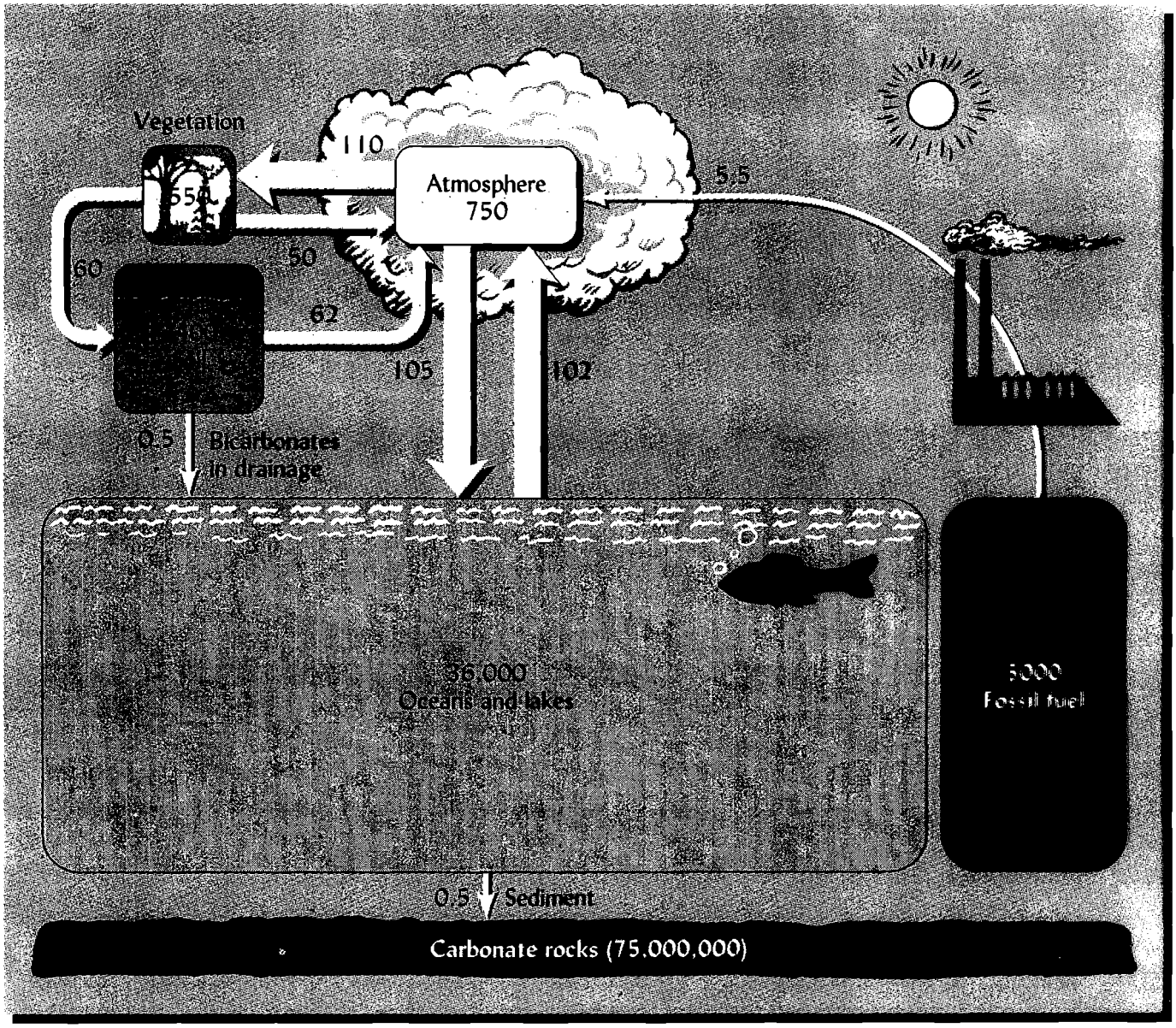
11

12

SOIL ORGANIC MATTER

The earth lay rich and dark and fell apart lightly under the points of their hoes.
—*P. S. BUCK,* THE GOOD EARTH

