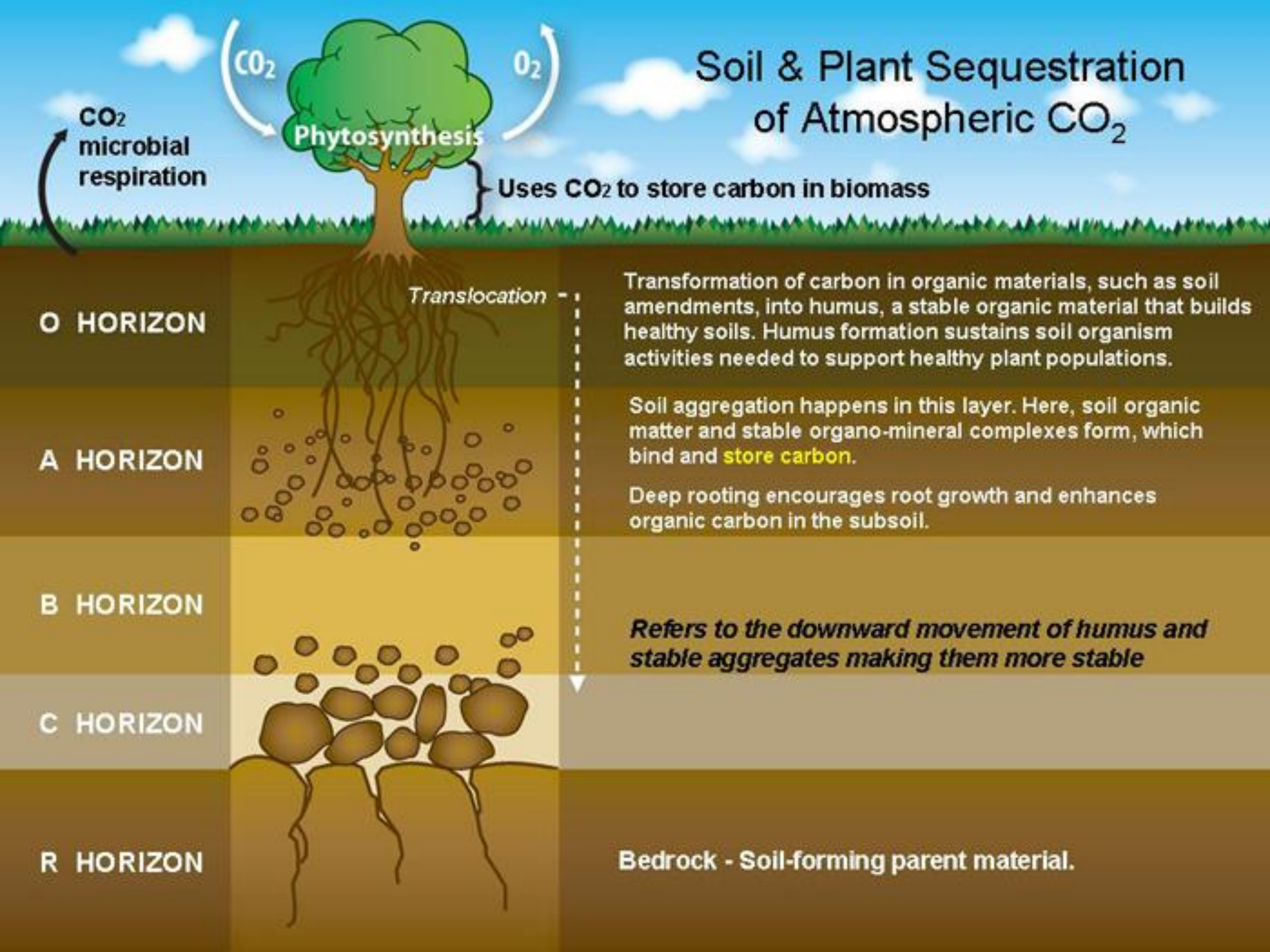
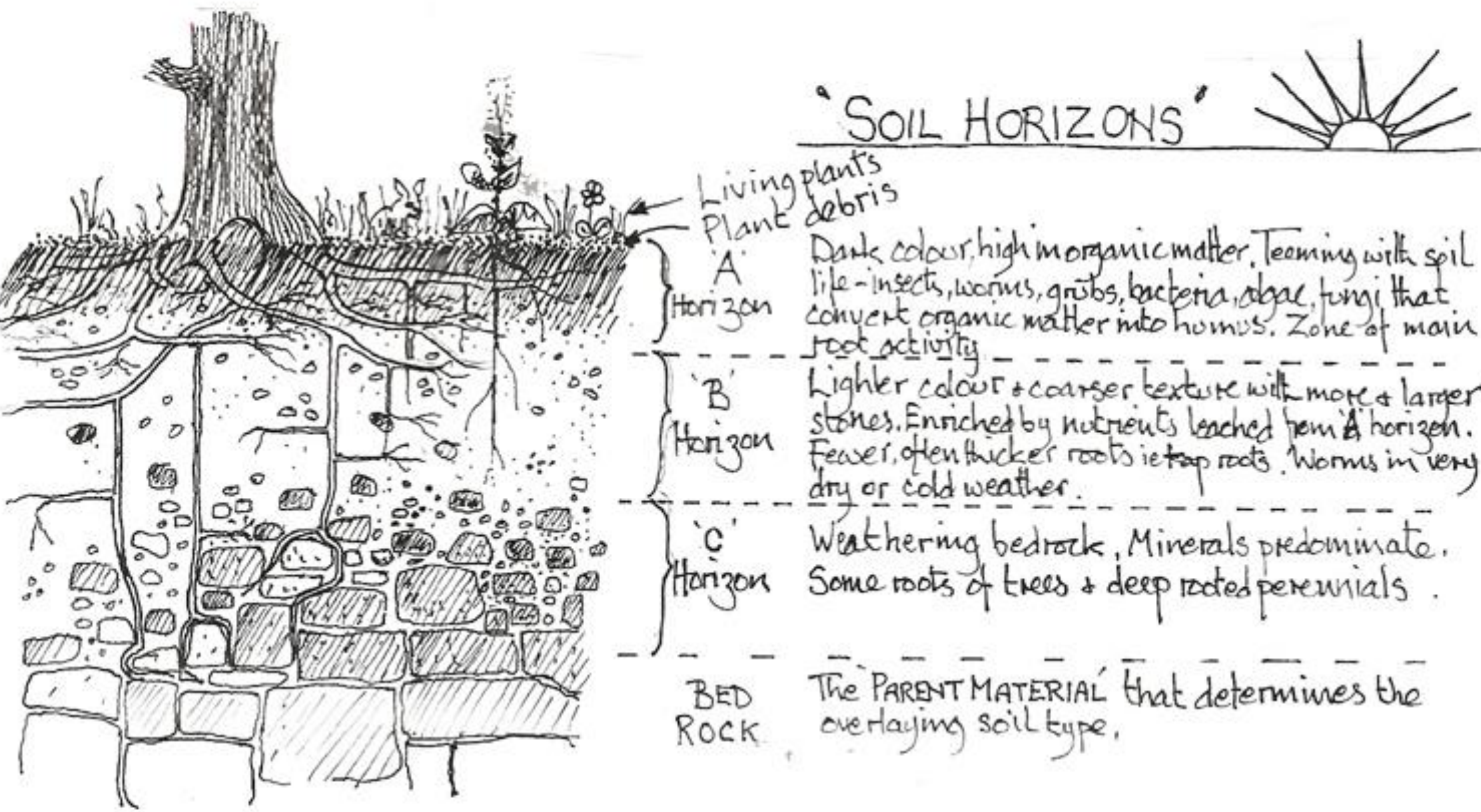
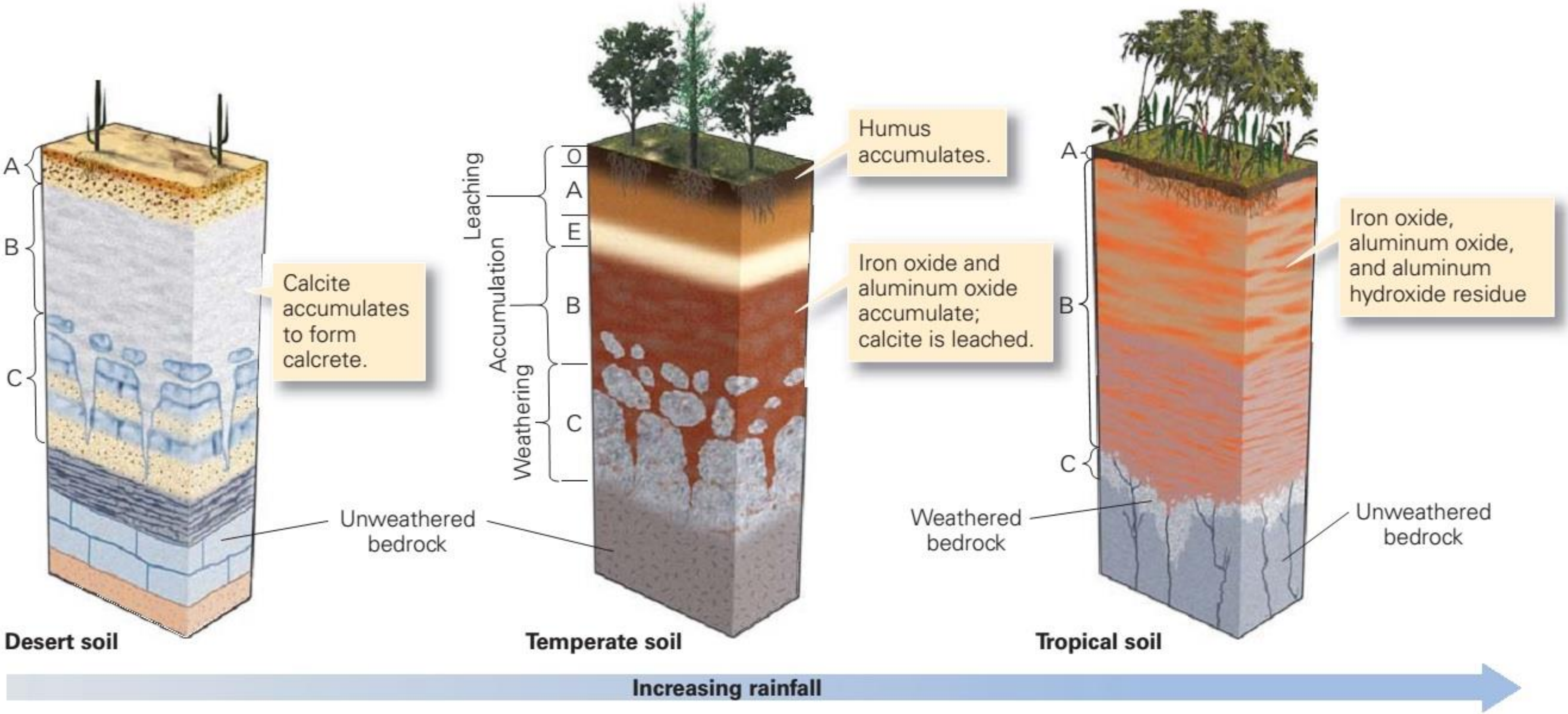
Soil, Water & Landscape

Catch and store energy


Soil & Plant Sequestration of Atmospheric CO_2
CO_2
O_2
Phytosynthesis
CO_2 microbial respiration
Uses CO_2 to store carbon in biomass
Translocation
O HORIZON
Transformation of carbon in organic materials, such as soil amendments, into humus, a stable organic material that builds healthy soils. Humus formation sustains soil organism activities needed to support healthy plant populations.
A HORIZON
Soil aggregation happens in this layer. Here, soil organic matter and stable organo-mineral complexes form, which bind and store carbon.
Deep rooting encourages root growth and enhances organic carbon in the subsoil.
B HORIZON
Refers to the downward movement of humus and stable aggregates making them more stable
C HORIZON
R HORIZON
Bedrock - Soil-forming parent material.


'SOIL HORIZONS'
Living plants
Plant debris
'A' Horizon
Dark colour, high in organic matter. Teeming with soil life - insects, worms, grubs, bacteria, algae, fungi that convert organic matter into humus. Zone of main root activity
'B' Horizon
Lighter colour & coarser texture with more & larger stones. Enriched by nutrients leached from 'A' horizon. Fewer, often thicker roots ie tap roots. Worms in very dry or cold weather.
'C' Horizon
Weathering bedrock. Minerals predominate. Some roots of trees & deep rooted perennials.
BED ROCK
The PARENT MATERIAL that determines the overlaying soil type.



(a) Aridisol forms in deserts. Rainfall is so low that no O-horizon forms, and soluble minerals accumulate in the B-horizon.

(b) Alfisol forms in temperate climates. An O-horizon forms, and less-soluble materials accumulate in the B-horizon.

(c) Oxisol forms in tropical climates where percolating rainwater leaches all soluble minerals, leaving only iron- and aluminum-rich residues.

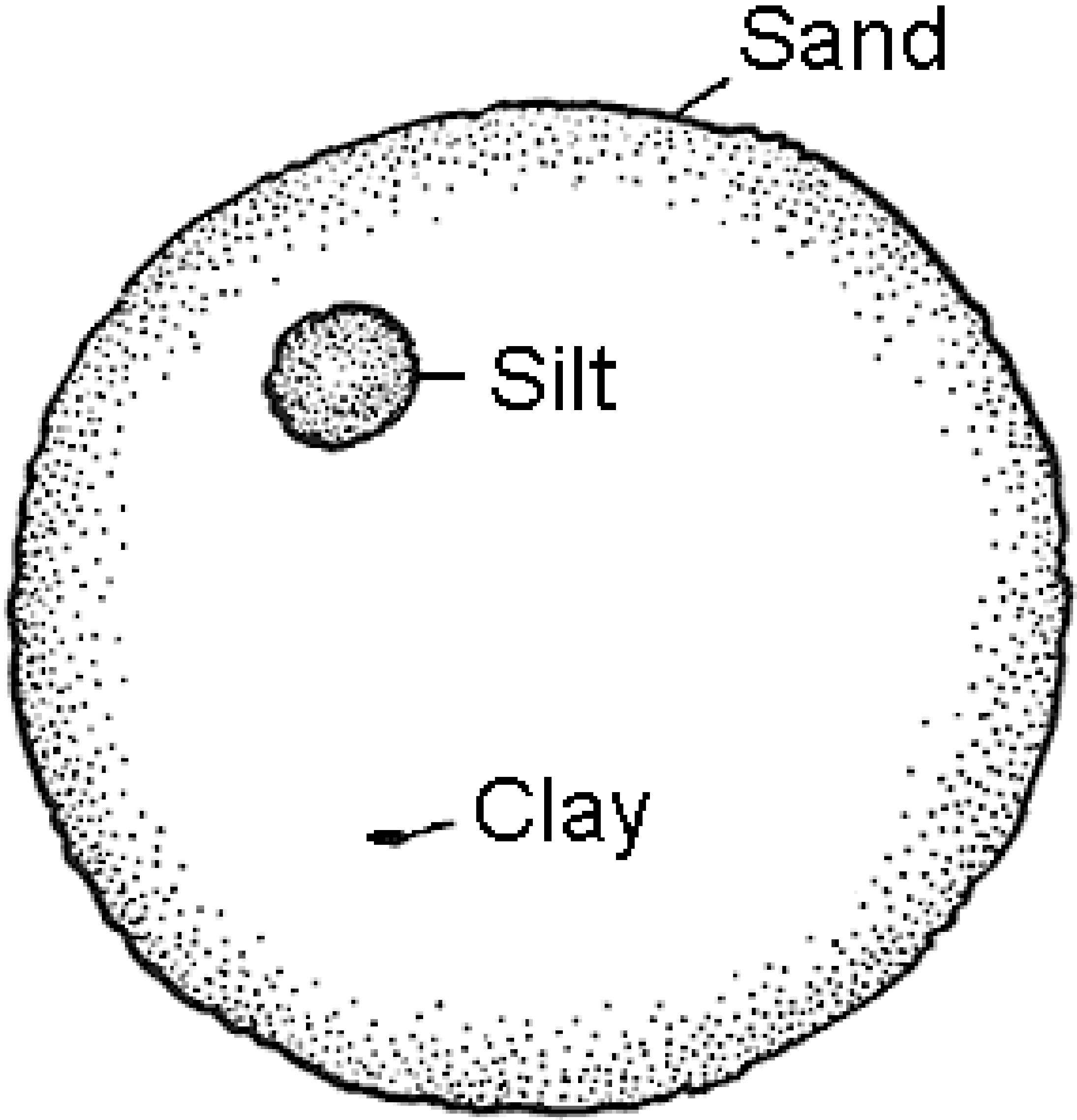
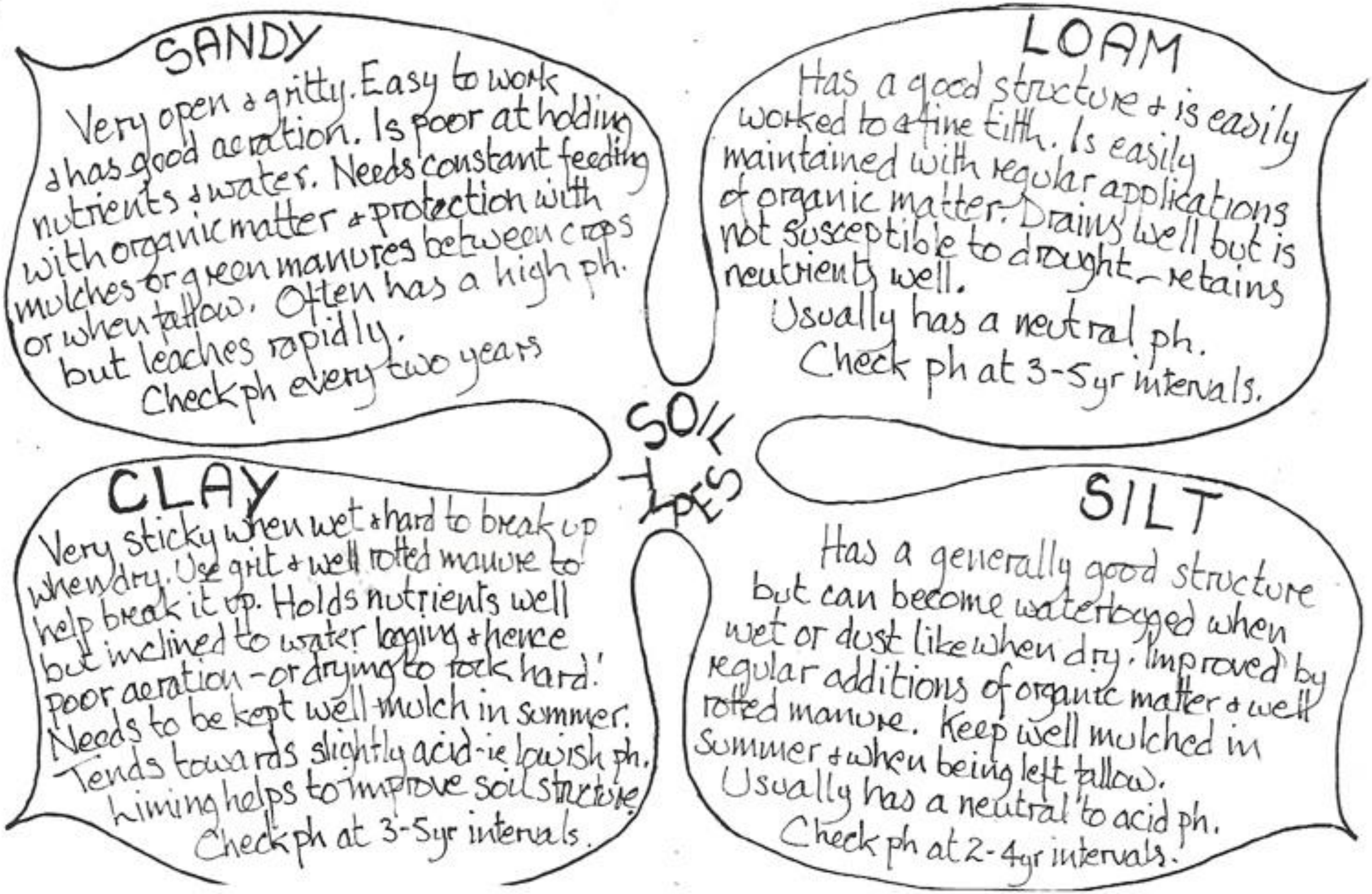

