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BOTANY

Ecosystem Studies at Cedar Creek Natural History Area

The simplest example of an ecosystem is a balanced aquarium, made by placing a wisp of hay, some pond water, and air in a glass jar which is then sealed and placed in indirect light. In a few weeks green plants and minute animals have appeared; the green plants use the energy of light and the raw materials carbon dioxide, water, and a few mineral nutrients, to form as products of photosynthesis gaseous oxygen and those complex organic substances which provide the food needed by themselves and by the animals. It may seem at first that this sealed balanced aquarium is a closed system, but brief reflection suggests that light is entering and heat is leaving, making it an *open* system as Bertalanffy (1950) showed to be true of all biological systems. A more familiar example of an ecosystem is a group of people and the room which holds them, though in this instance it is an unbalanced ecosystem because it lacks any producer organisms and contains only consumers. Fortunately, it is an open system which has allowed people to bring in with them a previous meal and will allow them to depart to reaffirm that dependence even within the room, for each breath recharges their blood with vital oxygen which would not be present in the atmosphere had it not been placed there in the past by photosynthetic plants.

The ecosystem idea is not new; it was presented at least seventy years ago when Forbes (1887) described a lake as a microcosm. But the term *ecosystem* was invented by the great British ecologist, Tansley, only in 1935. He defined it as "the whole *system* (in the sense of physics), including not only the organism-complex, but the whole complex of physical factors forming what we call the environment of the biome—the habitat factors in the wildest sense." Many have expressed the belief that this concept is an abstraction too intangible to deal with, but Tansley himself pointed out clearly that it is absolutely concrete when he said, "It is the systems so formed which, from the point of view of the ecologist, are the basic units of nature on the face of the earth." They are in fact the only concrete whole entities that one can put one's finger on in nature. Everything else we attempt to study is just a little scrap or shred of something larger. It is true that ecosystems are difficult to delimit because they are open systems, but in reality they are no more difficult in this respect than any individual organism when we examine carefully the complex and ill-defined interfaces between it and its environment.

Some of the interrelations of a typical complete ecosystem of northern Minnesota are shown in Fig. 1. The primary energy source is the radiation from the sun, and effects of the enormous radiation fluctuations are held within tolerable biological limits by the thermoregulating influences of the high specific and latent heats of water. In the diagram the materials and energy are seen to have two different fates; one portion circulates in a path from green plants

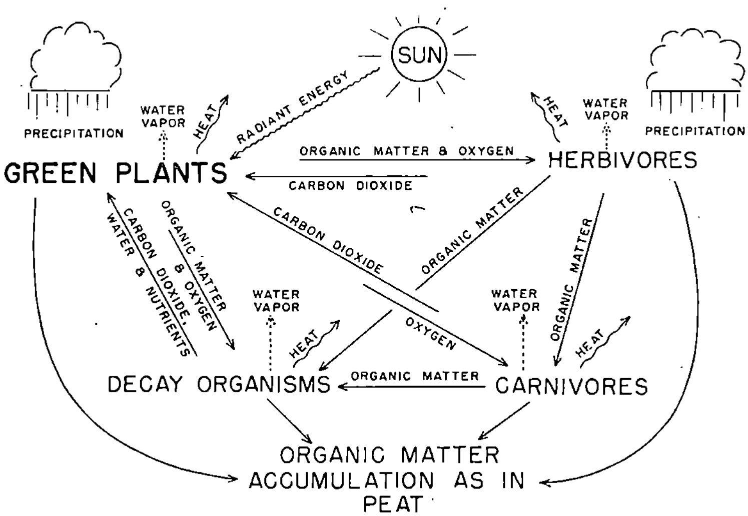

Fig. 1. Paths of exchange of matter and energy in a typical ecosystem of cool moist regions.

through herbivores, carnivores and decay organisms, or often through a shorter path with some returning to green plants. This is comparable with money in the pocket which circulates from day to day through a human ecosystem. The other is the setting aside of organic matter in a reserve fund as in peat, comparable with money in the bank.

How much energy is involved? On the average clear day in midsummer in central Minnesota about 1000 kilowatt-hours of solar energy fall on an area 30 by 30 feet, the area occupied by an average home. What becomes of all this energy when it falls upon the landscape? It has been estimated that only about one half of one percent is built into organic matter. Large amounts are expended merely in evaporating water. How do the various forms of plants, the herbs, shrubs and trees, and the various species of these, differ in their ability to transform this energy needed to support all the organisms of the ecosystem? These are the main questions we seek to answer.

