an approximate mile and a half length of the stream were selected on the basis of their similarities in length, width, and estimated gradient and flow. The seven stations were located as follows in Township 17 N and Range 20 W: I and II in Section 14; III in Section 22; and IV, V, VI, and VII in Section 21. These riffles ranged from 6 feet to 10 feet in width with a length of from 10 to 16 feet. Macroscopic plants were absent from the riffles although the margins of pools supported a sparse growth of *Dianthera americana* (water willow).

Bottom samples were taken by placing a Surber square-foot stream sampler at random within the main body of the riffle and dislodging the organisms by agitation of the sediments. After the organisms were concentrated in the apex of the net by a vigorous swishing they were transferred to a pint jar and taken to the laboratory. The samples which were refrigerated to retard activity and decomposition of the organisms, were examined within six hours under a widefield binocular microscope and the organisms separated to major groups, counted, then preserved in 70% ethyl alcohol containing a few drops of glycerine.

conducted and data collected. These included water and air tempera-

To supplement the bottom fauna data certain other analyses were conducted and data collected. These included water and air temperatures, daily precipitation and determinations of dissolved oxygen, carbon dioxide, phenolthalein and methyl orange alkalinity, and hydrogen ion concentration. Air temperature and daily precipitation records were secured through the courtesy of Mr. J. R. Prince from the University of Arkansas Weather Station, located approximately two miles from the collecting stations.

During the first part of the study one square foot sample was taken from each station twice a month. However, Stations I and II were discontinued on January 20, 1949, after three months of sampling because of impassable roads and during the week of January 24 to 31 Stations III and VI were eradicated by flood waters that changed the course of the stream. Consequently, only Stations IV, V, and VII were sampled over the entire six month period. Following this, two samples were taken from the remaining stations at each period of sampling.

Water analyses were conducted using techniques described in *The Standard Methods of Water Analysis* (1946). Water temperatures were taken with a laboratory stem thermometer; hydrogen ion concentrations were determined with a Hellige block comparator.

PHYSICO-CHEMICAL FEATURES OF THE STREAM

Clear Creek is typical of Ozark headwater, spring-fed streams in that turbidity is exceedingly low except at times of heavy rains. This lack of turbidity is also reflected in the basic economy of the stream since turbidity may be the result of planktonic organisms in the water. Their virtual absence here suggests (as indicated by the frequent presence of diatom-distended digestive tracts of midge larvae) that the primary trophic level revolves around the *Aufwuchs* assemblage rather than true phyto-plankton.

Water temperatures during the period of study ranged from 18.0°C. to 1.0° C. At this latitude an ice cover seldom if ever occurs.

Alkalinity in Clear Creek consisted entirely of bicarbonates. The concentration progressively decreased, with some fluctuation, from the highest value (137 p.p.m. on October 22) to a low of 61 p.p.m. on February 14, the last date alkalinity was sampled. This progressive decrease has been accounted for in a Kentucky limestone stream by Neel (1951) who attributed it to dilution of ground water by surface runoff which is greatest in winter months. Figure 1 shows precipitation from October, 1948, to March, 1949. It can be seen that while the greatest amounts did not occur in January and February the distribution of rainfall was such that it can be inferred that the ground remained saturated for greater periods of time. This in turn results in greater dilution of ground water and less bicarbonate in the stream.

Hydrogen ion concentration was not determined consistently. However, results are in agreement with Neel's (1951) findings for streams in Kentucky although pH values had a lower range than he described with a low of 6.8 occuring on February 1.

Free carbon dioxide rarely occurred. A maximum concentration of 7 p.p.m. was recorded on February 1.

Results and Discussion

The bottom fauna of Clear Creek was composed mostly of insects. Trichoptera, Ephemeroptera, and Diptera were represented by the largest number of individuals and also included 66% of the total number of species. Within these three major groups only about 28% could be determined with fair accuracy to species. This agrees with Roback's (1953) figure for the Tendipedidae (25%) of the Savannah River. This and similar studies clearly point out the need for additional life history studies of aquatic insects. In such streams as Clear Creek where the fauna is so clearly insectan a very valuable and accurate tool (Guyer and Hutson, 1955) would be the use of funnel or tent traps to supplement the benthic sampling.