Sand
Silt
Clay

TABLE 8.6
RECOMMENDED SCALE OF SOIL PARTICLE SIZES (mm).
[After McDonald *et al*]

	Fine clay	< 0.002
	Clay particles	0.002
	Silt	0.002 - 0.02
SAND		**0.02 - 2.0**
	fine	0.02 - 0.2
	coarse	0.2 - 2
GRAVEL		**2 - 60**
	Fine	2 - 6
	Medium	6 - 20
	Coarse	20 - 60
COBBLES		60 - 200
STONES		200 - 600
BOULDERS		>600


SOIL TYPES
SANDY
Very open & gritty. Easy to work & has good aeration. Is poor at holding nutrients & water. Needs constant feeding with organic matter & protection with mulches or green manures between crops or when fallow. Often has a high ph. but leaches rapidly.
Check ph every two years
LOAM
Has a good structure & is easily worked to a fine tilth. Is easily maintained with regular applications of organic matter. Drains well but is not susceptible to drought – retains neutrients well.
Usually has a neutral ph.
Check ph at 3-5yr intervals.
CLAY
Very sticky when wet & hard to break up when dry. Use grit & well rotted manure to help break it up. Holds nutrients well but inclined to water logging & hence poor aeration – or drying to rock hard! Needs to be kept well mulch in summer.
Tends towards slightly acid – ie lowish ph.
Liming helps to improve soil structure.
Check ph at 3-5yr intervals.
SILT
Has a generally good structure but can become waterlogged when wet or dust like when dry. Improved by regular additions of organic matter & well rotted manure. Keep well mulched in summer & when being left fallow.
Usually has a neutral to acid ph.
Check ph at 2-4yr intervals.

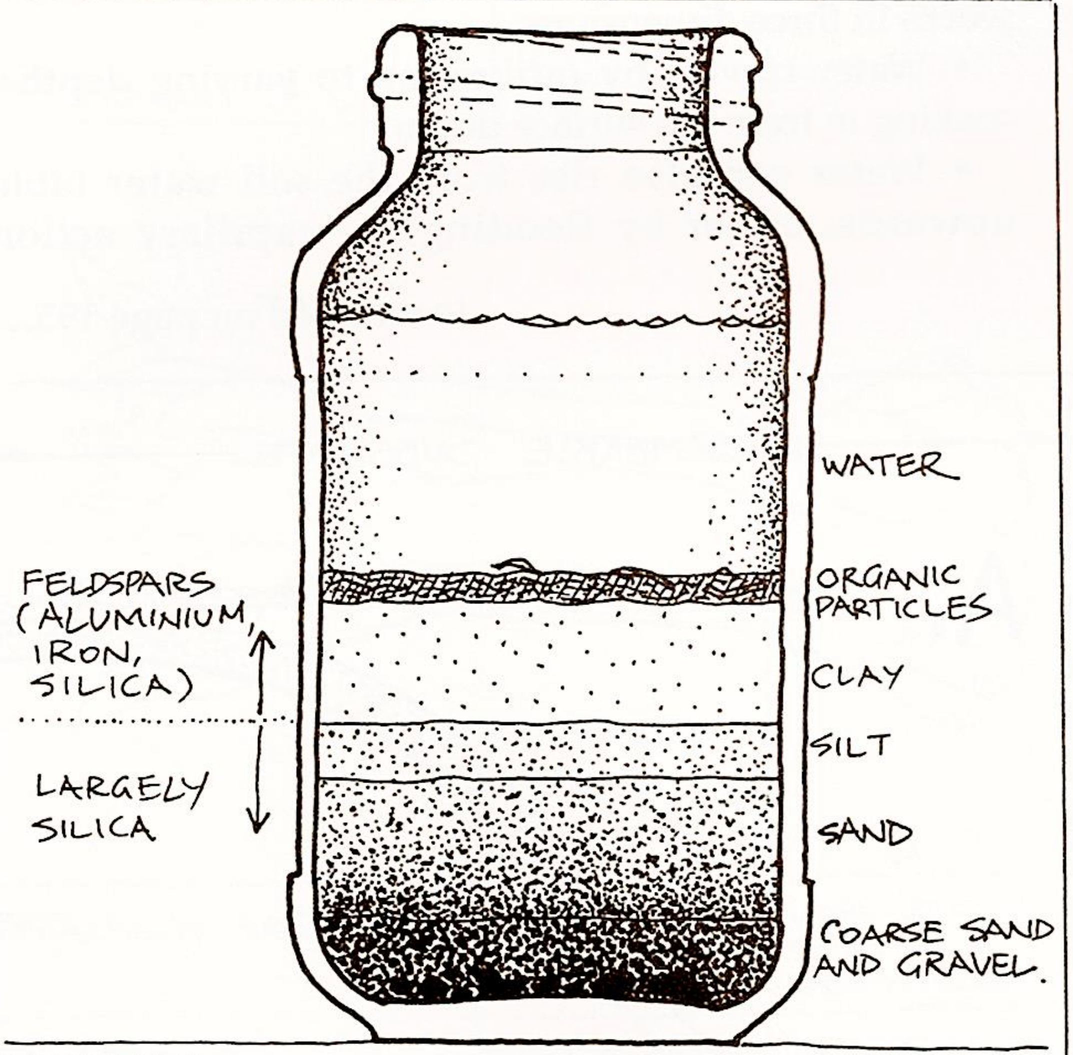


FIGURE 8.2

JAR METHOD

of assessing crude soil composition; useful for classification, uses for mud brick or pisé work. Soil sample is shaken in water and allowed to stand until layers form (1–20 days). The volume of each fraction determines uses and a texture classification (see **FIGURE 8.1**).

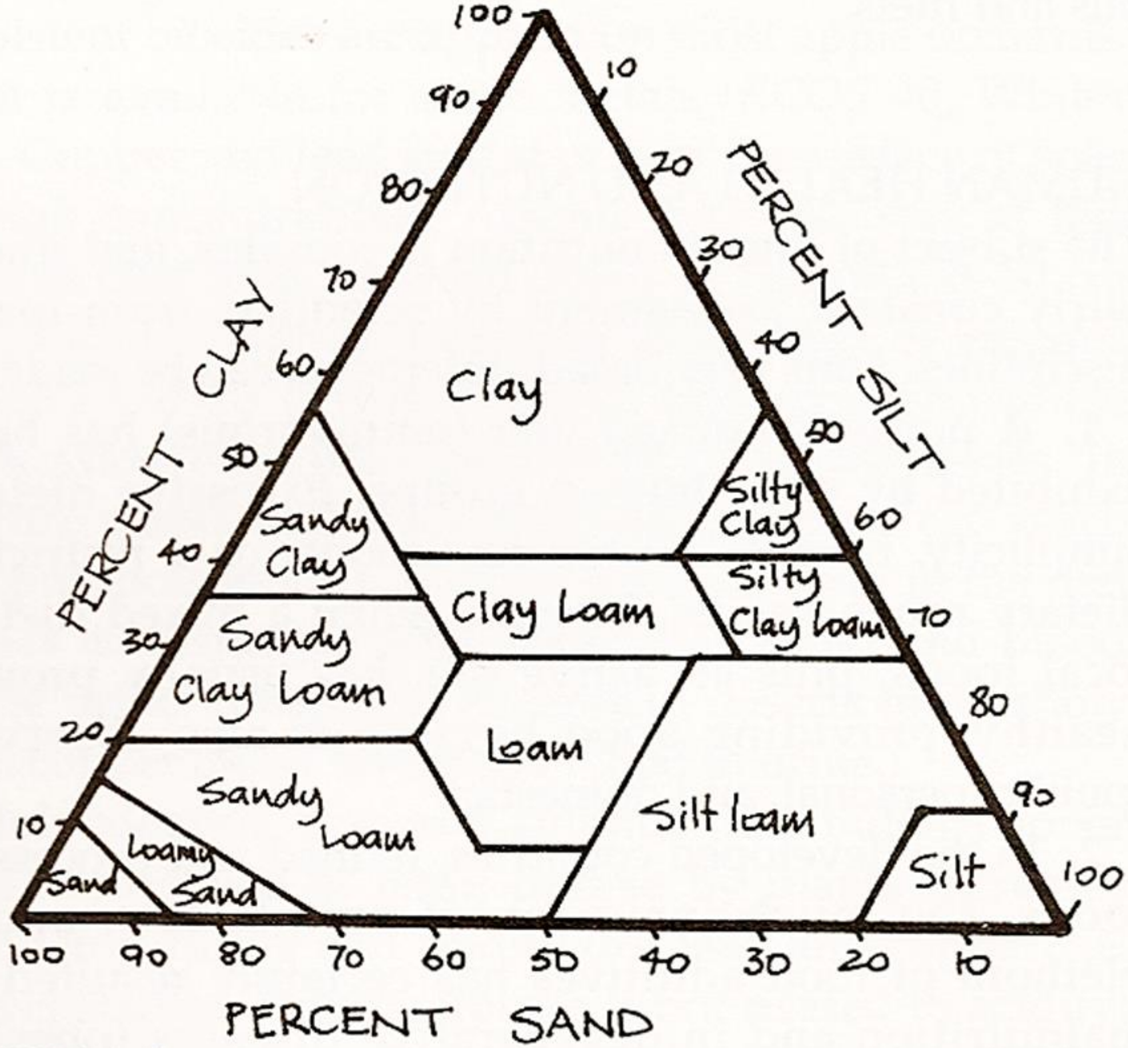
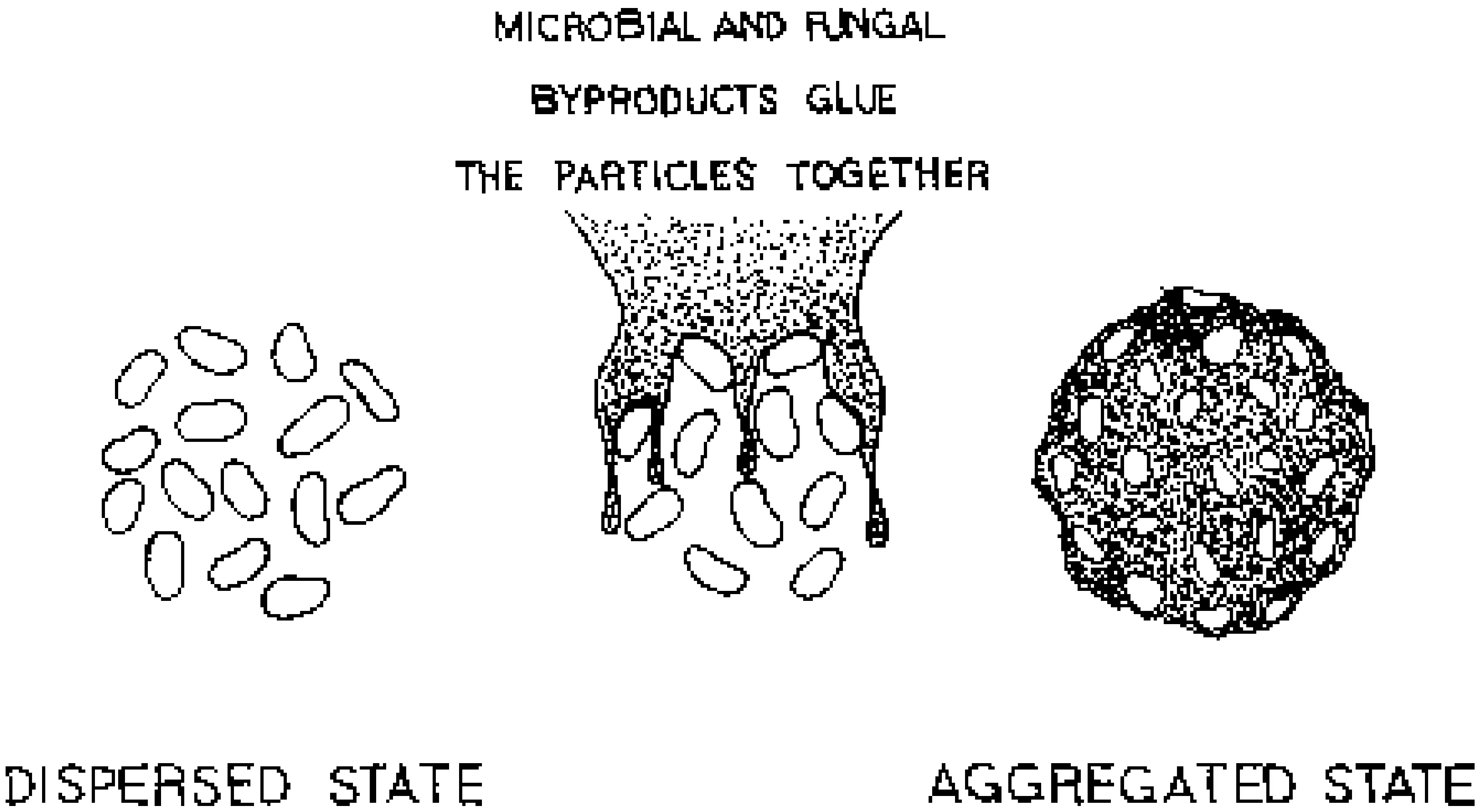
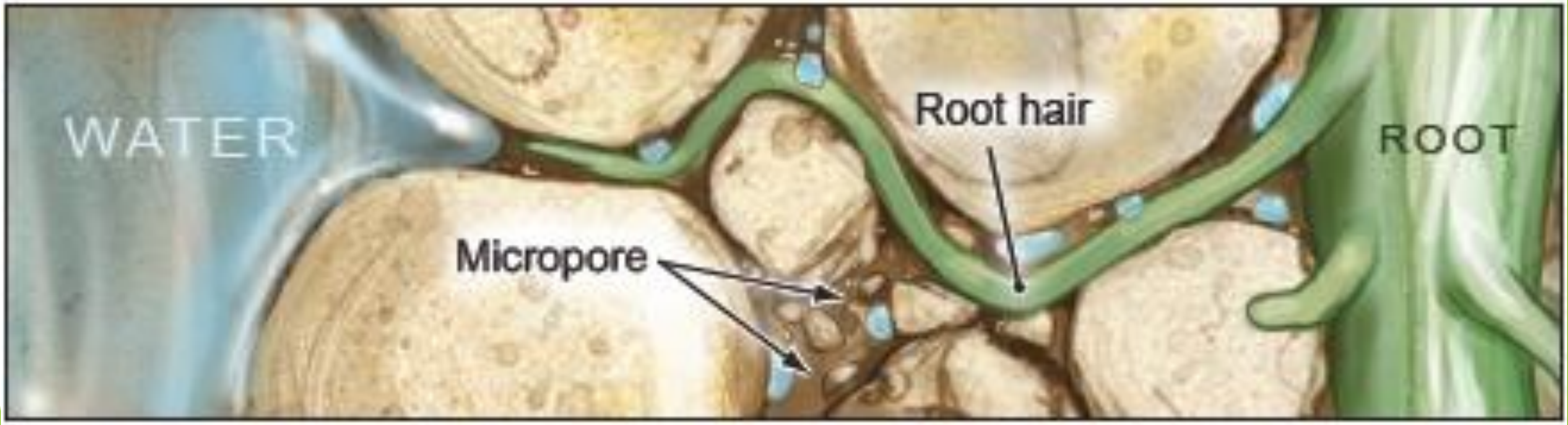


