

of one by lumbering and the other by fire does not diminish their integrity. Each, if given a chance, renews itself. Neither invades the other, as I have seen in Minas Geraise and Para.

More recently, ecologists have found ways of simplifying even complex communities to express the fundamental basis of their existence and their relationships with the physical world. This has been said facetiously as a matter of "who eats whom." Like many a jest, it has a penetrating core of truth.

It all starts with the elementary fact that to be alive requires a supply of energy, and that the ultimate source of energy for living organisms is the sun. This energy, as every schoolboy learns, is made available by a photochemical process involving green plants principally. In the process, organic carbon compounds are formed from which energy can be released and used by the living substance to maintain a multitude of life activities, including maintenance, growth, and reproduction of the living substance and the organisms it composes.

The resulting situation is simplified by considering those carbon compounds that are assimilable as food. Green plants and a very limited number of other photosynthetic organisms are autotrophic, which means that they can start from scratch with carbon dioxide and water and sunlight and manufacture simple carbohydrates, granted the pre-existence of chlorophyll and certain catalyzing enzymes and the living matrix itself. (This is no place to go into the question of the origin of life on the world or for that matter whether on another world it might be based on iron rather than carbon).

Starting from this base, all animals and all non-photosynthetic plants, such as parasites and saprophytes, are heterotrophic and cannot start from scratch. They must eat something. I use the word eat rather loosely to include all methods of acquiring organic carbon and its associated energy supply. This does not refer to acquisition in solution of essential mineral nutrients such as nitrogen, phosphorus, sulfur, magnesium, iron, calcium, and certain trace elements, although these are parts of many foods.

This situation can now be seen to be truly a matter of who eats whom. Green plants are called primary producers. Organisms eating such plants are first order consumers. Rabbits eat pea plants and carrots when they get a chance. But foxes eat rabbits when they get a chance, and they are second order consumers. There may be other identifiable levels in the food chains until one comes to the top predators of any ecological system which are in this gross sense without enemies because none of their consorts is capable of successfully attacking them. Still, even the top predators die because they, like the lowliest green plant, are subject to the ravages of parasites, to starvation, and to accidental death.

The sequence described in this general and non-scientific language is one of transfer of energy-bearing carbon compounds from one level to another with each trophic-dynamic level having fewer numbers of organisms and less biomass. (Now I have used some technical language, but the meanings are now implicit.) On this basis, the biological system of a community can be described quantitatively if one samples adequately, aggregates data, and simplifies everything about who eats whom.

This concept of a pyramid of numbers of organisms and the amount of substance contained in each level is upset, however, by the degraders and decomposers. I have already referred to the fact that the top predators die for one reason or another other than themselves being gross food for somebody else. It is now seen that this isn't really true. Nearly every organism, perhaps all of them if we knew enough, is subject to parasitism. And not every part of every organism is alive. Many structures of both plants and animals are composed at least partly of substances produced by the living organism, perhaps once alive but certainly not now alive. For example, a large healthy tree may be more than 90 percent dead. All such organic material, whether a dead organism or part of a still living one, is subject to decomposition and degradation by saprophytes. These organisms, as distinct from parasites that live on living substance, usually killing it, live on dead substances. They are mostly but not entirely bacteria, fungi, microscopic animals, and small worms.

So the cycle is completed, because the degraders and decomposers reverse the build-up process and return complicated compounds to simple forms such as mineral nutrients that are again available to green plants. As has been known for many centuries, and as we are reminded at every funeral, man is mortal. "Dust thou art, to dust returnest."