Soil is a large Carbon Sink



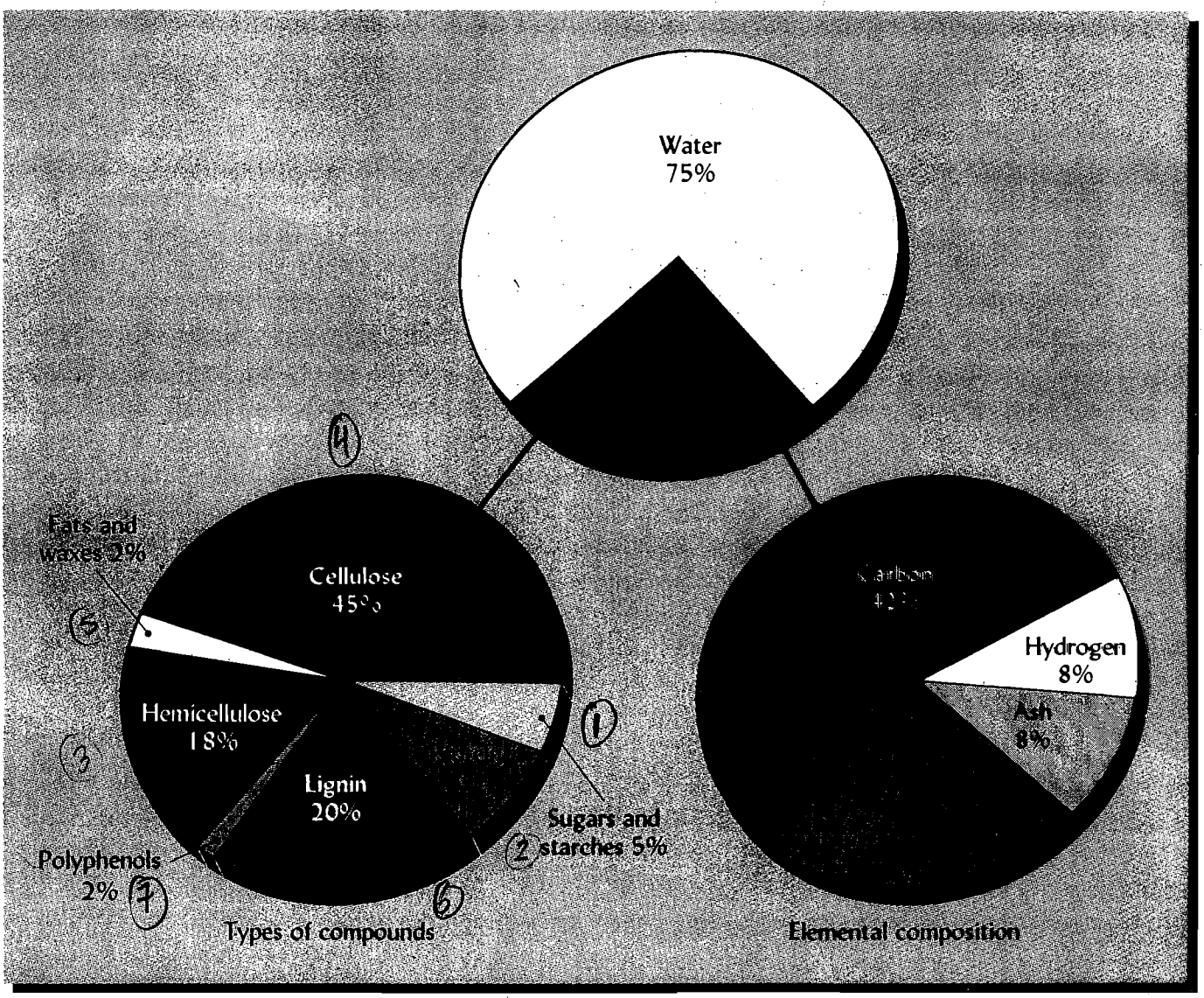


FIGURE 12.2 Composition of representative green-plant materials. The pie charts show typical composition. The major types of organic compounds are indicated at left and the elemental composition at right. The *ash* is considered to include all the constituent elements other than carbon, oxygen, and hydrogen (nitrogen, sulfur, calcium, etc.).