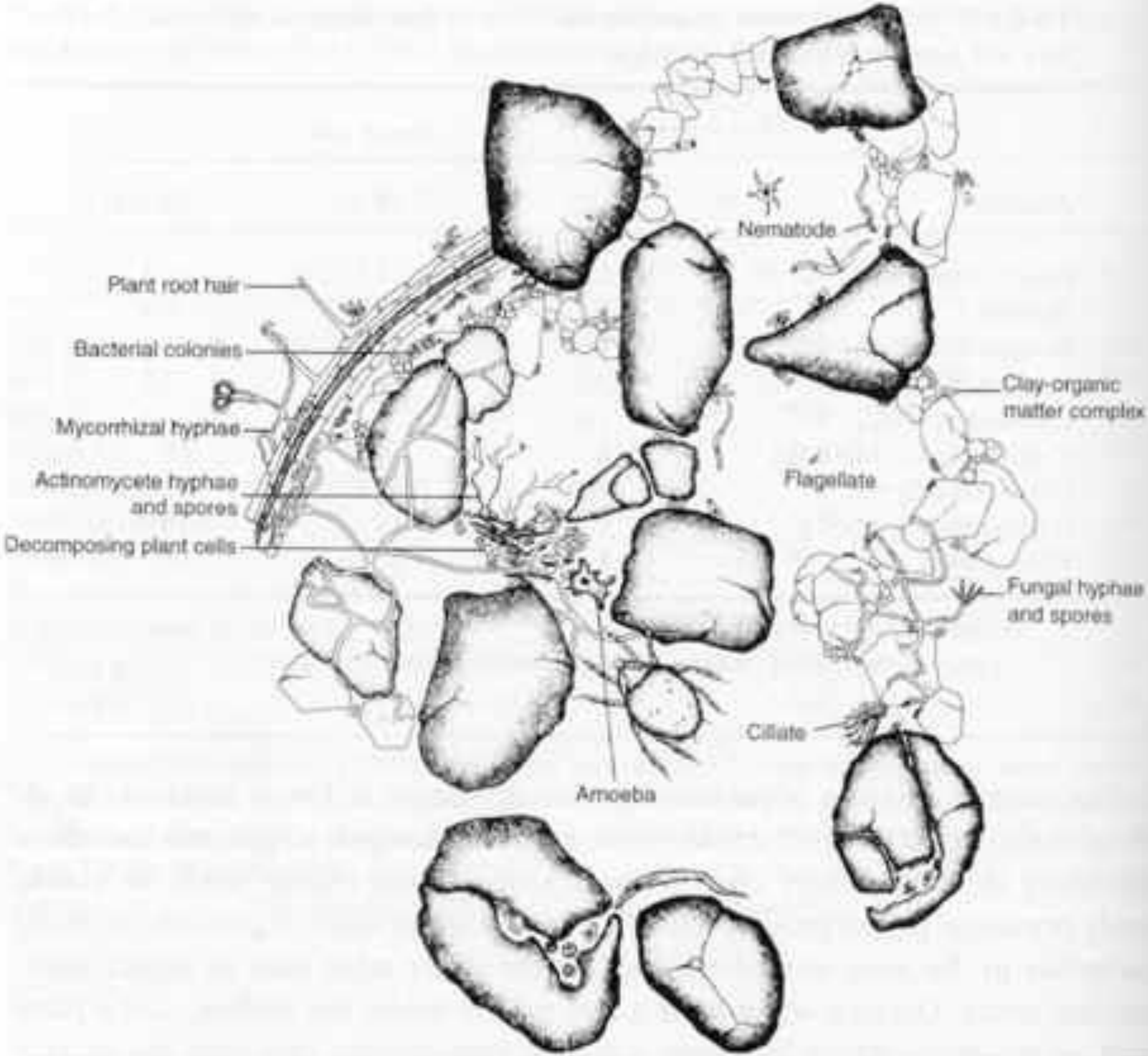
FIGURE 8.1

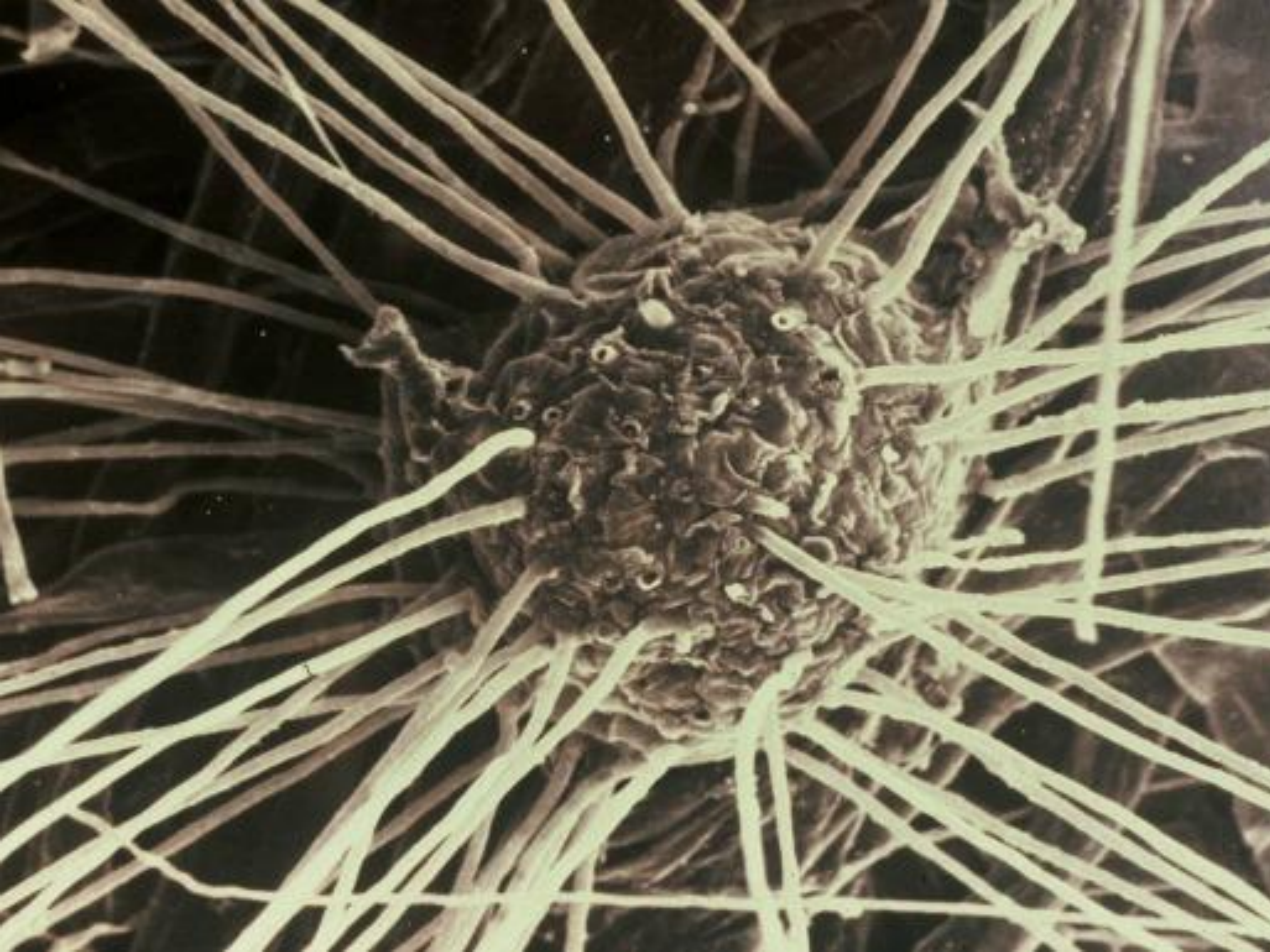
SOIL PROCESSES.

The USDA classification of soil types by particle size.


MICROBIAL AND FUNGAL
BYPRODUCTS GLUE
THE PARTICLES TOGETHER
DISPERSED STATE
AGGREGATED STATE


WATER
Root hair
ROOT
Micropore


Plant root hair
Bacterial colonies
Mycorrhizal hyphae
Actinomycete hyphae and spores
Decomposing plant cells
Nematode
Clay-organic matter complex
Flagellate
Fungal hyphae and spores
Ciliate
Amoeba



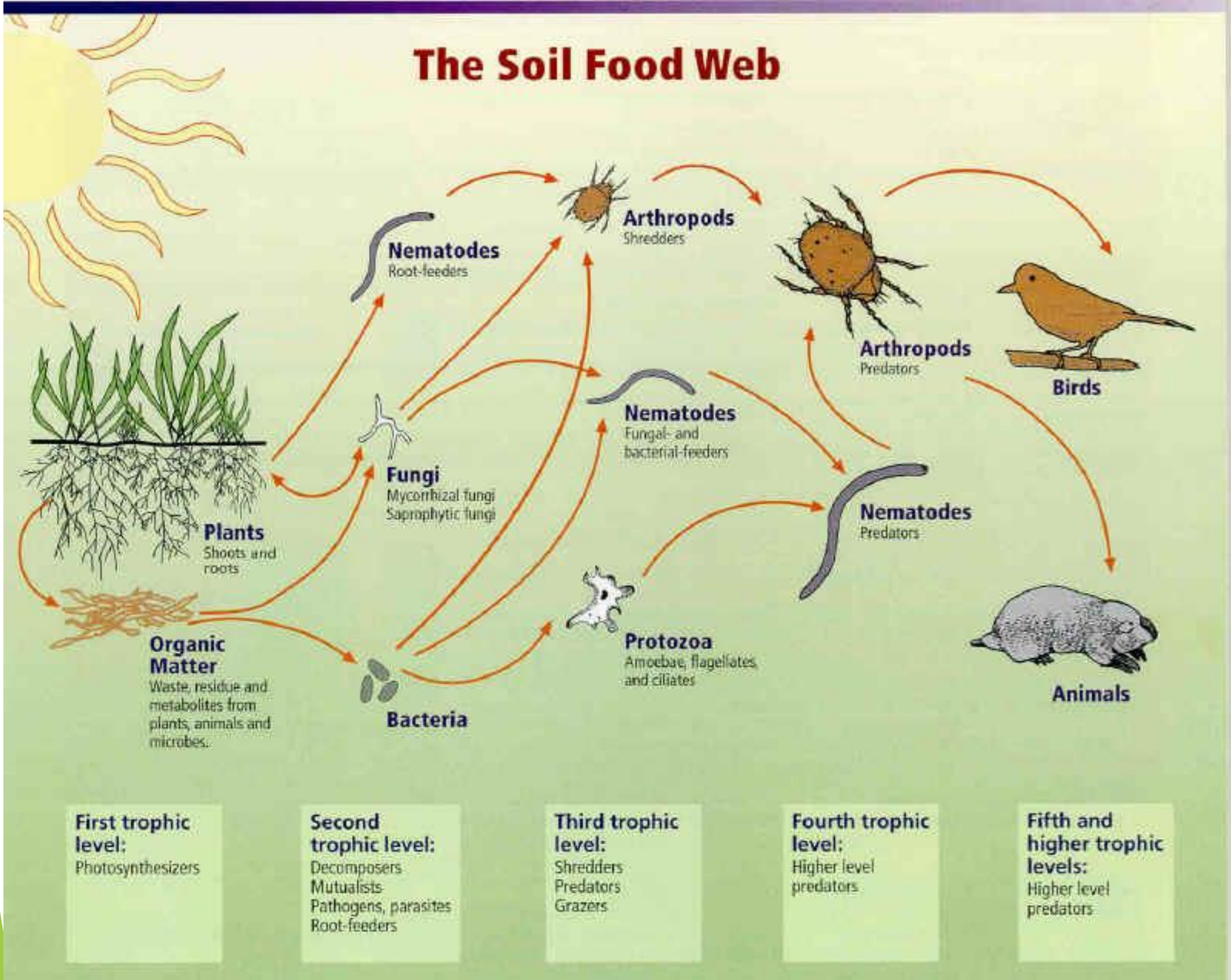
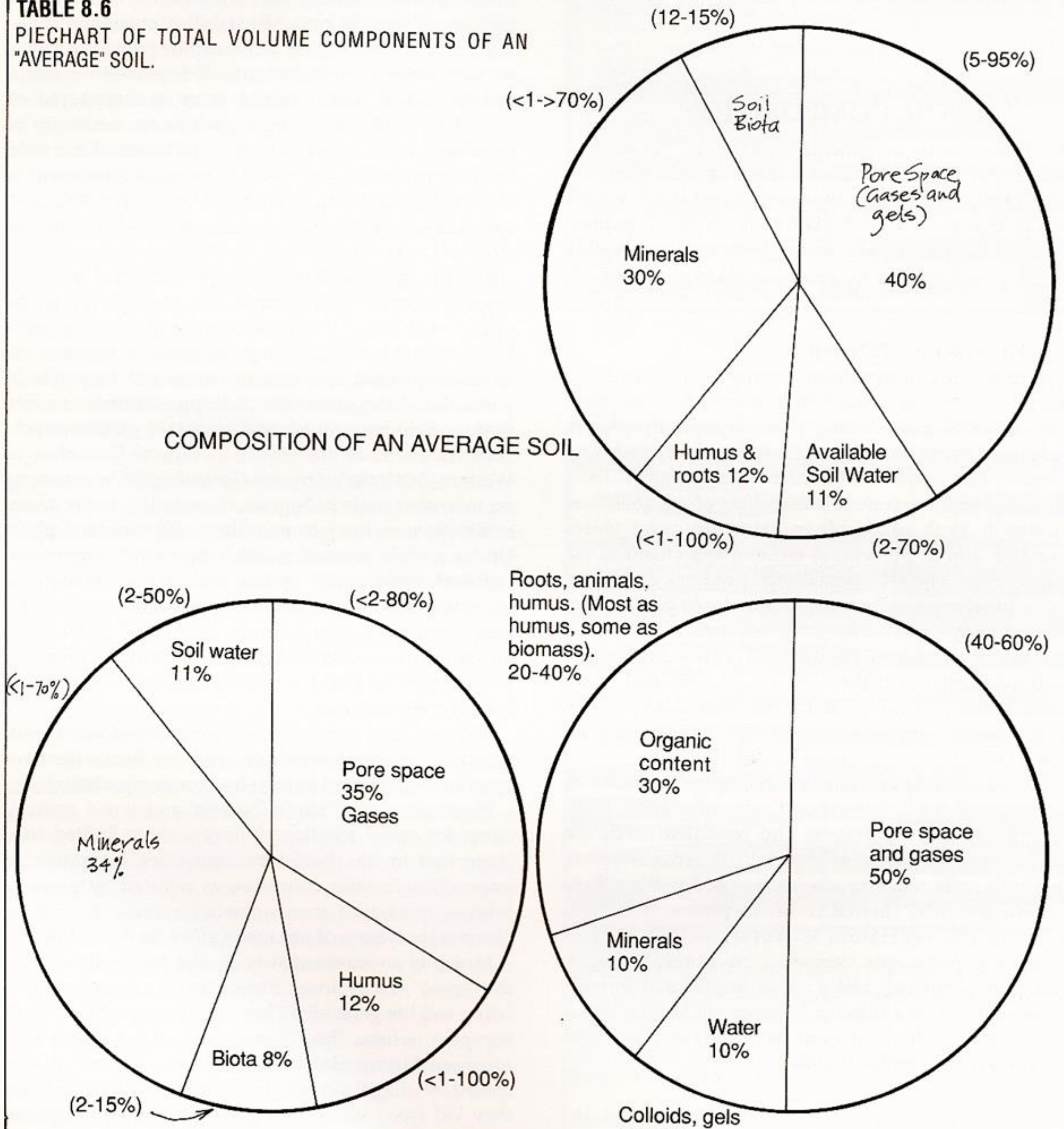

The Soil Food Web
Nematodes
Root-feeders
Arthropods
Shredders
Arthropods
Predators
Birds
Nematodes
Fungal- and bacterial-feeders
Fungi
Mycorrhizal fungi
Saprophytic fungi
Plants
Shoots and roots
Nematodes
Predators
Protozoa
Amoebae, flagellates, and ciliates
Organic Matter
Waste, residue and metabolites from plants, animals and microbes.
Bacteria
Animals
First trophic level:
Photosynthesizers
Second trophic level:
Decomposers
Mutualists
Pathogens, parasites
Root-feeders
Third trophic level:
Shredders
Predators
Grazers
Fourth trophic level:
Higher level predators
Fifth and higher trophic levels:
Higher level predators

TABLE 8.6

PIECHART OF TOTAL VOLUME COMPONENTS OF AN "AVERAGE" SOIL.