The Cedar Creek Natural History Area has played a notable role in pioneer ecosystem studies of the world because it was there that Raymond L. Lindeman, a graduate student in the Department of Zoology on the Minneapolis campus of the University, began in 1936 his now classical four-year study of "The seasonal food-cycle dynamics in a senescent lake". Lindeman, though he had the use of only one eye, published six important articles and accomplished, with the help of his diligent wife, before his untimely death at age 27, more than many scientists ever do in a normal life span. In his honor we would here propose the name "Lindeman Lake" for that little body of water which is still unnamed.

In the spring of 1957 a new chapter in ecosystem studies began in the Cedar Creek area when the Hill Family Foundation of St. Paul generously granted to the University of Minnesota a sizeable sum for initiating a study of the energy relations of terrestrial ecosystems to extend the work begun by Lindeman twenty-two years ago.

It is the methods employed in our renewed attack on ecosystem problems that we wish to describe briefly here. We have thus far dealt mainly with emergent aquatic vegetation where samples of nearly pure stands of a single species could be harvested without too much difficulty. The annual aquatic grass, wild rice (*Zizania aquatica*) is a good starting point because all of the organic material accumulated is the product of a single growing season except for the weight of the grain from which it sprouted. Furthermore, by wading out into a stand of wild rice growing in soft muck, one can harvest the roots in a circular patch of known area about a central marking post by gently tugging at the stems. The root systems can later be detached from the stems and the two parts weighed separately after the roots have been carefully cleaned. After oven-drying a representative portion, the dry weight accumulated per acre per year may be calculated. Fractions of the dry sample which are ground to a fine powder can be tested in a calorimeter to ascertain energy content so that the portion of the solar energy falling on a unit area of landscape which is built into organic matter each year may be determined.

The sampling of cattail (*Typha sp.*) vegetation with its underground rhizomes which survive more than one year is more complicated and results are difficult to place upon an annual basis. For sampling underground parts a coring device has been made, consisting of two pieces of steel tubing of slightly different diameters welded together, one inside the other. The one of smaller size is actually just a short protruding sharpened cutting edge only ¾ inch long. The tube is driven into the soil with a heavy maul, and after the core passes the cutting aperture the tube widens out so that there is ample room for it. When the filled coring device has been withdrawn with a small block and tackle supported from a simple tripod, the core of soil is easily removed by merely turning the core tube upside down; the soil core falls into a container without urging. The mineral substratum is composed of such fine grained glacial outwash sand that only the roots and a few pebbles lie on top of a fine screen after the sample has been washed under a hose at the Cedar Creek Laboratory. The underground parts can then be dried and weighed and the weight and energy content per acre of landscape computed.

In studies of this kind some sort of standard is needed for comparison. For this we are using hybrid corn tailor-made for the study area, planted by machine, and fertilized at recommended rates. Working out the annual rate of organic accumulation for corn and wild rice which survive for a single growing season is relatively simple, but when one deals with plants which store within their living bodies material to be partly used the next year, as in cattails, the difficulties increase; and in shrubs and trees which grow for many years the estimation of accumulation of organic matter in individual years becomes a truly perplexing problem. We hope in time to learn not only which kind of plant is most efficient in trapping and storing solar energy, but also whether it is the pioneer, the transitional, or the late developmental stage of vegetation that is most efficient in this.

LITERATURE CITED

BERTALANFFY, L. VON. 1950. The theory of open systems in physics and biology. *Science 111:* 23-29.

FORBES, S. A. 1887. The lake as a microcosm. *Bul. Sci. A. Peoria* 1887; 77-87. (Reprinted with emendations in Ill. Nat. Hist. Surv. Bul. 15: 537-550. 1925).

LINDEMAN, R. L. 1941. a. Seasonal food-cycle dynamics in a senescent lake. *Amer Midl. Nat.* 26: 636-673.

LINDEMAN, R. L. 1941. b. The developmental history of Cedar Creek Bog, Minnesota. *Amer. Midl. Nat.* 25: 101-112.

LINDEMAN, R. L. 1942. a. Experimental simulation of winter anaerobiosis in a senescent lake. *Ecology* 23: 1-13.

LINDEMAN, R. L. 1942. b. The trophic-dynamic aspect of ecology. *Ecology* 23: 399-418.

TANSLEY, A. G. 1935. The use and abuse of vegetation concepts and terms. *Ecology* 16: 284-307.