Lect 12

Soil Organic Matter, VERY COMPLEX!

Classified by Analyses not by specific molecular structure

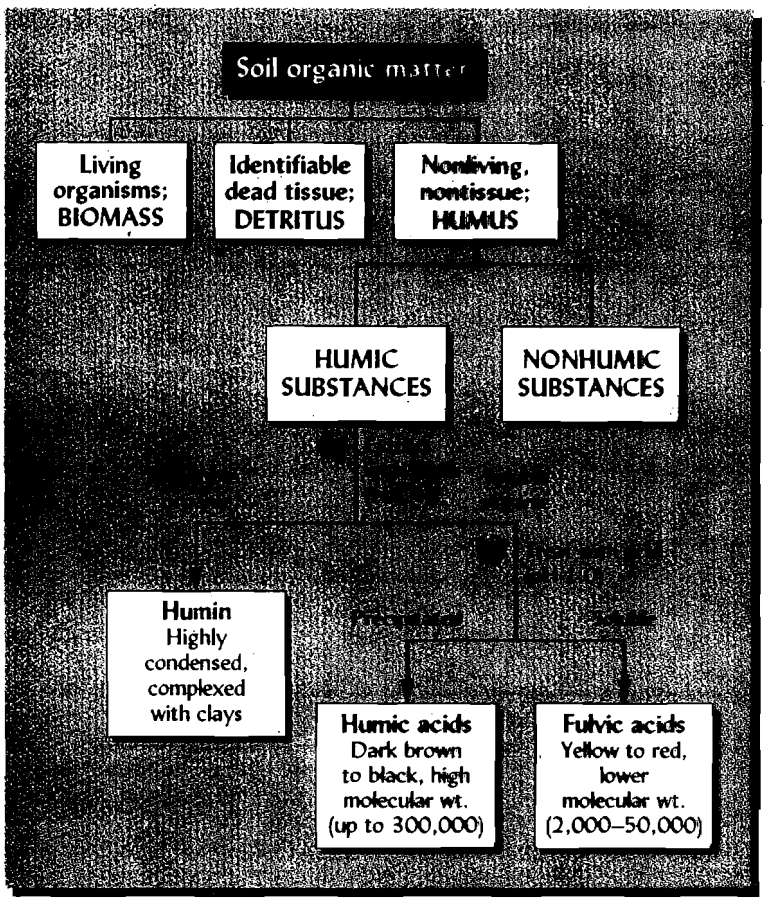
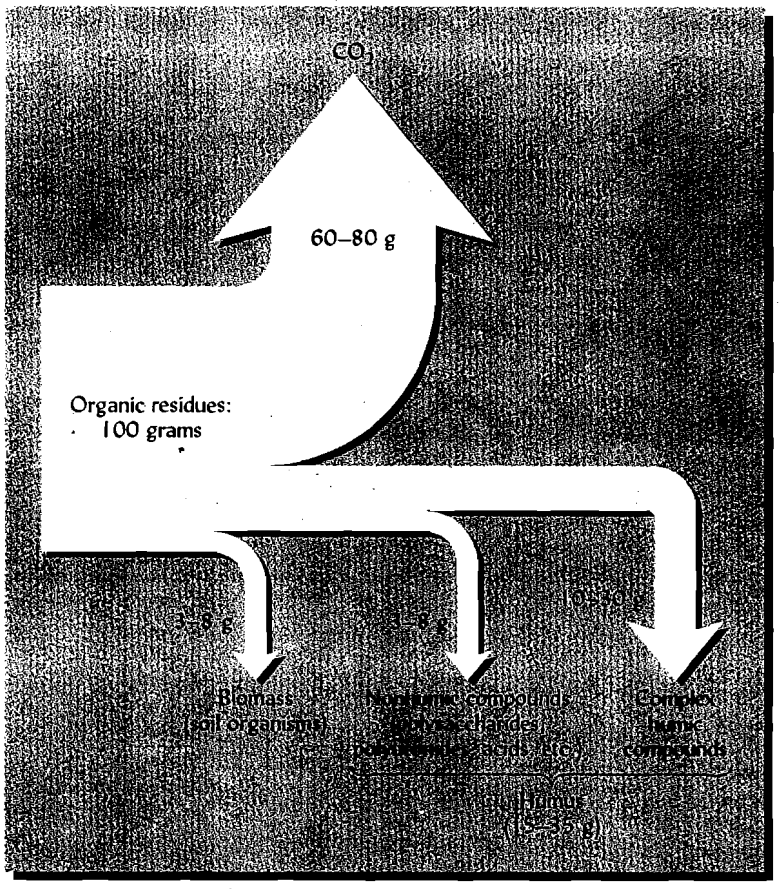