THE COMPOSITION OF A GARDEN LOAM WITH MULCH AND A RICH SOIL BIOTA. (A range of proportions from wet peats to compact mineral soils is given in brackets).


LOW
MEDIUM
HIGH

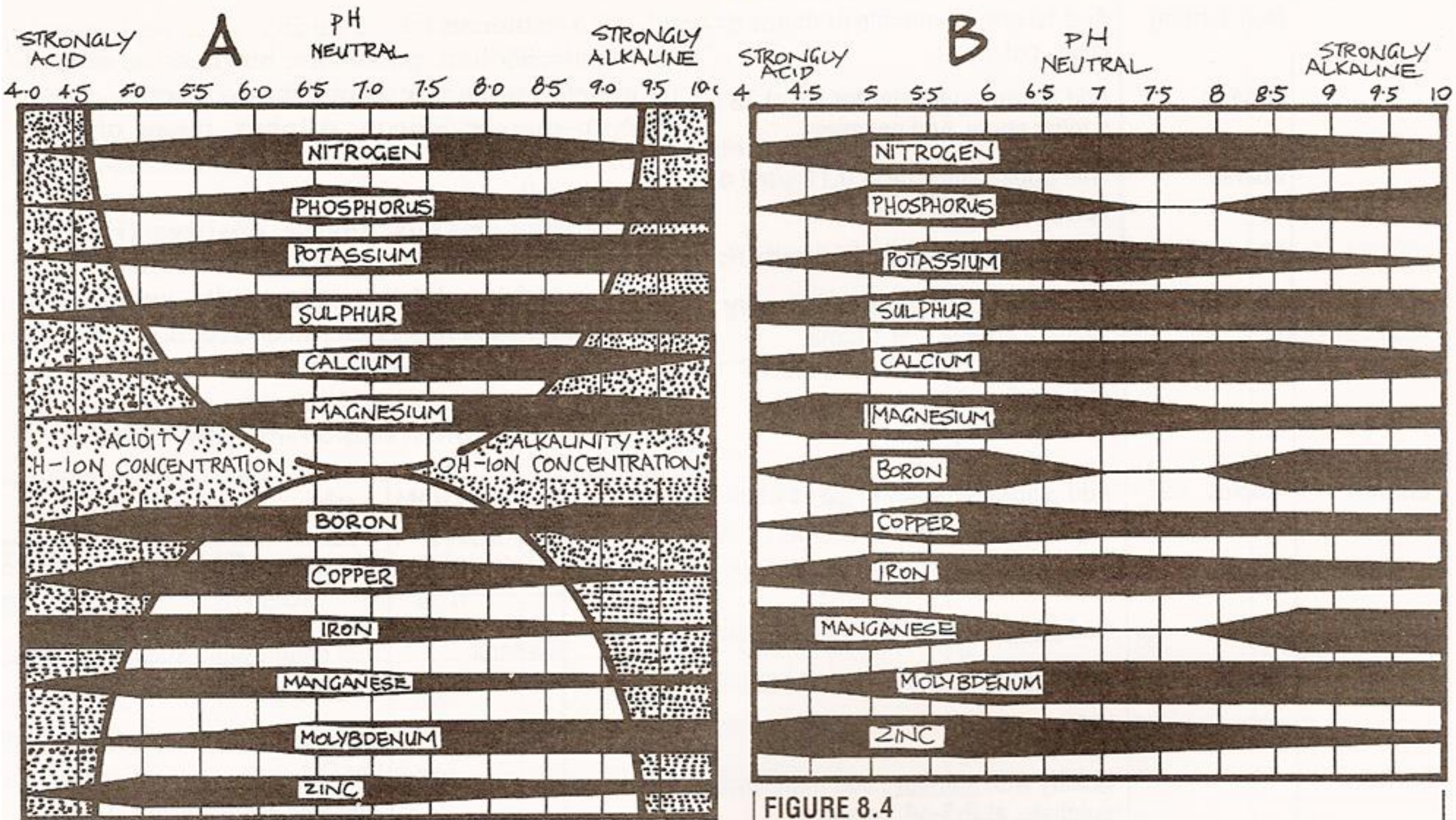
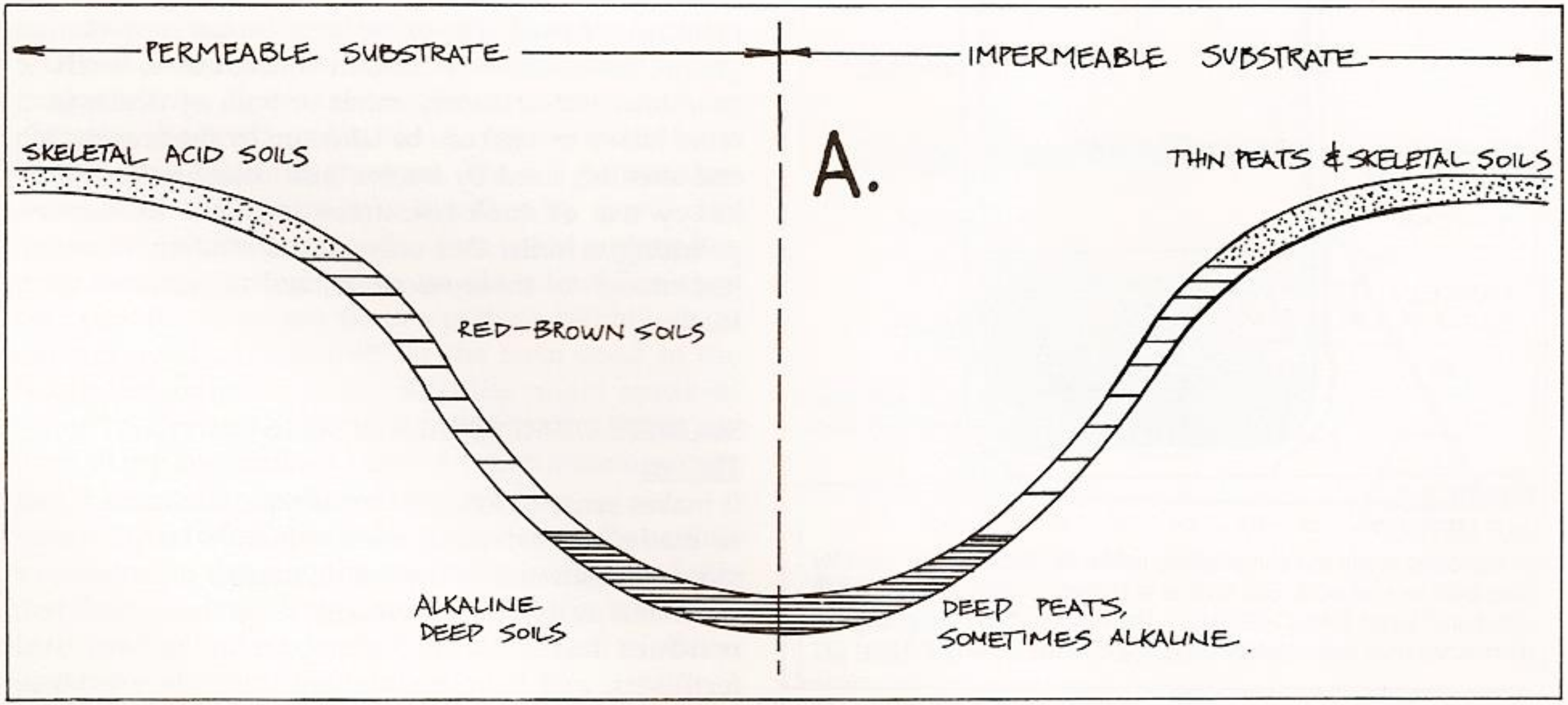


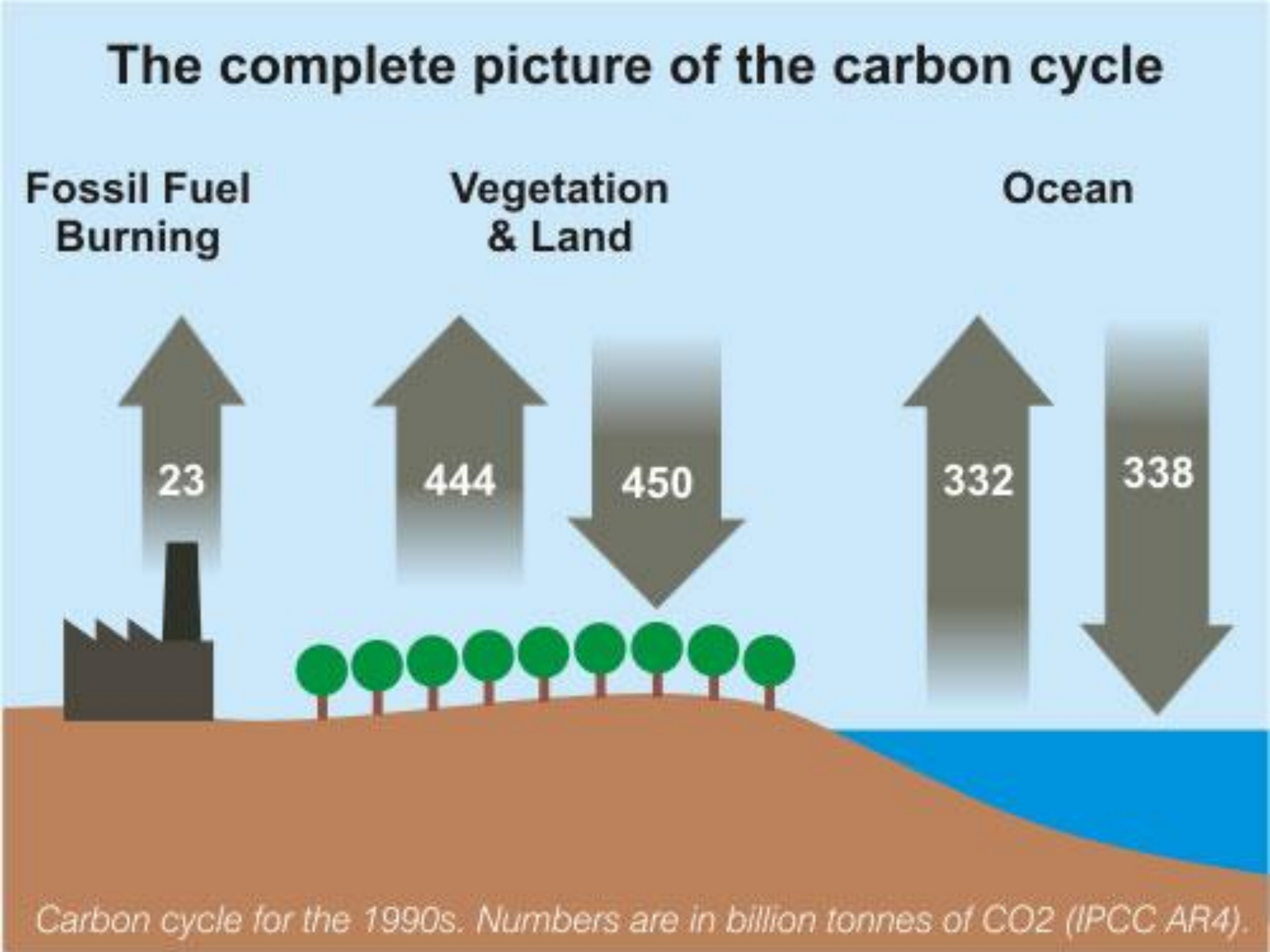
FIGURE 8.4

INFLUENCE OF pH ON AVAILABILITY OF PLANT NUTRIENTS

A In inorganic (mineral) soils. The widest parts of the black areas indicate maximum availability of each element. The curves represent pH values.
[After Nelson, L. B., (Ed.), *Changing patterns of fertiliser use,* Soil Science America, Madison, WI (1968)].

B In organic soils. The widest parts of the black areas indicate maximum availability of each element.
[After Lucas, R. E., amd J. F. Davis, "Relationships between pH values of organic sols and availability of 12 plant nutrients", *Soil Science*, 92:17-182 (1961)]


PERMEABLE SUBSTRATE
IMPERMEABLE SUBSTRATE
A.
SKELETAL ACID SOILS
THIN PEATS & SKELETAL SOILS
RED-BROWN SOILS
ALKALINE DEEP SOILS
DEEP PEATS, SOMETIMES ALKALINE.



Carbon cycle for the 1990s. Numbers are in billion tonnes of CO2 (IPCC AR4).