The following is a check list of all species (and groups) of organisms collected during the six month study:

PLATYHELMINTHES
Curtisia foremani (Girard)
NEMATODA
(Undetermined species)
CRUSTACEA
Orconectes nana nana Williams
Orconectes neglectus neglectus (Faxon)
Lirceus hoppinae (Faxon)?
PLECOPTERA
Isoperla clio (Newman)
Isogenus (Hydroperla) crosbyi (N & C.)
Neoperla clymene (Newman)
Taeniopteryx maura (Pictet)
Brachyptera fasciata (Bluemeister)
EPHEMEROPTERA
Isonychia sp.
Baetis sp. (*pygmaeus* gr.)
Stenonema tripunctatum Banks
Pseudocloeon sp.
Caenis sp.
Heptagenia sp.
Heptagenia sp.
Ephemerella sp. (*invaria* gr.)
MEGALOPTERA
Corydalus cornutus L.
DIPTERA
Simulium piscidium Riley?
Eriocera fultonensis Alex.
Tipula sp.
Pentaneura sp. (*flavifrons* gr.)

Thienemanniella sp.
Orthocladius (Orthocladius) sp.
Orthocladius (Euorthocladius) sp.
Metricnemus sp. near *lundbecki* Joh.
Cardiocladius sp. near *obscurus* Joh.
Diamesa fulva Joh.
Cricotopus sp.
Calosectra sp. near *mancus* (Walker)
Calopsectra sp.
Polypedilum (Polypedilum) obtusum (Townes)
Tendipes (Limnochironomus) sp. near *fumidus* (Joh.)
Microtendipes pedellus (DeGeer)
Cryptochironomus sp.
Atherix sp.?

TRICHOPTERA
Cheumatopsyche sp.
Hydropsyche slossonae Banks
Hydropsyche sp. (*bifida* gr.)
Hydropsyche sp. near *betteni* Ross
Hydropsyche sp. near *simulans* Ross
Chimarra obscura (Walker)
Chimarra aterrima Hagen?
Helicopsyche borealis (Hagen)
Polycentropus sp.
Agapetus sp.

COLEOPTERA
Helichus sp.
Psephenus herricki (DeKay)
Elsianus sp.

HYDRACARINA
Hygrobates sp.
Sperchon sp.

GASTROPODA
Ferrissia sp.
Goniobasis sp.

The horizontal distribution of the benthos within the riffles of a stream is highly variable. Three major patterns of variability of numbers are possible: (1) from shore to the center of the stream, (2) from the head to the lower end of the riffle and, (3) between the riffles upstream and downstream. Studies of the first of these possibitities have demonstrated that small streams (below about 15 feet width) tend to have a uniform production from shore to center Leger, 1910; Needham, 1928, 1934; Pate, 1931, 1932; Behny, 1937). Since stream width is generally dependent on position along the length of the stream these same studies have contributed to our knowledge of the third possible pattern of variability. In general bottom fauna production per unit area tends to decrease downstream. The second source of variation has not been adequately studied nor was the experimental design of this study such that it would clarify the problem. Needham's (1934) comment on the extreme variability of bottom samples is possibly a reflection of this source of variation.

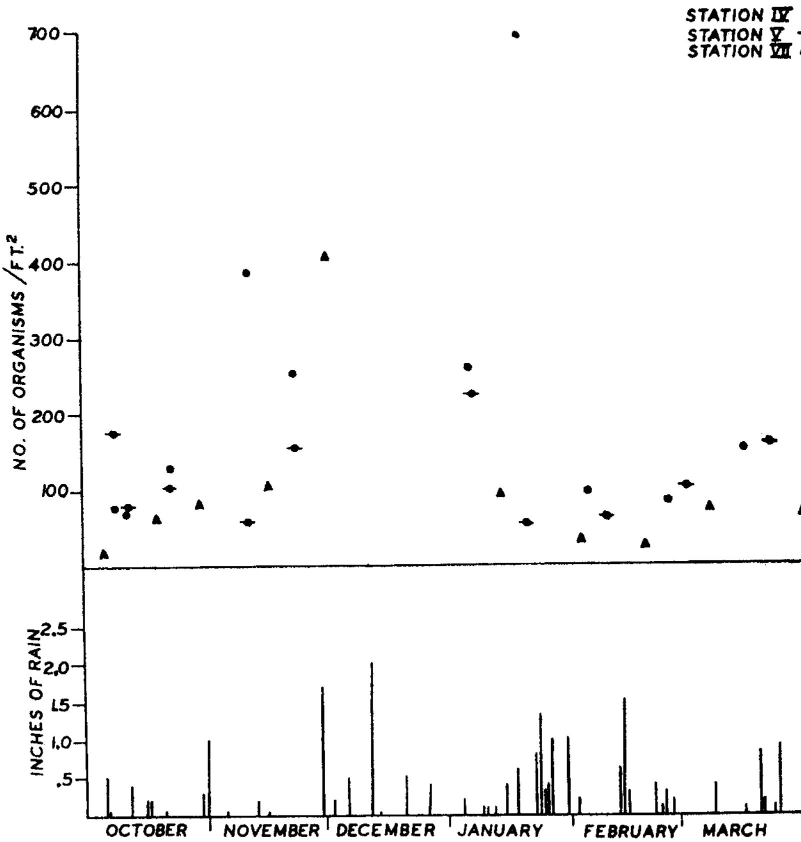

Figure 1. Seasonal changes in total organisms as sampled at 3 stations (top) compared with daily rainfall (bottom). Rainfall of less than .05 inch per day was not recorded.