FIGURE 12.9 Classification of soil organic matter components separable by chemical and physical criteria. Although surface residues (litter) are not universally considered to be part of the soil organic matter, we include them because they are the principal component of the O horizons in soil profiles. Solubility in alkali and acid is a widely used criterion for grouping different fractions of soil humus. The classical scheme dividing soil humic substances into humin, fulvic acids, and humic acids fractions (shown in the lower part of the flowchart) is based on their insolubility in NaOH (humin) and their subsequent solubility (fulvic acids) and insolubility (humic acids) in acid solutions (pH = 1).



Fate of 100 g of organic residue

FIGURE 12.10 Disposition of 100 g of organic residues one year after they were incorporated into the soil. More than two-thirds of the carbon has been oxidized to CO_2, and less than one-third remains in the soil—some in the cells of soil organisms, but a larger component as soil humus. The amount converted to CO_2 is generally greater for aboveground residues than for belowground (root) residues. (Estimates from many sources)

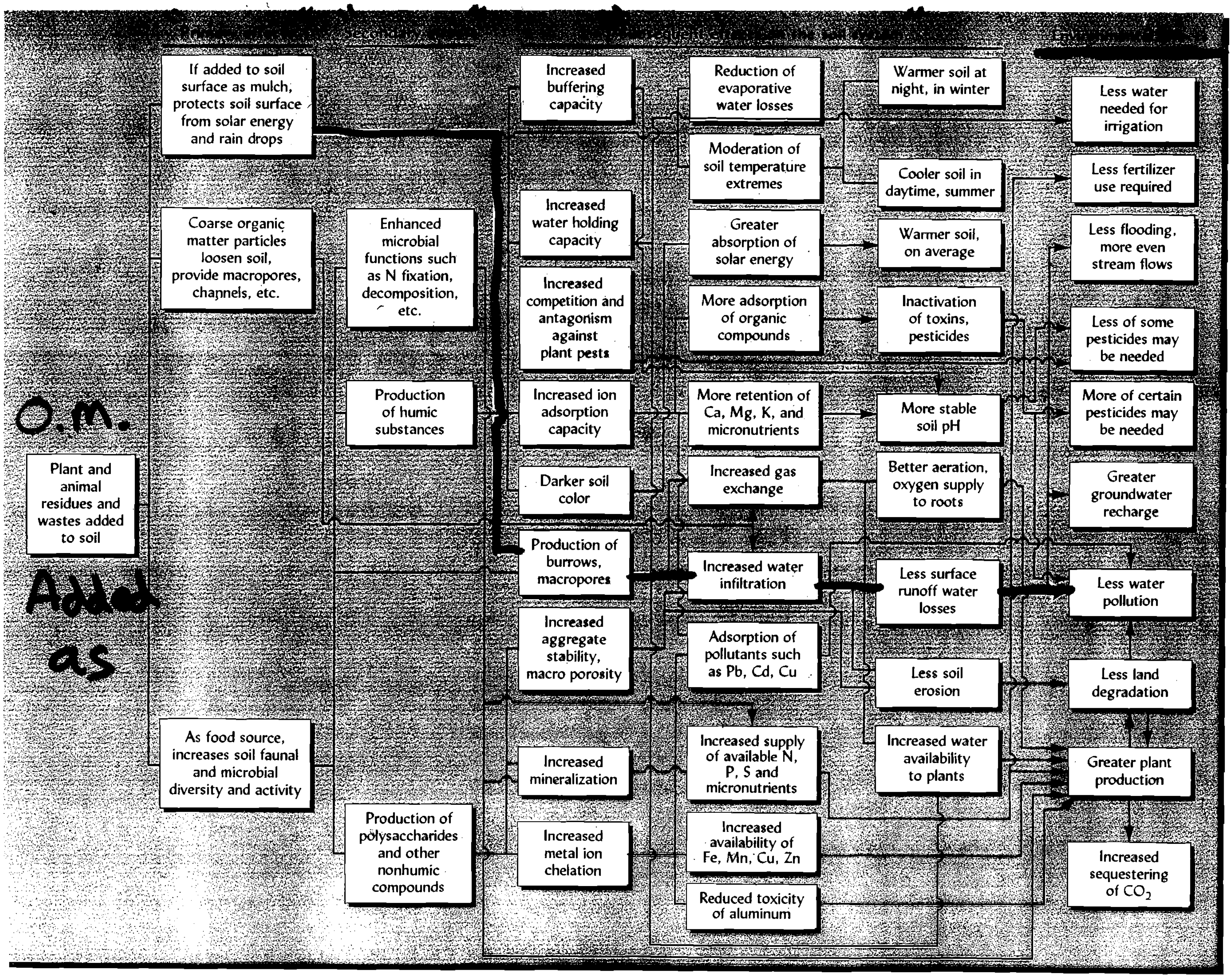


FIGURE 12.14 Some of the ways in which soil organic matter influences soil properties, plant productivity, and environmental quality. Many of the effects are indirect, the arrows indicating the cause-and-effect relationships. It can readily be seen that the influences of soil organic matter are far out of proportion to the relatively small amounts present in most soils. Many of these influences are discussed in this and other chapters in this book. The thicker line shows the sequence of effects referred to in the text in Section 12.7.