Water

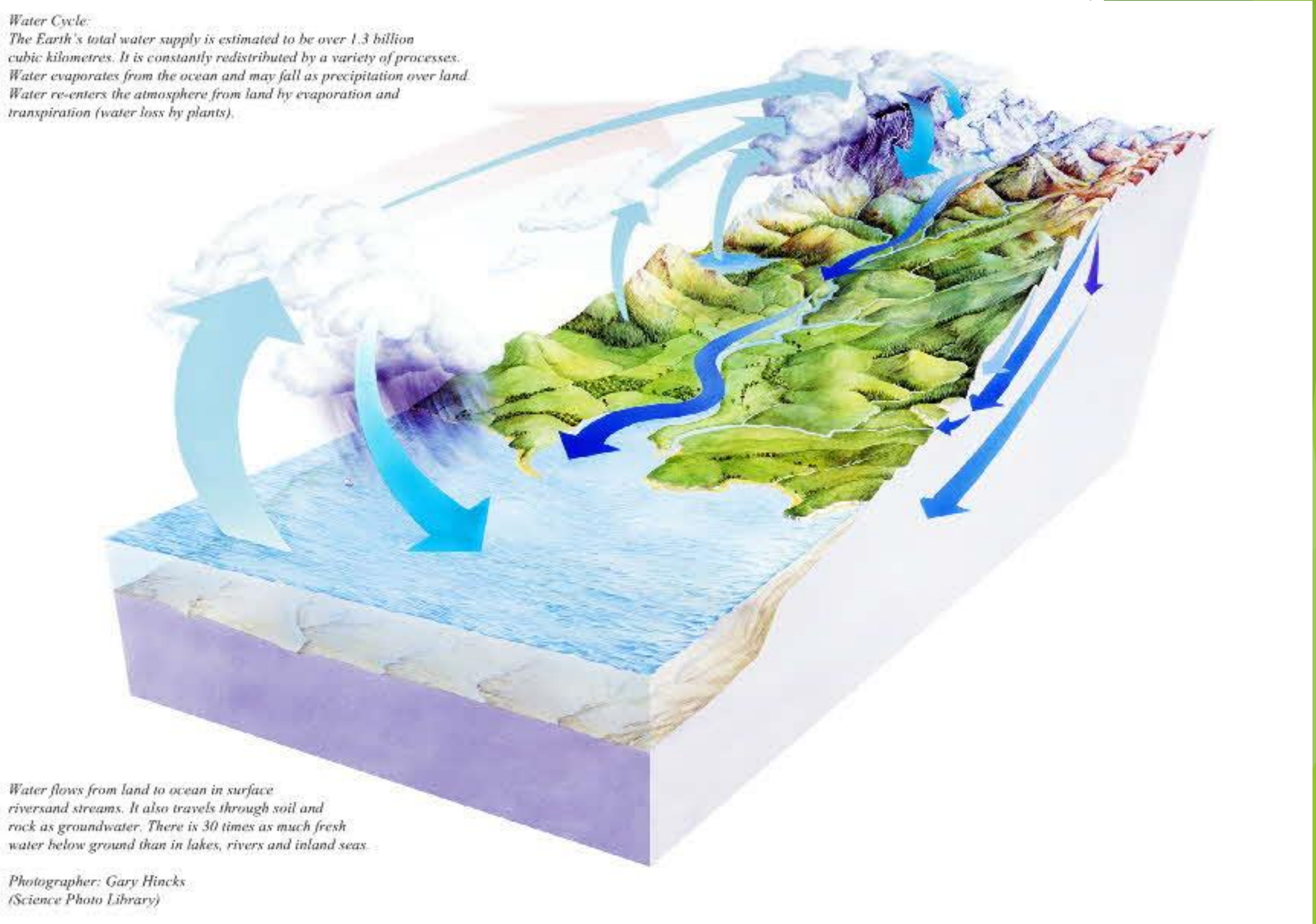

Water Cycle:
The Earth's total water supply is estimated to be over 1.3 billion cubic kilometres. It is constantly redistributed by a variety of processes. Water evaporates from the ocean and may fall as precipitation over land. Water re-enters the atmosphere from land by evaporation and transpiration (water loss by plants).
Water flows from land to ocean in surface riversand streams. It also travels through soil and rock as groundwater. There is 30 times as much fresh water below ground than in lakes, rivers and inland seas.
Photographer: Gary Hincks
(Science Photo Library)

TABLE 7.1
RENEWAL TIMES OF ALL WATER IN BASIC STORAGES (seawater and freshwater) [From: Southwick, C.H., *Ecology and the Quality of our Environment*, Van Nostrand Reinhold, NY, 1976.]

LOCATION IN STORAGES	DISTRIBUTION (% of total water)	RENEWAL TIME (Turnover rates, cycles)
Ocean	93.8	37,000 years
Glaciers and permanent snow	1.986	16,000 years
Groundwater (to 5 km depth)	4.1	4,600 years
(Actively exchanged)	0.274	300 years
Lakes	0.0051	13 years
Atmosphere	0.000959	9 days
Rivers	0.00008	13 days
Biological water	0.000005	3.4 days

TABLE 7.2

FRESHWATER LOCATION.

Freshwater is only 3% of all water on earth, and very little is in circulation, most being locked up in storages.

STORAGE	% OF FRESHWATER
Ice and glaciers*	75.0
Groundwater more than 800 m deep	13.5
Groudwater less than 800 m deep	11.0
Lakes	0.3
Soils	0.06
Atmosphere (in circulation at any one time)	0.035
Rivers	0.03

*Frozen ground or permafrost is not assessed in this table. It represents a considerable storage (about 40% of the landmasses of Canada and the Soviet Union.


ALL WATER
FRESH WATER

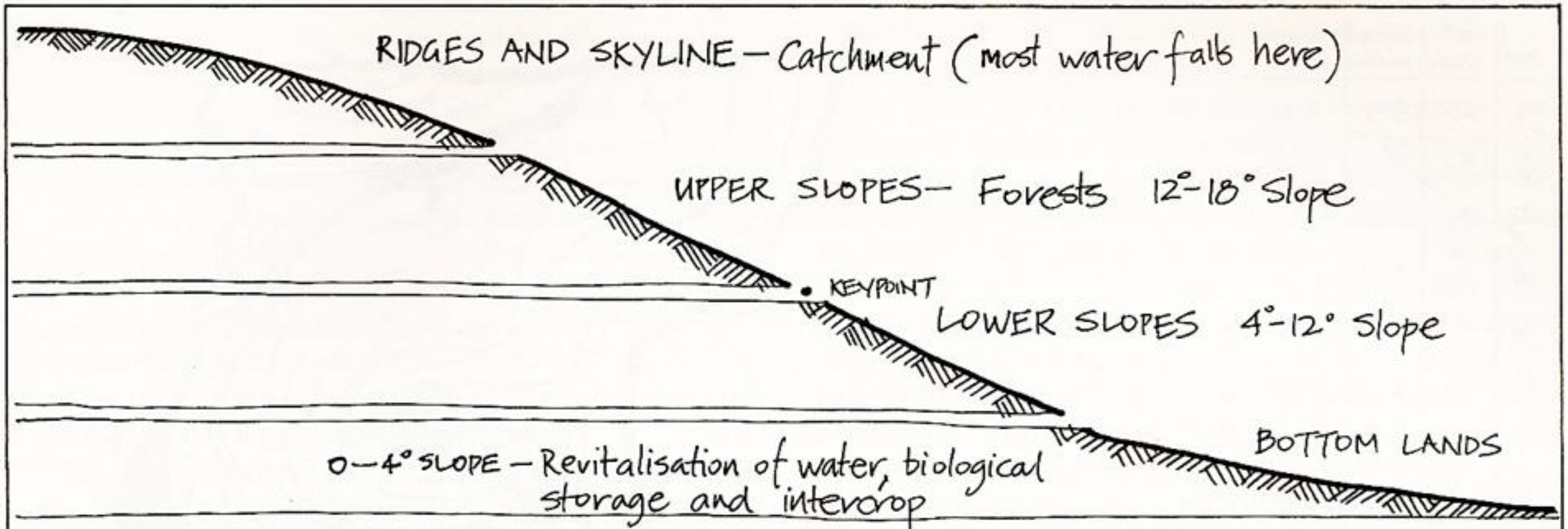

RIDGES AND SKYLINE – Catchment (most water falls here)
UPPER SLOPES – Forests 12°-18° Slope
KEYPOINT
LOWER SLOPES 4°-12° Slope
BOTTOM LANDS
0–4° SLOPE – Revitalisation of water, biological storage and intercrop

FIGURE 7.15

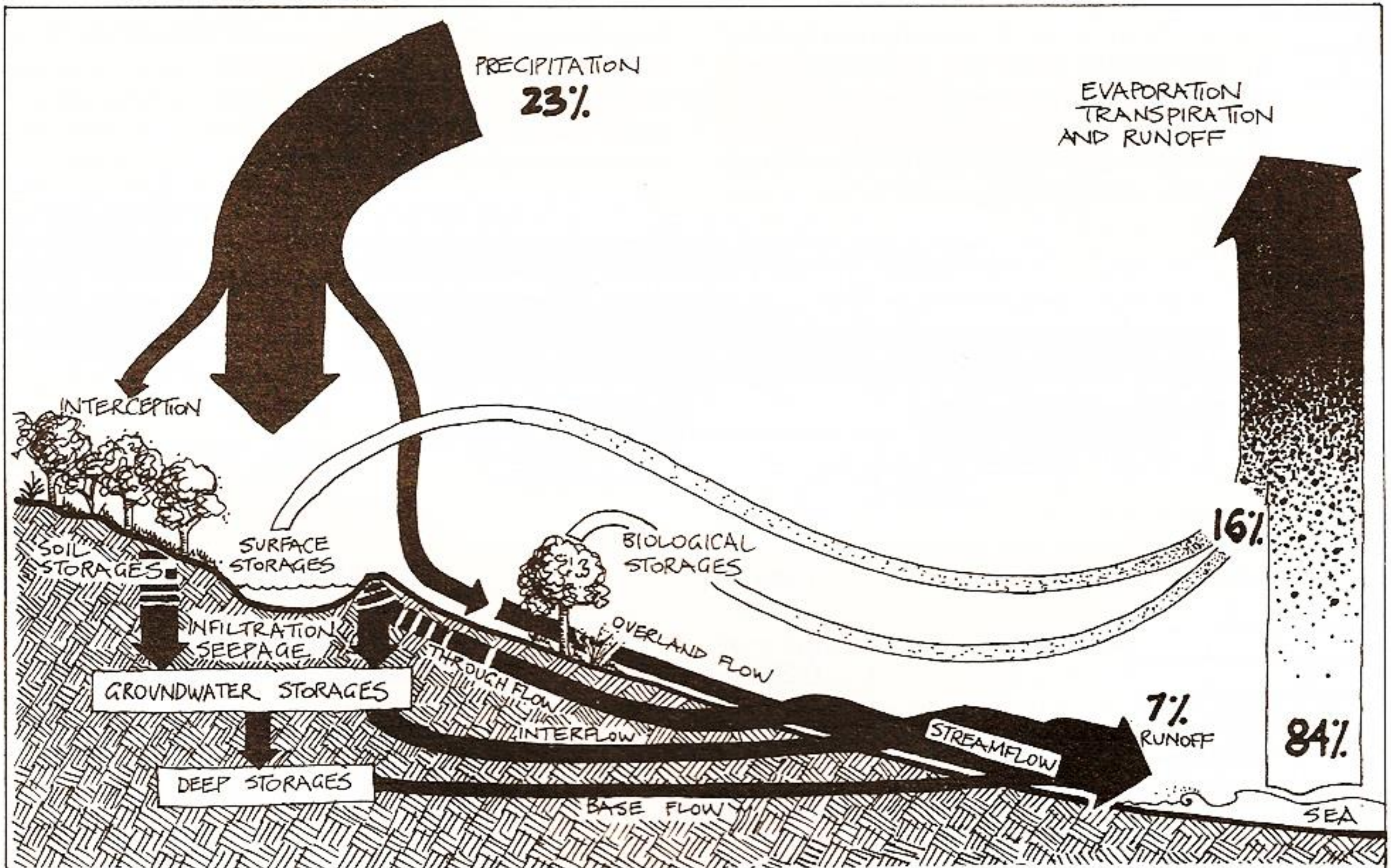


FIGURE 7.1

THE GLOBAL WATER CYCLE (Land and sea)

Omits most of the biological effects but gives the broad schematic of the water cycle. We can affect all parts of this cycle in adverse or beneficial ways.

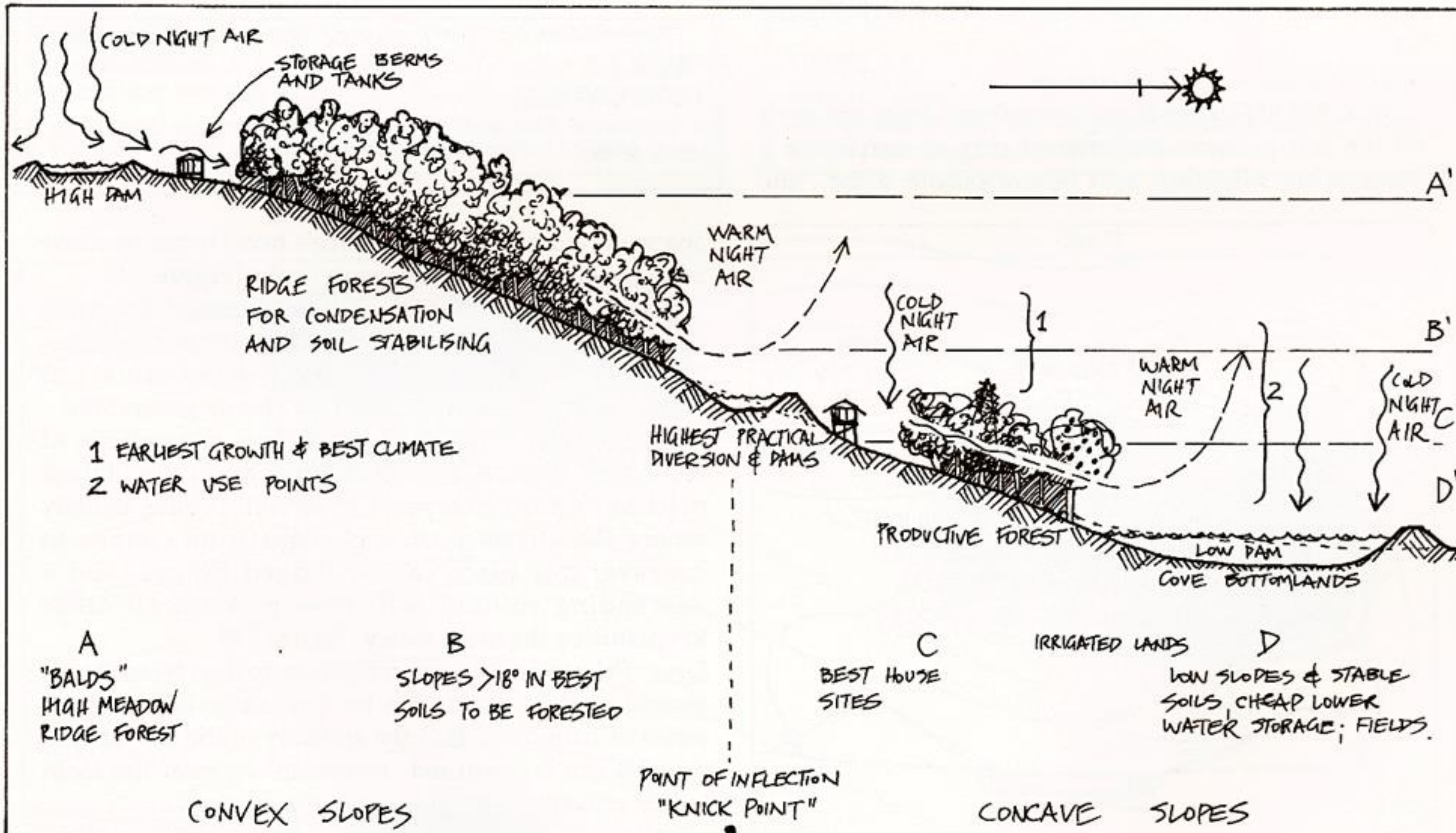


FIGURE 7.3

HUMID LANDSCAPE DAM PLACEMENT ON SLOPE

Schematic of water storages with respect to slope, forests, and dwellings.