Clear Creek exhibits a highly significant lack of homogeneity of standing crop between stations as tested with chi-square. This agrees with results of other workers (cf. Serber, 1936). It appears that this lack of homogeneity becomes more pronounced as cold weather progresses. Figure 1 shows a scatter diagram of total numbers per sample of three stations plotted together. It is apparent that the range of variation in numbers steadily increases up to about the last week of January. At this time of the most pronounced environmental factors becomes operational—flooding and subsequent erosion. This erosional effect has been observed in other streams (Moffett, 1936; Stehr and Branson, 1938). Figure 1 shows daily rainfall plotted with total numbers. Obviously, rainfall in an area (in this instance the weather station was about two miles away) is only an approximate index to stream flow. However, since a direct relationship must exist it was used. During the fall two heavy rainfalls occurred (November 1 and 2 and November 28 and 29). These did not produce more than a small rise in level with no detectable population erosion and decimation. During the last week of January, however, a heavy rainfall did cause a large rise and very pronounced erosion. It is thus seen that some heavy rains do not produce erosion while others do. This apparent discrepancy is explainable on the basis of rainfall immediately proceeding the heavy rain. In November, heavy rains occurred after reasonably long dry periods; hence, most of the precipitation was absorbed rather than producing heavy runoff. In January, on the other hand, the heavy rains were preceeded by several days of intermittant rain which caused the soil to become saturated with water. Consequently, the January heavy rains caused stream flooding as a result of the greatly increased runoff.

As can be seen in Figure 1 this flooding caused the displacement and destruction of a good part of the riffle community. Destruction did not occur to all groups equally, dependent upon the organisms' ability to maintain their original position. Of all groups present the Tendipedidae, with their largely tubicolous habit, survived best. From 8.8% of the total before flooding the Tendipedidae rose to 25%, while other groups decreased in relative percentage.

Clear Creek showed a distinct difference in percentage composition of most major groups between farthest upstream and downstream stations. The following are average percentages of samples taken from October through December:

	PERCENT OF TOTAL ORGANISMS	
	Station I (Upstream)	*Station VII (Downstream)*
Trichoptera	68.4	33.0
Ephemeroptera	14.0	41.0
Simulium	6.7	5.3
Tendipedidae	3.0	11.4
Plecoptera	1.0	5.8
All others	7.9	3.5

SUMMARY

1. Clear Creek is a headwater tributary of the Illinois River in the Ozark Uplift of Arkansas. It is made up of numerous pools and riffles which form an open trough floored with chert gravel. Aquatic vegetation is sparsely represented along pool margins by water willow, *Dianthera americana*..

2. A six month study (October, 1948, to March, 1949) revealed that chemically, the waters resembled those described by Neel (1951) in Kentusky limestone streams. Alkalinity consisted entirely of bicarbonates with only an occasional sample containing CO_2 in small amounts. The pH ranged lower than reported by Neel (loc. cit.). Oxygen values were always high.

3. The physical features were dominated by one outstanding thing—heavy rains in the late winter which caused severe erosion and change in stream bed configuration.

4. The standing crop of riffle-inhabiting benthic invertebrates rose from a relatively low value in late fall to a peak of production in midwinter. This populous community was at that time abruptly decimated by severe stream erosion. Following this there was a very gradual increase in numbers.

5. Following severe erosion the relative percentage composition changed, apparently as a result of certain groups (the Tendipedidae) being more able to survive the erosional conditions.

6. An upstream-downstream relative percentage composition difference existed. In the most upstream station the caddisflies dominated with the mayflies occurring next in abundance. In the most dowstream station caddisflies were second in order of abundance with the mayflies occurring with the greatest frequency. The downstream also showed a large increase in numbers of Tendipedidae.

7. A total of fifty-three species or groups was collected. A very large number could not be identified beyond genus because of inadequate knowledge of life histories and immature stages. Bottom faunal investigations should be supplemented by rearing the aquatic insects to maturity.

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