Conceptual Model

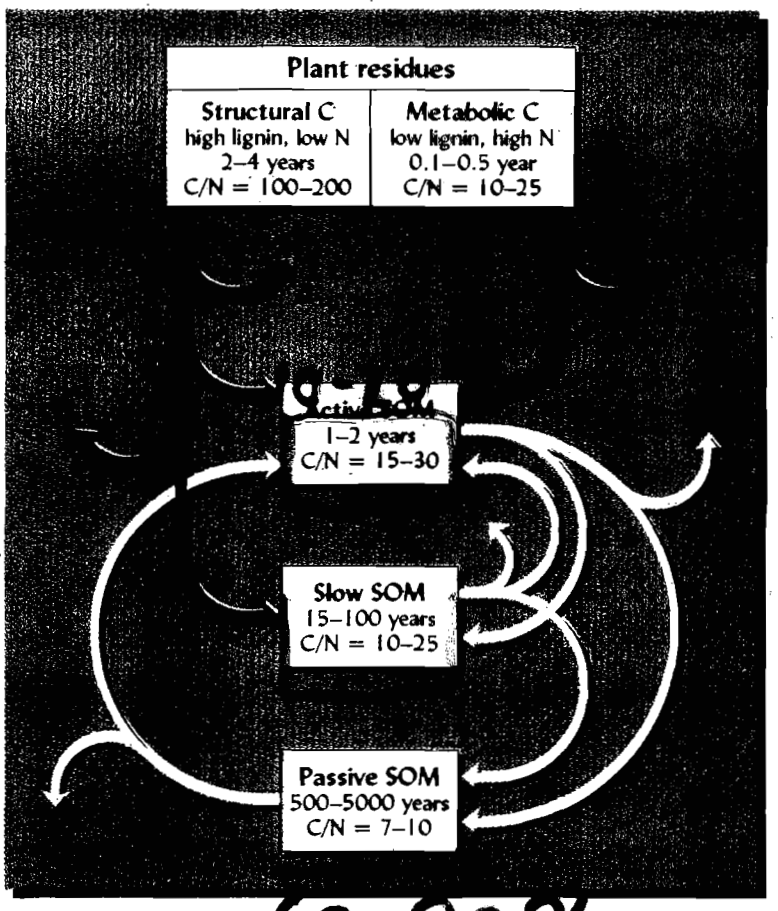


FIGURE 12.15 A conceptual model that recognizes various pools of soil organic matter (SOM) differing by their susceptibility to microbial metabolism. Models that incorporate *active, slow,* and *passive* fractions of soil organic matter have proven very useful in explaining and predicting real changes in soil organic matter levels and in attendant soil properties. Note that microbial action can transfer organic carbon from one pool to another. For example, when the nonhumic substances and other components of the active fraction are rapidly broken down, some resistant, complex by-products may be formed, adding to the slow and passive fractions. Note that all these metabolic changes result in some loss of carbon from the soil as CO_2. [Adapted from Paustian, et al. (1992)]