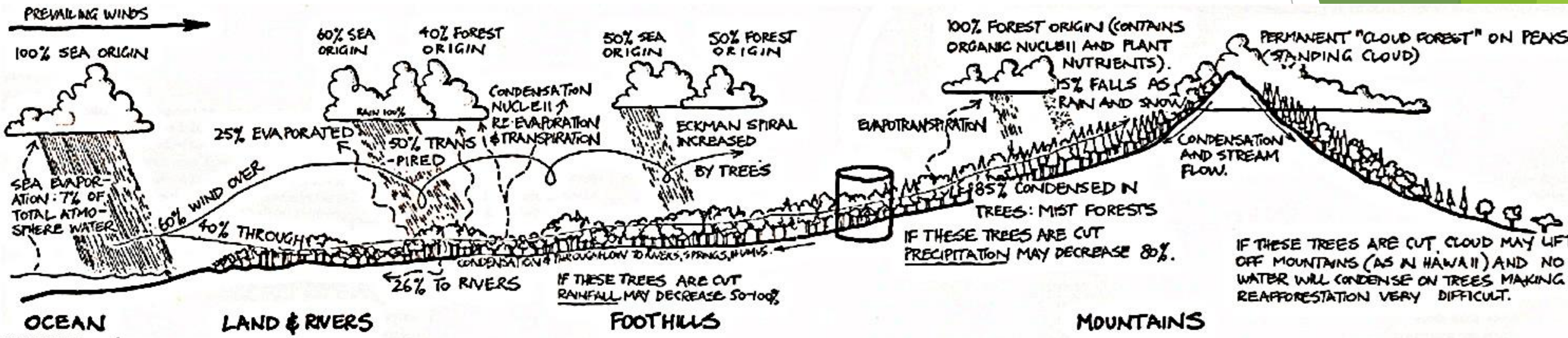
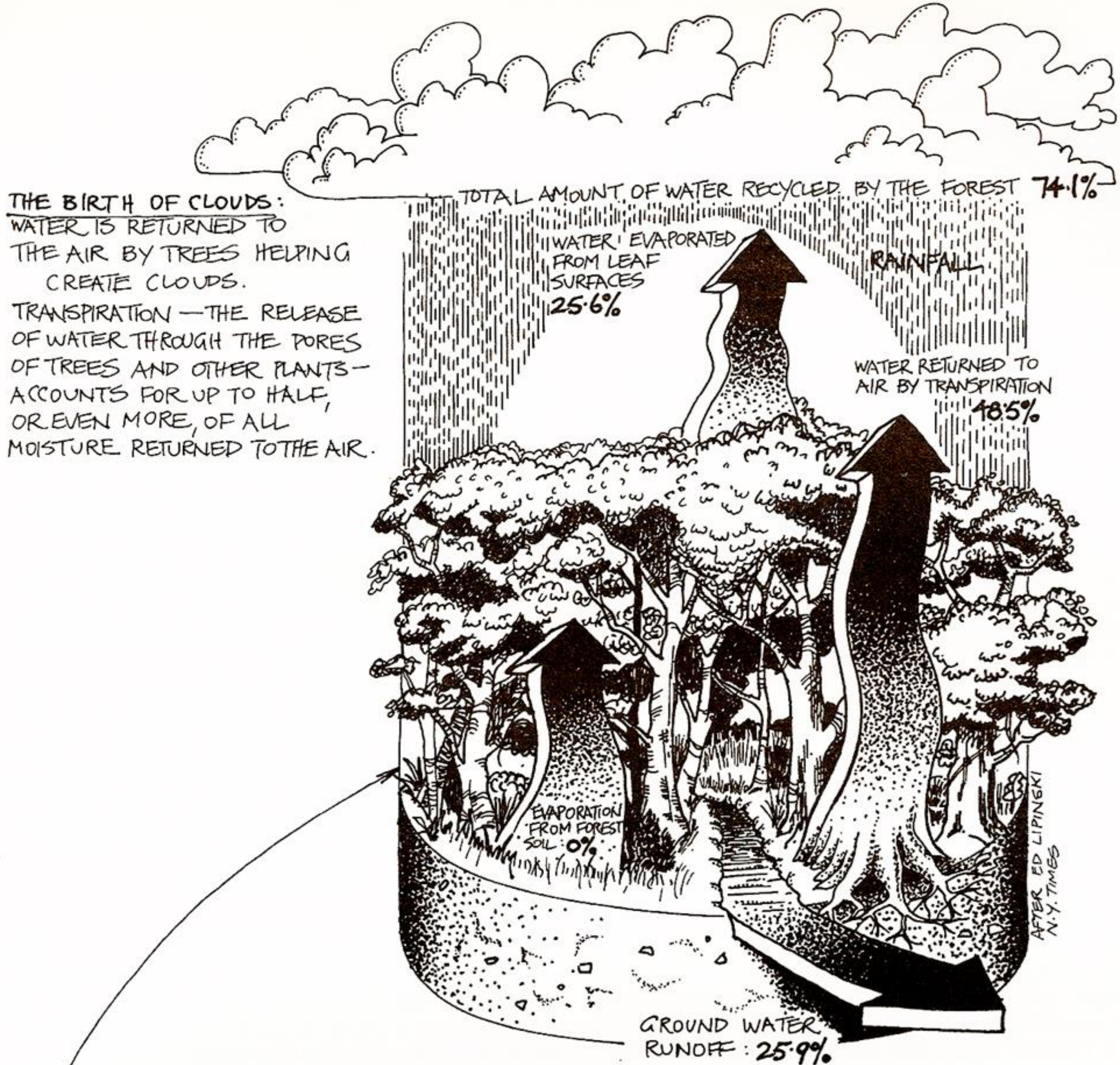


FIGURE 6.5
FOREST INTERACTIONS WITH CLIMATE. (Based on work in Brazil).

Forests inland produce most of the water for subsequent rainfall; recycled water is repeatedly transpired to the airstream.


THE BIRTH OF CLOUDS:
WATER IS RETURNED TO THE AIR BY TREES HELPING CREATE CLOUDS.
TRANSPIRATION — THE RELEASE OF WATER THROUGH THE PORES OF TREES AND OTHER PLANTS — ACCOUNTS FOR UP TO HALF, OR EVEN MORE, OF ALL MOISTURE RETURNED TO THE AIR.
TOTAL AMOUNT OF WATER RECYCLED BY THE FOREST 74·1%
WATER EVAPORATED FROM LEAF SURFACES 25·6%
RAINFALL
WATER RETURNED TO AIR BY TRANSPIRATION 48·5%
EVAPORATION FROM FOREST SOIL 0%
GROUND WATER RUNOFF: 25·9%
AFTER ED LIPINSKI N.Y. TIMES

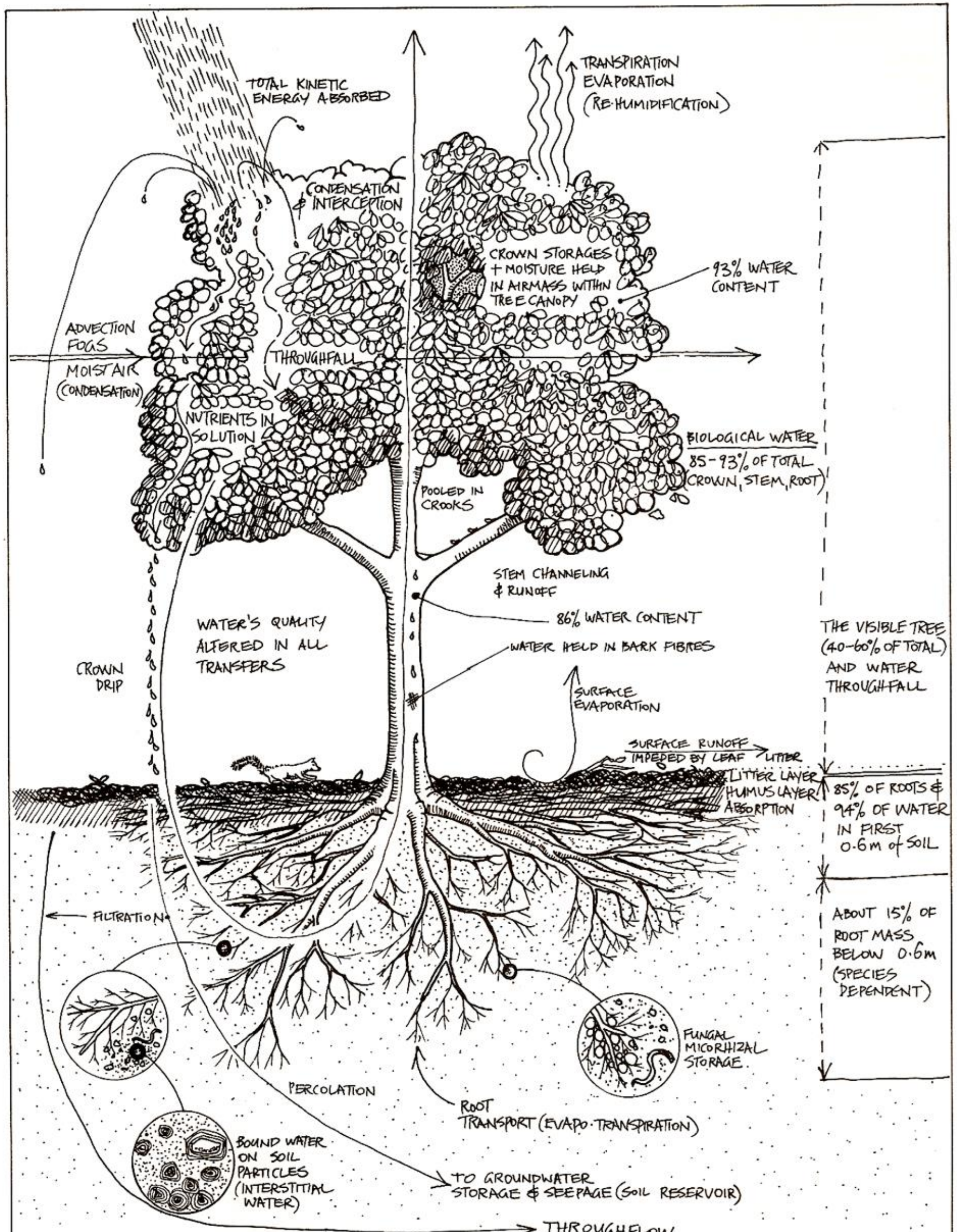


FIGURE 6.6
HOW A TREE INTERACTS WITH RAIN
Every tree, every plant species, intercedes in rain to change the composition, energy, and distribution of water; the overall effect of trees is to *moderate and conserve* incoming energy.

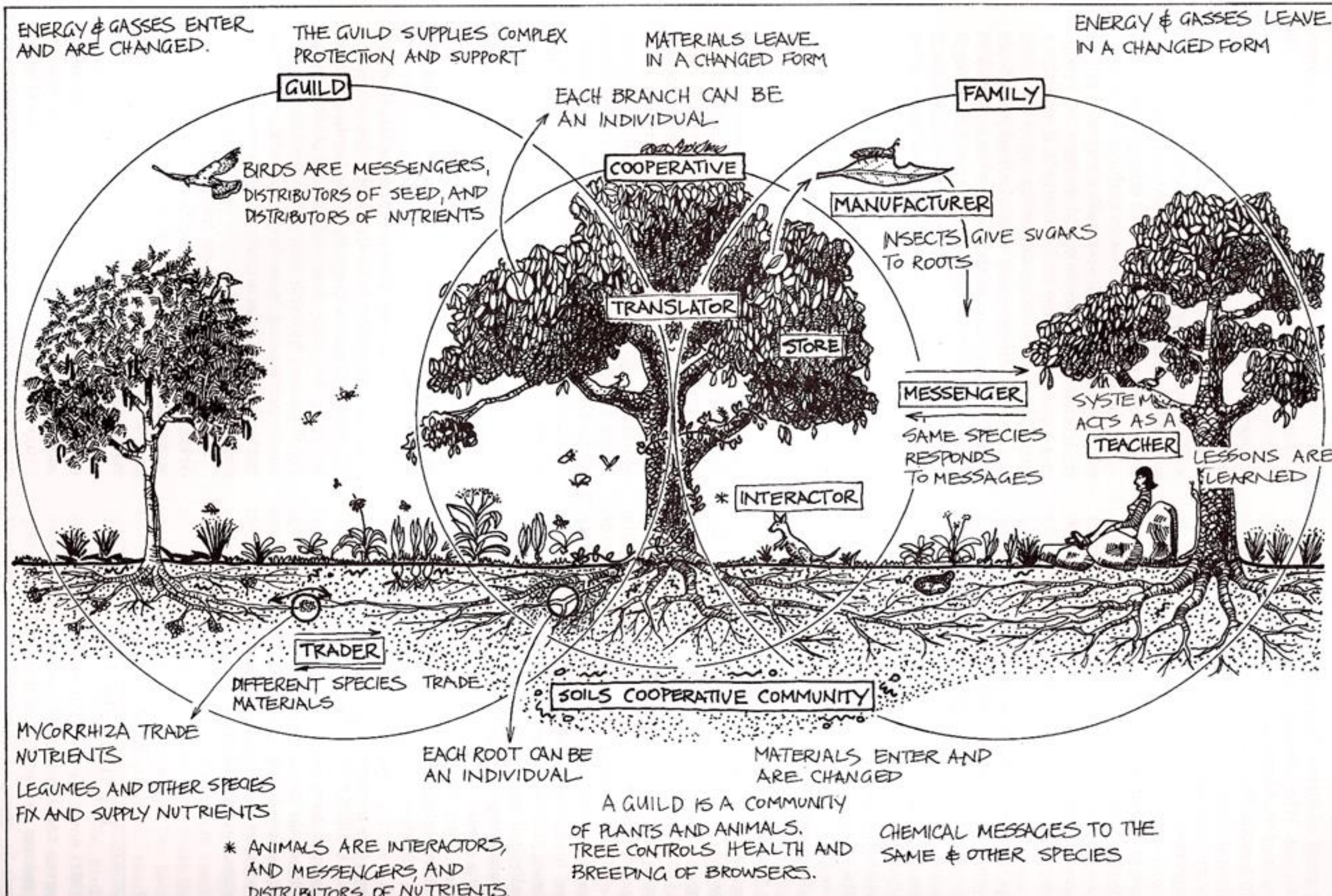


Figure 6.1
TREES IN A WHOLE SYSTEM
The tree itself is a cooperative, depends on a guild, is a member of a family of like species, and is involved in the creation of complex molecules from inorganic and organic elements - a transformer, or translator, of gases, liquids, and solids

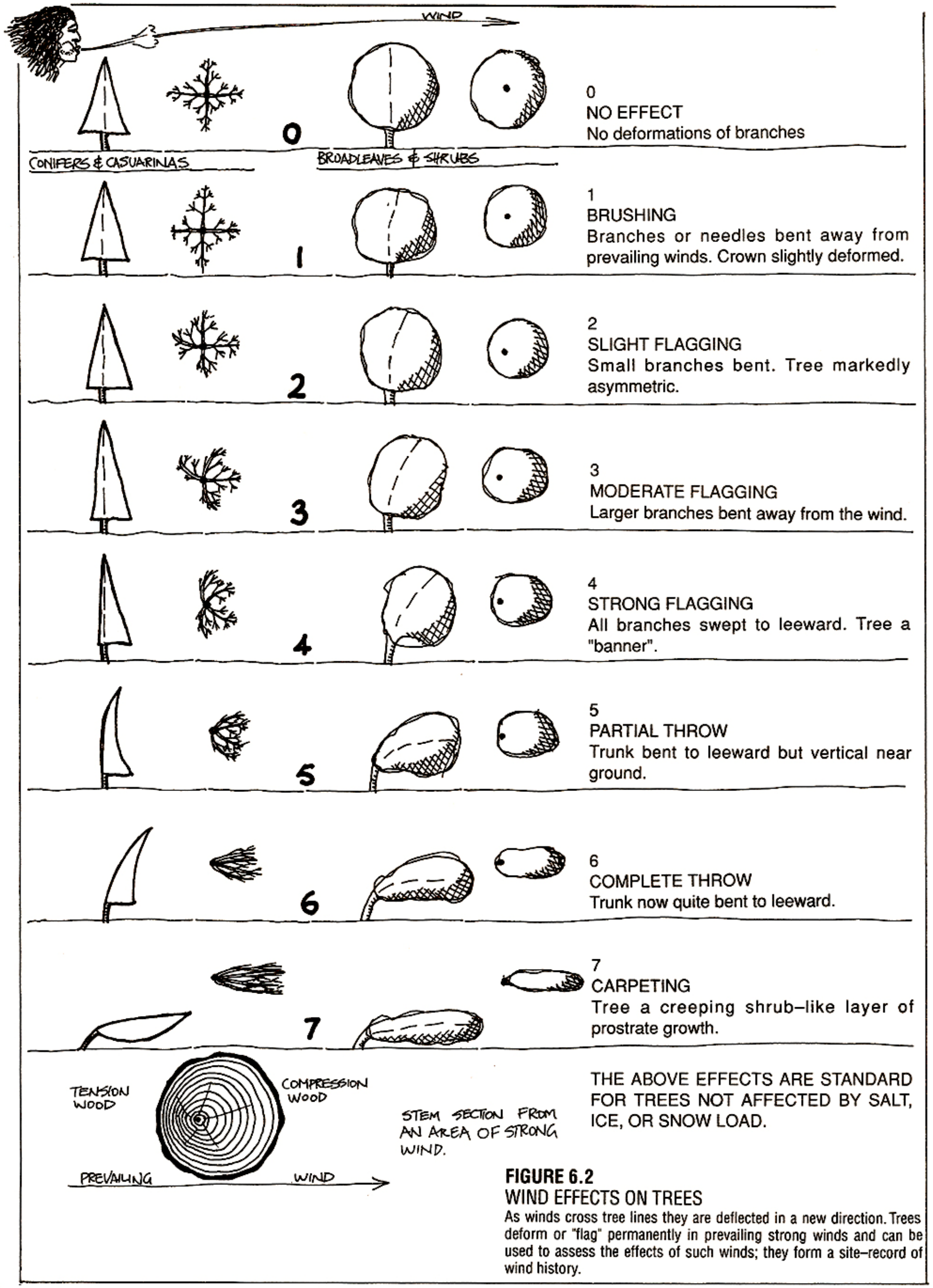


FIGURE 6.2
WIND EFFECTS ON TREES
As winds cross tree lines they are deflected in a new direction. Trees deform or "flag" permanently in prevailing strong winds and can be used to assess the effects of such winds; they form a site–record of wind history.

