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ECOLOGICAL PYRAMIDS

In trying to understand communities, ecologists find it useful to determine certain numeric values and convert them into graphs that give a pictorial representation of the relationships. Some of the most valuable of these are ecological pyramids. This plate shows the three kinds of pyramids in common use.

Color titles A through D, the heading Pyramid of Numbers, and the structures in the two pyramids in the first section.

One kind of ecological pyramid is the pyramid of numbers. The organisms in each trophic level are actually counted, where possible, or estimated from representative samples. In a very small forest, for example, it is entirely possible to count all the trees. Counting all the individual plants in even a tiny meadow would be a different matter.

A sort of pyramid is then constructed, making the area of each box proportional to the number of individuals in that community. The decomposers are usually not shown separately in ecological pyramids but are included as part of each level of consumer. If they were shown separately in a pyramid of numbers, they would overwhelm the other trophic levels. One cubic centimeter of soil often contains more than a million bacteria, for instance. (How many cubic centimeters of soil are there in a small forest?)

A pyramid of numbers will take different shapes according to the sizes of the producers. In a grassland, each *producer* is very small, so their numbers are very considerable. An equal area in a forest will contain only a few large trees, so a pyramid of numbers for a forest will show a very small area for producers, although the trees might support just as many consumers as the grass does in the grassland.

Color the heading Pyramid of Biomass and the trophic levels in the two pyramids in that section.

"Biomass" means the actual mass (weight) of living matter in the organisms in each trophic level. Collecting the data from which to build this pyramid is even more tedious than for a pyramid of numbers, but it has been done for many communities. In a typical terrestrial community, a pyramid of biomass has the conventional pyramidlike shape, with a large base to represent the mass of plants necessary to support a smaller mass of *herbivores,* which in turn support a smaller mass of *primary carnivores,* and so on. However, since a pyramid of biomass shows the biomass at one particular point in time, the proportions can be distorted if one trophic level has a peculiar reproductive rate. This often happens in aquatic communities, where the producer level is dominated by algae that reproduce so rapidly that they replace the ones that are eaten as fast as they are consumed. At any given time, there is a smaller biomass of algae than of organisms feeding on them, but if we were to make a pyramid of the biomass produced over an extended period of time, that pyramid would closely resemble the pyramid of energy described below.

Color the heading Pyramid of Energy and structures A through D in the remaining pyramid.

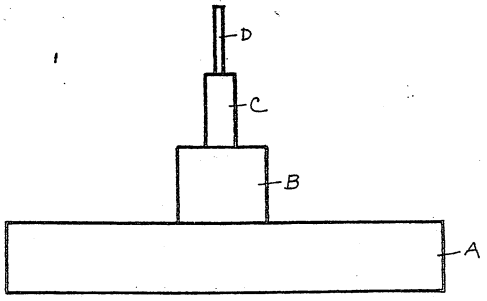
A pyramid of energy displays the total amount of energy captured and stored in the biomass of each trophic level over one year. (The energy is measured in kilocalories—what nutritionists call Calories, with a capital "c"—or in joules, a unit of energy from physics.) A pyramid of energy takes very nearly the same shape for every community. Each trophic level captures only about 10 percent of the energy contained in the biomass of the level below it. The remaining 90 percent is unassimilated (since even the most efficient digestive system cannot digest and absorb everything) or is used and dissipated as heat in the activities of life. Thus a *secondary carnivore* eating a primary carnivore takes in only about 1 percent (10 percent of 10 percent) of the energy present in the original producers and converts only about 0.1 percent of that energy into its own body mass.

The pyramid of energy shows very clearly that if food for feeding people is scarce, we can feed far more people on plant foods than we can on meat from plant-eating animals. It also shows why in nature the largest number of trophic levels normally found is five, and then usually only in aquatic communities where the big fish eat the little fish who eat the littler fish who eat the almost microscopic organisms who eat the algae.

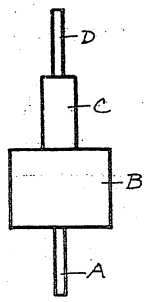
ECOLOGICAL PYRAMIDS.

PRODUCERS$_A$
HERBIVORES$_B$
PRIMARY CARNIVORES$_C$
SECONDARY CARNIVORES$_D$

PYRAMID OF NUMBERS☆

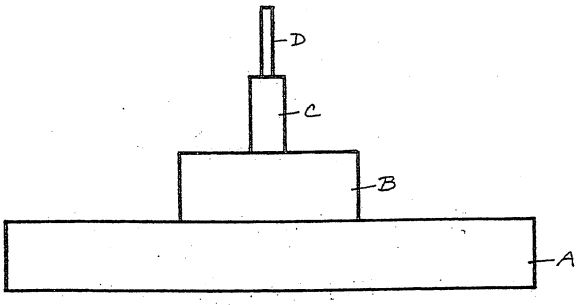


GRASSLAND

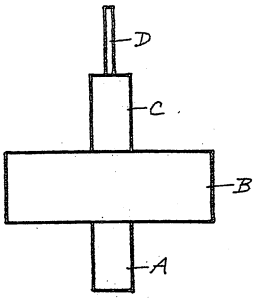


TEMPERATE FOREST

PYRAMID OF BIOMASS☆



GRASSLAND



OPEN OCEAN

PYRAMID OF ENERGY☆