60-90%

i.e. - not all O.M. is equal

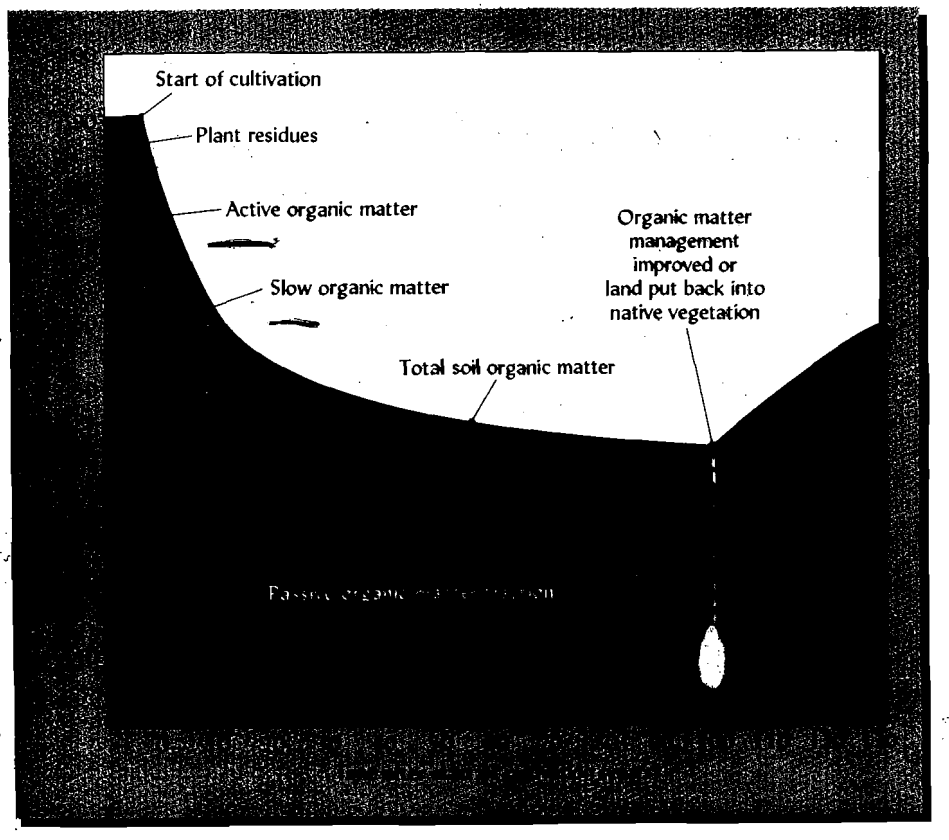