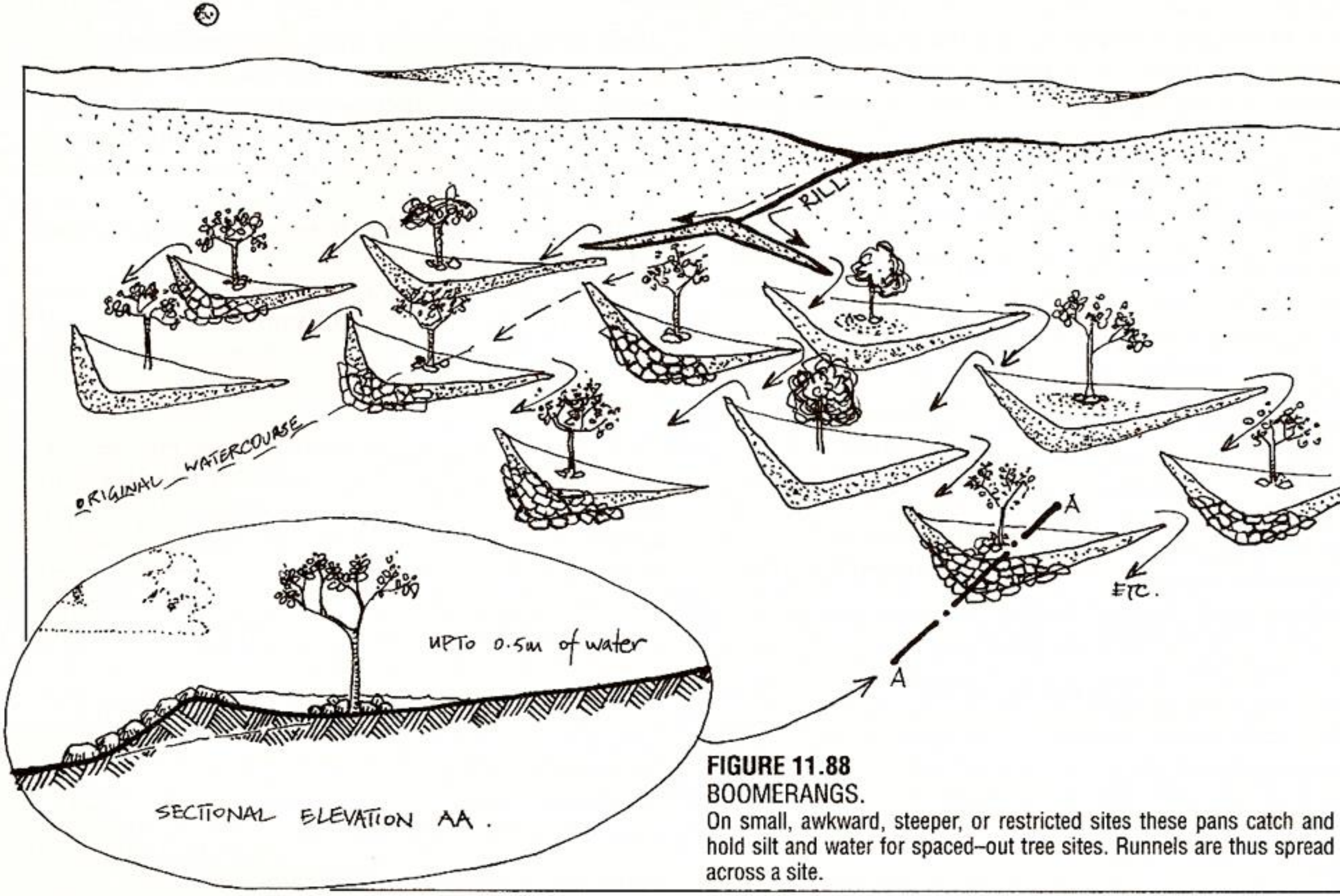
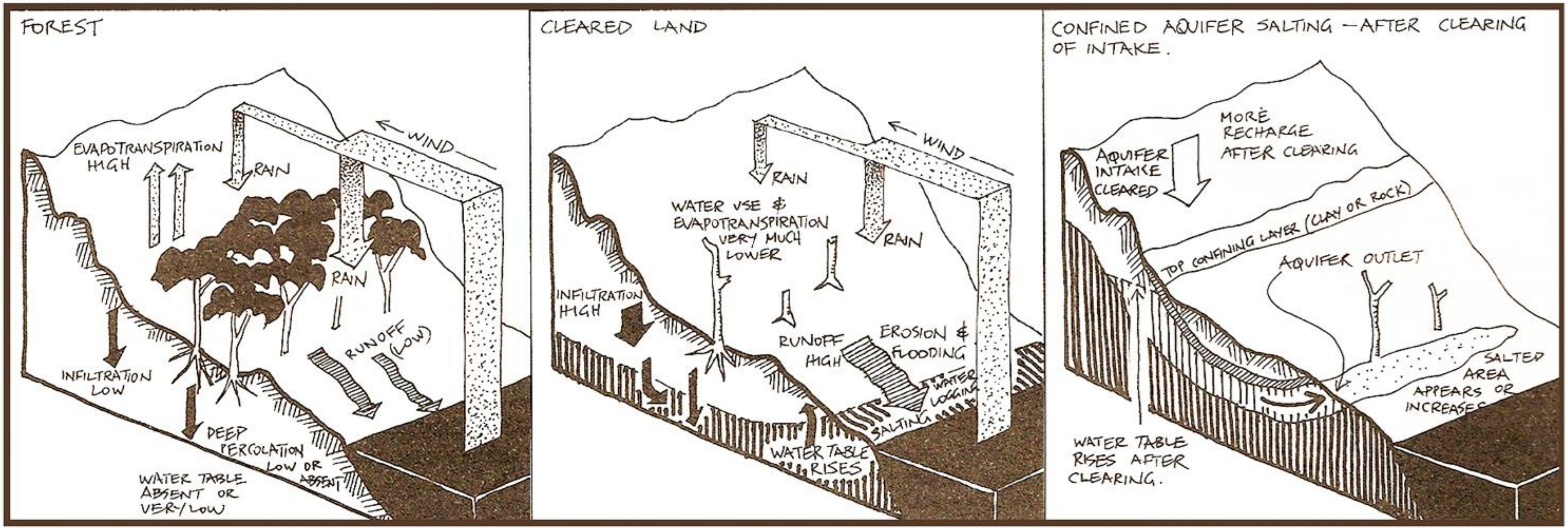


FIGURE 11.88
BOOMERANGS.
On small, awkward, steeper, or restricted sites these pans catch and hold silt and water for spaced–out tree sites. Runnels are thus spread across a site.


FOREST
EVAPOTRANSPIRATION HIGH
RAIN
WIND
RAIN
RUNOFF (LOW)
INFILTRATION LOW
DEEP PERCOLATION LOW OR ABSENT
WATER TABLE ABSENT OR VERY LOW
CLEARED LAND
RAIN
WIND
WATER USE & EVAPOTRANSPIRATION VERY MUCH LOWER
RAIN
INFILTRATION HIGH
RUNOFF HIGH
EROSION & FLOODING
WATER LOGGING
SALTING
WATER TABLE RISES
CONFINED AQUIFER SALTING – AFTER CLEARING OF INTAKE.
MORE RECHARGE AFTER CLEARING
AQUIFER INTAKE CLEARED
TOP CONFINING LAYER (CLAY OR ROCK)
AQUIFER OUTLET
SALTED AREA APPEARS OR INCREASES
WATER TABLE RISES AFTER CLEARING.

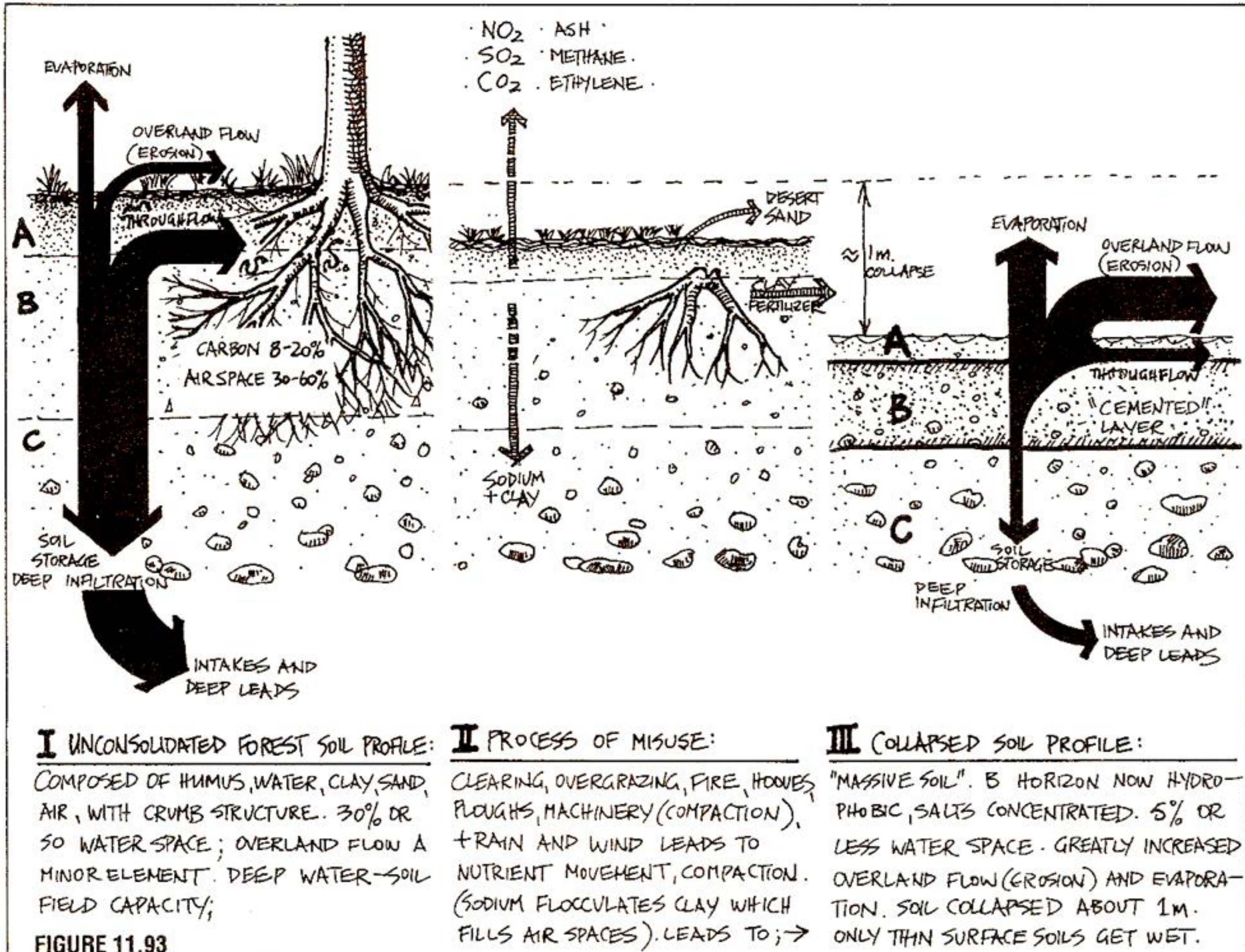


FIGURE 11.93

PROCESS OF SOIL COLLAPSE.

After misuse, sodium ions displace calcium, clays deflocculate and soil pore spaces fill; soil collapses to a cemented hardpan which seals off the subsoil. It is now almost impossible to plant trees without a long rehabilitation process, interceptor banks, and humus development (West Australian soils).

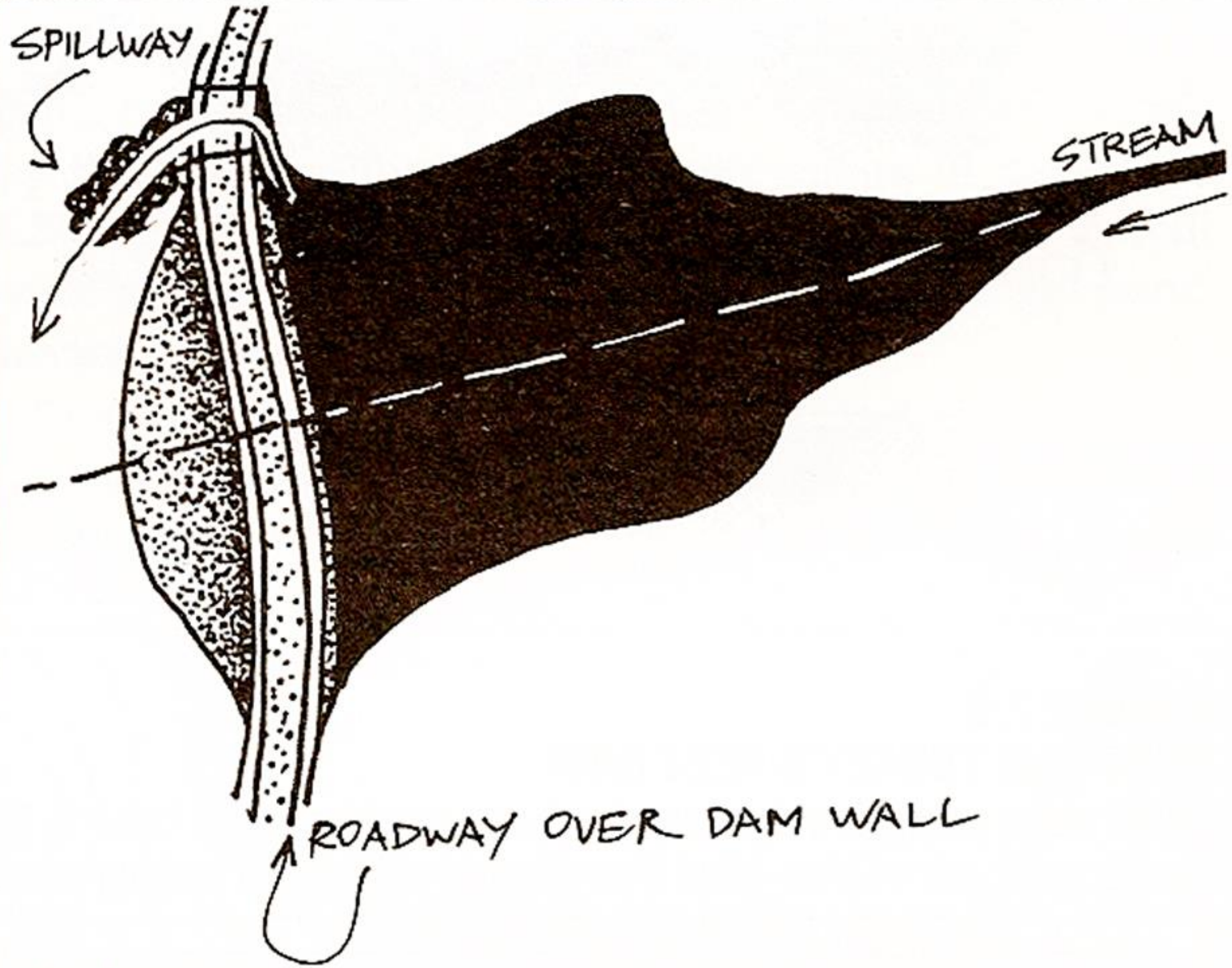


FIGURE 7.8
BARRIER DAM
"The engineer's dam." Can affect fish, migration, and be difficult to spill; works well as part of a keyline series only.

