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ECOSYSTEM STUDIES AT CEDAR CREEK NATURAL HISTORY AREA, II

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The Cedar Creek Natural History Area occupies approximately 4000 acres of northern Anoka and southern Isanti counties, 30 miles north of Minneapolis and St. Paul, Minnesota. It is administered jointly by the University of Minnesota and the Minnesota Academy of Science. Funds for recent extensive additions of land and for the construction of the laboratory were generously provided by the Fleischmann Foundation. The facility is being directed by Prof. A. N. Wilcox, under the supervision of Dean T. C. Blegen of the University of Minnesota Graduate School.

It was not possible for the senior author to report the progress of the Hill Foundation project "Energy relations of terrestrial ecosystems" at the 1959 Meeting of the Minnesota Academy of Science because of absence on sabbatical leave in South America. The first report presented at the Bemidji meeting has been published. (Lawrence, Bray & Pearson 1957-1958), and the reader is referred to that article for background on the objectives of ecosystem studies. The detailed results of the 1957 studies have been published (Bray, Lawrence, & Pearson 1959).

The work began in 1957 with attempts to discover whether aspen bark was green because of contained chlorophyll, and if so whether photosynthesis occurs there in winter. Reports of affirmative tests by Pearson and Lawrence (1958, 1957-1958) have since appeared.

In the summer of 1958, J. R. Bray, L. C. Pearson, Alfred Rogosin, and Vincent Heig explored the chlorophyll content per unit area of landscape of several different communities, and for herbaceous communities, the relation of chlorophyll to the total biomass standing on such areas. These studies showed that for a given kind of life form of plant, the chlorophyll content increased directly with the increasing dry weight of the plant bodies, some communities containing as much as 15 times the amount of chlorophyll as others. This sug-

gested that annual productivity of the vegetation may depend upon the amount of chlorophyll that the biomass can expose to the available solar radiation. A first report is published. (Bray 1960).

In August 1958, Dr. Ovington joined the project, and during the 1959 growing season he carried on a detailed systematic monthly sampling program in prairie, bur oak savannah, Hill's oak woodland, broad and narrow leaf cat-tail marshes, and a maize field. Jackpine plantations of three different ages: 7, 10, and 15 years were also sampled in the summer. The regularly spaced maize and jackpine plantations served as standards of comparison for the more diverse natural communities. In each of the areas the sample plants were carefully selected by techniques that would provide data suitable for statistically valid analysis and interpretation, and the plant material was separated according to source into roots, young and old stems, young and old leaves, and fruits. Data were accumulated on height of plants, chlorophyll content, and dry weight. Another study involved plastic screens which were pegged down under tamarack, cedar, white pine, and aspen canopies to catch the litter fall. Portions of each of the collected samples were ground into fine powder for ascertaining caloric value and for conducting chemical analyses for the elements nitrogen, phosphorus, potassium, calcium and magnesium. Chemical analyses of the 1000 samples are being carried out under the direction of Dr. Courtland L. Agre, Chairman of the Department of Chemistry at Augsburg College. A bulk sample of each of the materials from the autumn 1959 harvest was submitted to R. E. Frazier, of Minnesota State Board of Health for radiostrontium analysis in the hope of learning something about distribution of that fallout substance in the plant portion of ecosystems; results of these studies are of special interest. In the field and laboratory work at Cedar Creek, Dr. Ovington was assisted by his wife, Joyce, by Gerald Martin, Dale Heitkamp, Phillip Neumann, Marjorie Israel, Betty Bostrom, and Allan Bonde. Mrs. Lawrence has helped with the budget, and the senior author has aided in planning and expediting the work. Miss Jean McIntosh has attended to a multitude of administrative details. Alvar Peterson, custodian of the laboratory, has helped in many ways including planting, cultivating and fertilizing the maize on his own farm adjacent to the study area.

The data collected in 1959 are still in a partly undigested condition but it is expected that important interpretations may result from them in due time.

Another facet of the work has been the attempt to ascertain amounts of water vaporized from open water and from vegetation. It is perhaps necessary to explain why a project concerned with the *energy* relations of ecosystems should become involved in the measurement of annual water expenditures of different kinds of plant cover per unit area of landscape. Estimates of the portion of the total solar energy striking the landscape which actually is stored in the organic products of photosynthesis that can be harvested and weighed generally have been reported to be less than 1%, although Ovington and Heitkamp (1960) have very recently found as much as

7% of the available radiation stored in some coniferous tree plantations in England. In contrast with this utilization, estimates prepared by Penman for England have indicated that approximately 40% of the incoming solar energy is involved in the vaporization of water. Actual measurements are few and none have been made in Minnesota. If this use of energy can be directly measured it will greatly help in our estimates of annual energy budgets.

In the early summer of 1958, three cylindrical steel cattle tanks four feet in diameter and two feet deep were installed in a marsh adjacent to the laboratory. One was in an open water pond, one in sedges, and one in a cat-tail stand. The task of installing some of these was extraordinarily difficult because ice was encountered below the vegetated surfaces so that the transplanting of the natural vegetation had to be spread over almost two weeks. By the end of that summer twice as much water had been vaporized from the tank filled with cat-tail plants as from the open water surface. Amount of water lost from the sedge tank had been about half way between. It had been supposed by the senior author that such thin walled tanks would surely be split by freezing if left undrained the following winter, but when spring of 1959 arrived, water stood at higher levels inside the tanks than outside indicating that the tanks had not been ruptured. Meanwhile the cat-tail plants in the one tank had died, probably frozen, and they became naturally replaced during the summer by marsh grasses. By autumn of 1959, the original sedge tank had vaporized three and one half times as much as the open water tank, and the grasses in the original cat-tail tank, now surrounded by cat-tails much taller than themselves had lost less than the sedges, a little less than twice as much as the open water tank.

In mid-December, 1959, four additional tanks were purchased with National Science Foundation funds and a new technique was attempted for transplanting. A swamp willow five feet tall, an alder six feet tall, a paper birch fifteen feet tall, and a tamarack ten feet tall, all growing on organic substrata, were transplanted. The method consisted of cutting a circle, just slightly smaller than the tank, around each shrub or tree with a chain saw, through the ten inch layer of ice which prevailed at the time, sliding out the frozen mass, inserting the tank into the enlarged hole, and placing the ice cylinder containing the plant's relatively undisturbed roots into the tank, making sure to retain the original orientation compass-wise. This unique transplanting was done by Heitkamp, Neumann, and Bonde. It provides an opportunity to study water expenditures of various kinds and sizes of plants in the very places where they grew naturally. Observations made in May, 1960, suggest that the transplanting technique was successful because the plants in the tanks are behaving in ways apparently identical with those of their neighbors outside. We shall provide automatic replacement of water losses during the summer through installation of reservoirs and float valves.

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