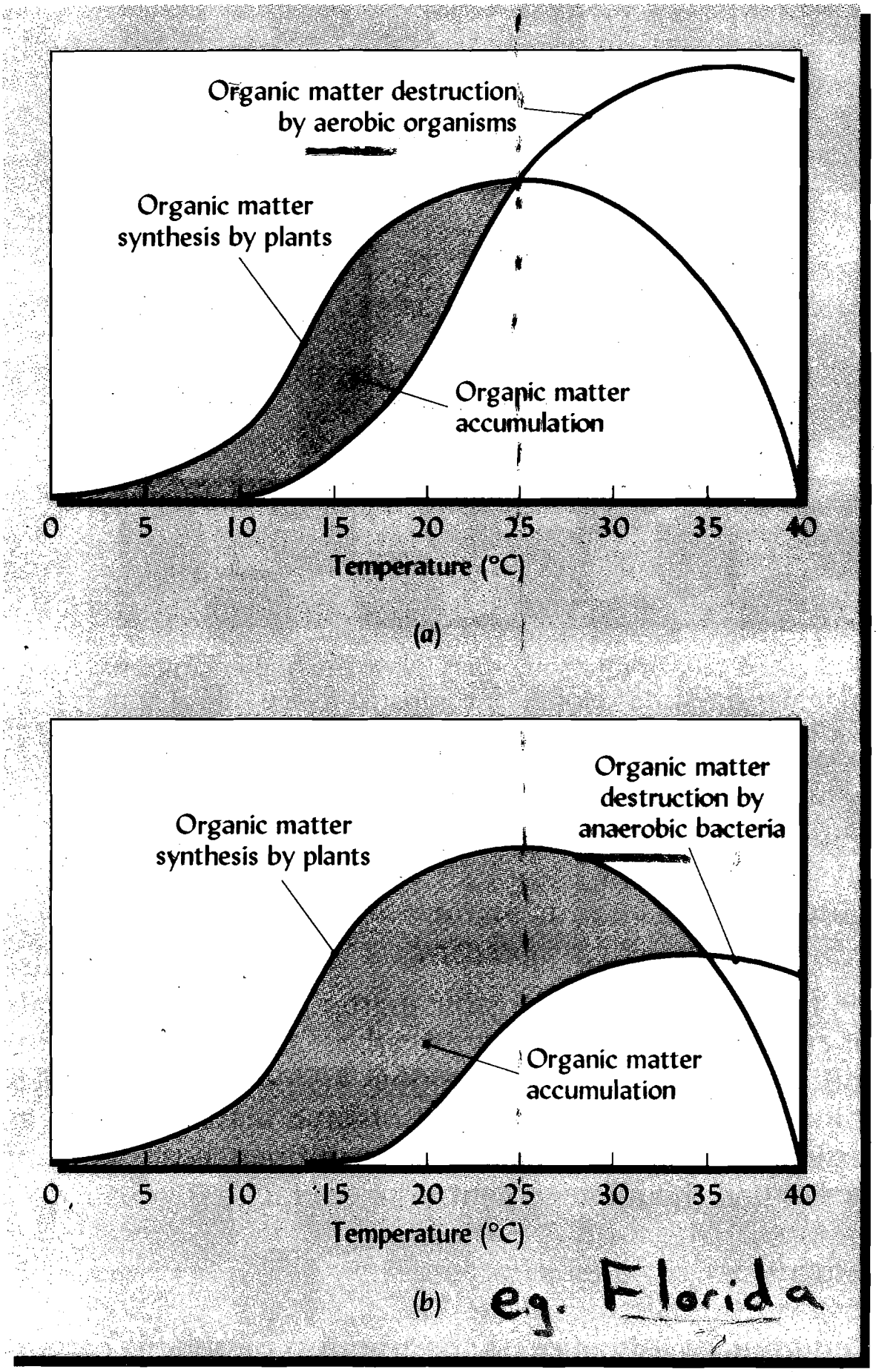


FIGURE 12.16 Changes in various fractions of organic matter in the upper 25 cm of a representative soil after bringing virgin land under cultivation. Initially, under natural vegetation, this soil contained about 91 Mg/ha of total organic matter. The resistant *passive fraction* accounted for about 44 Mg/ha, or about half of the total soil organic matter. The rapidly decomposing *active fraction* accounted for about 14 Mg, or about 16% of the total soil organic matter. After about 40 years of cultivation, the passive fraction had declined by about 11% to about 39 Mg/ha, while the active fraction had lost 90% of its mass, declining to only 1.4 Mg/ha. Note that much of the organic loss due to the change in land management came at the expense of the active fraction. This was also the fraction that most quickly increased when improved organic matter management was adopted after the 100th year. The susceptibility of the active fraction to rapid change explains why even relatively small changes in total soil organic matter can produce dramatic changes in important soil properties such as aggregate stability and nitrogen mineralization, associated with this soil organic matter fraction.

Small changes can have dramatic effects in relatively short-time



O_2

lack of C_2

eg. Florida

Frequency of Lightning

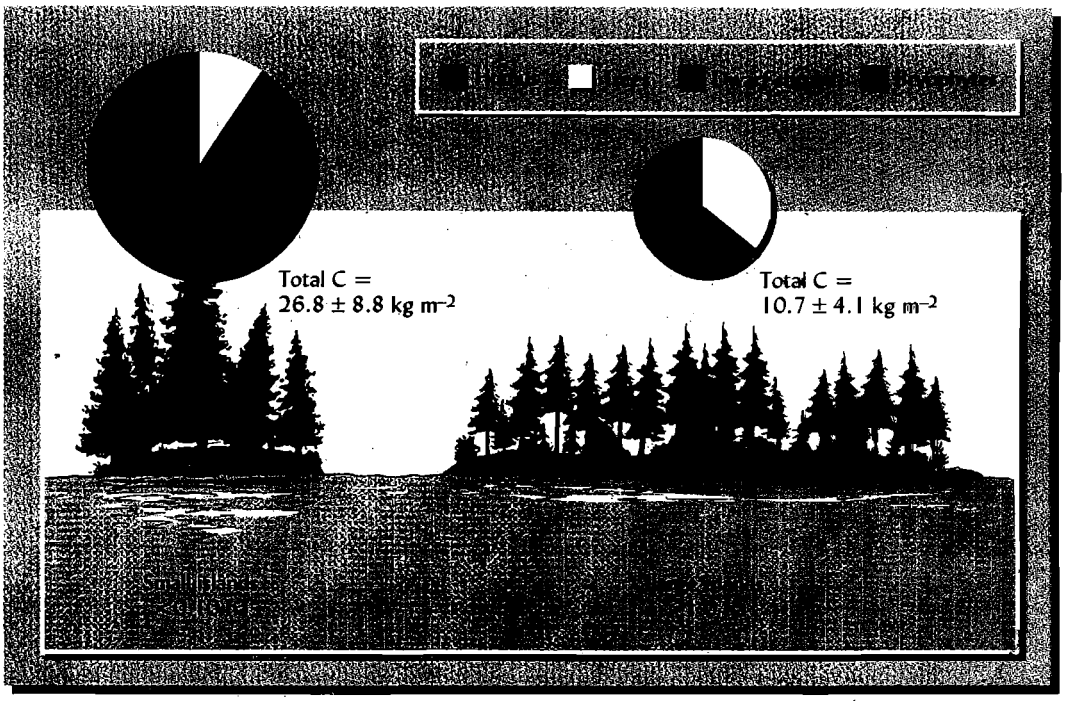


FIGURE 12.7 Effect of plant litter quality on humus accumulation in soil. In a study of some 50

- Over mature trees
- more C