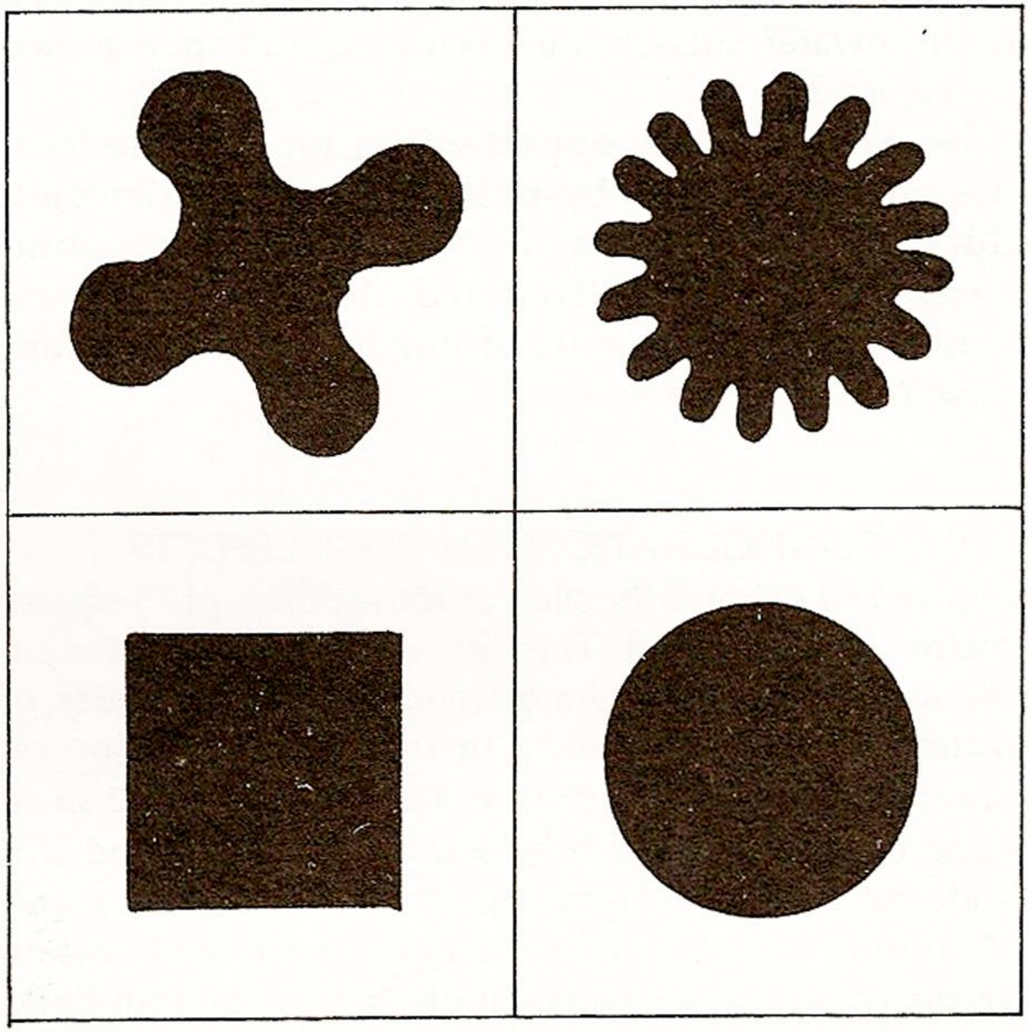


FIGURE 13.19
4 PONDSOF SAME AREA,
but differing widely in their capacity to provide for edge plants such as blueberries, to feed fish from edge vegetation, and to irrigate nearby tree roots.

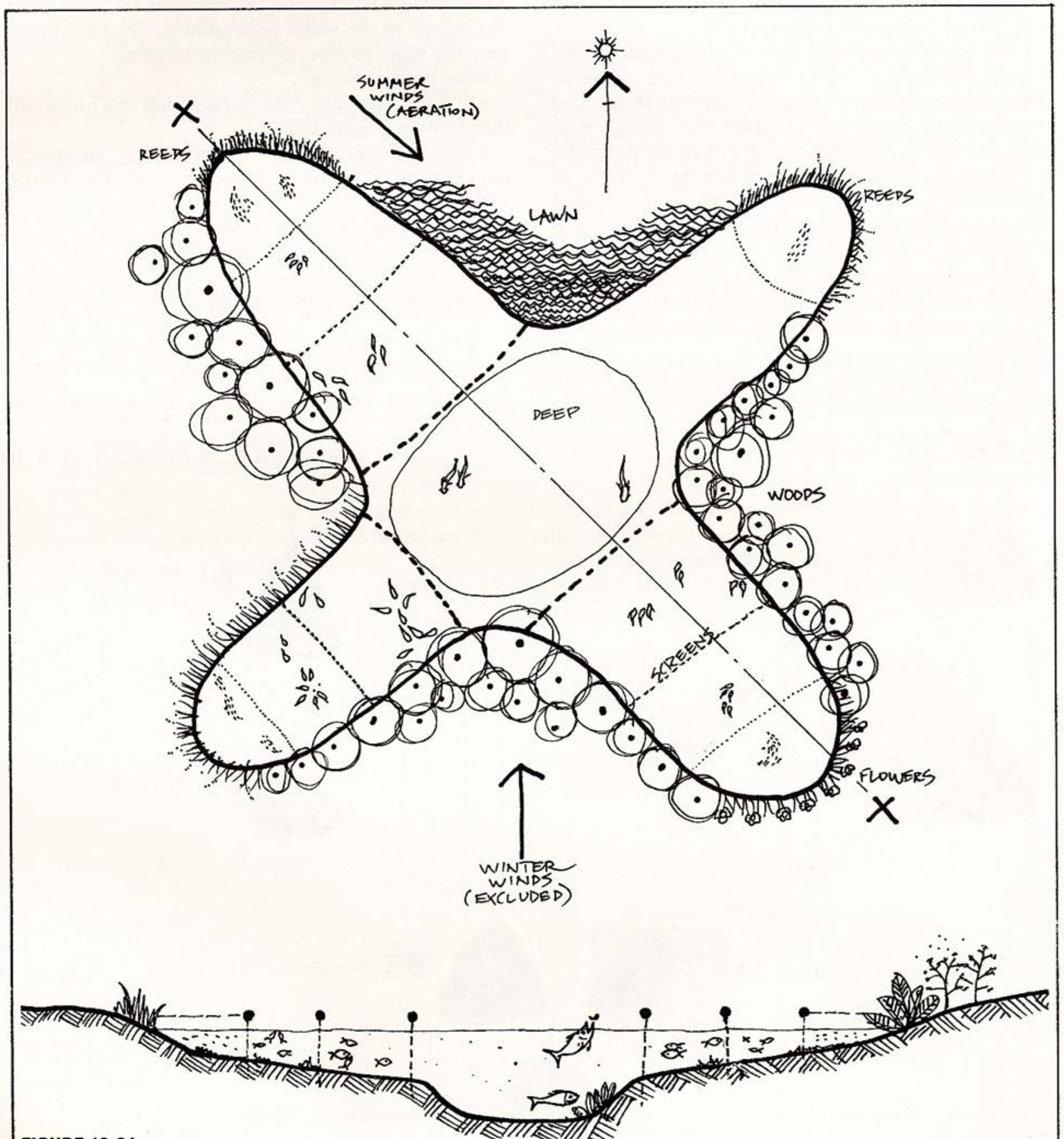


FIGURE 13.21
ONE POND WITH COMPLEX SCREENS.
In this complex pond, sequences such as shown in FIGURE 13.20 are annidated (nested) in one body of water divided by screens or walls.

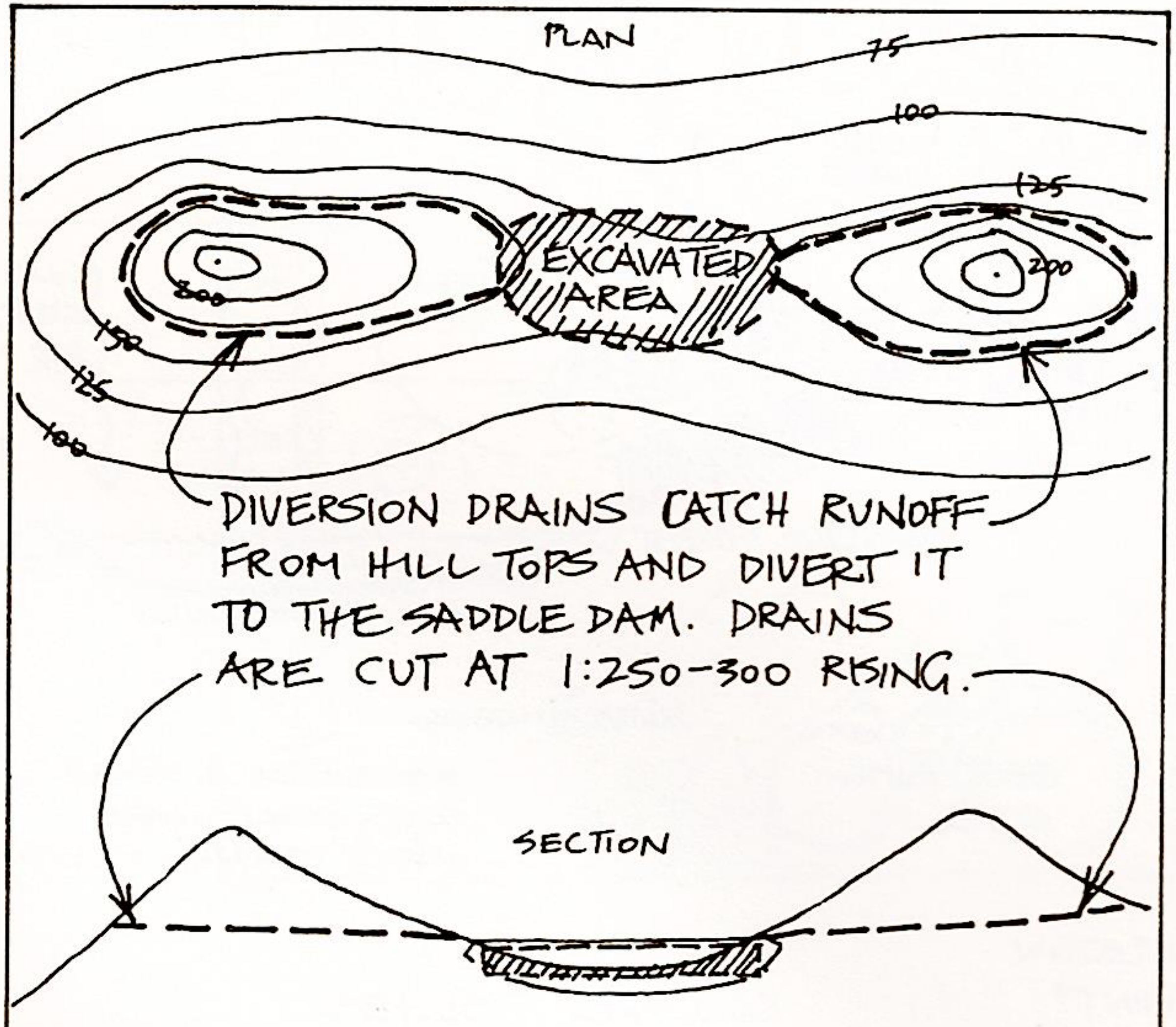


FIGURE 7.4

SADDLE DAM

Very useful for fire control, wildlife, limited irrigation. The "highest" type of dam in the landscape that fills from hill runoff.

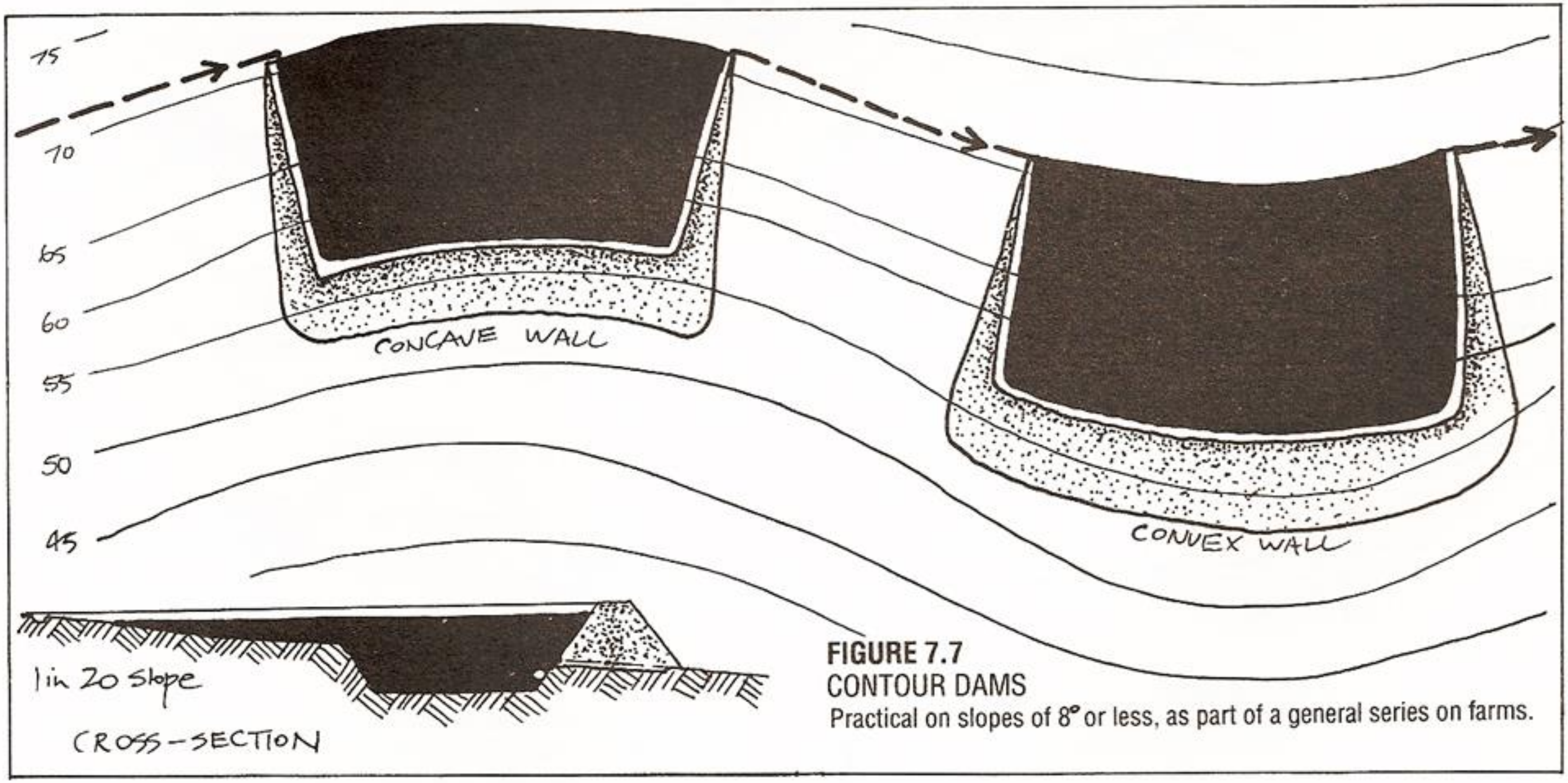


FIGURE 7.7
CONTOUR DAMS
Practical on slopes of 8° or less, as part of a general series on farms.

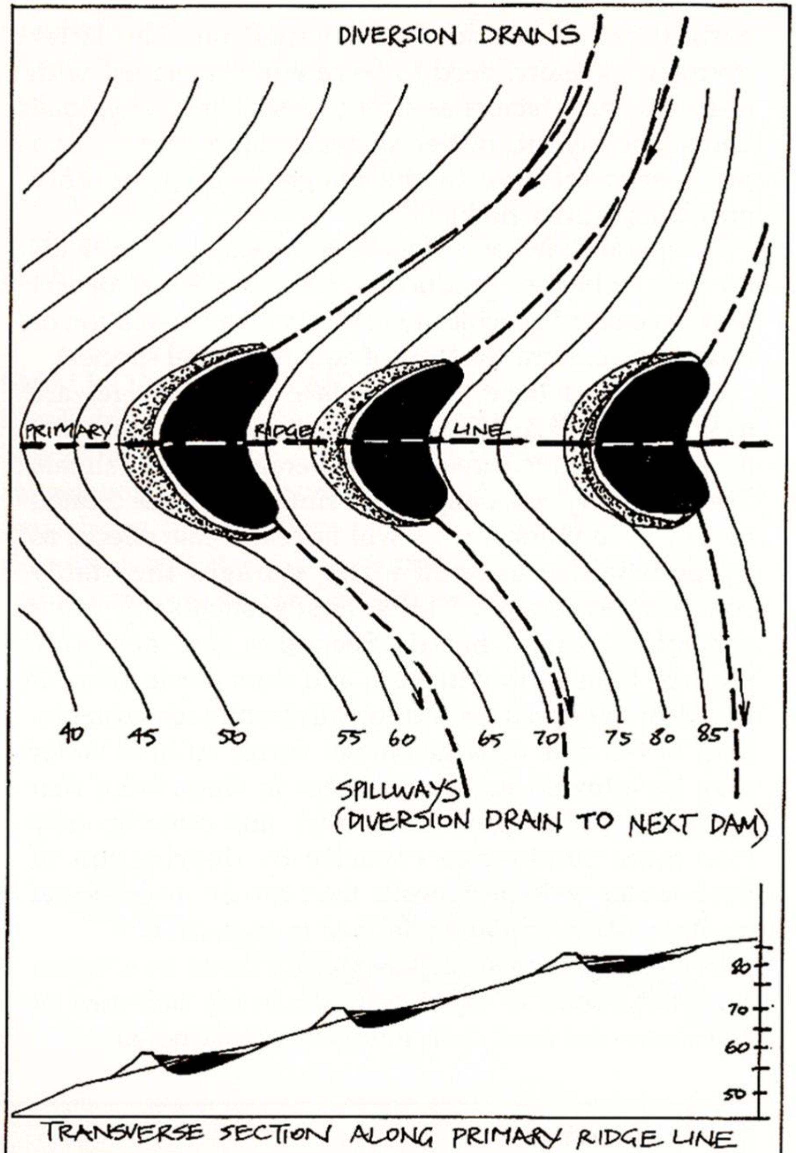


FIGURE 7.5

RIDGEPOINT DAM

or "horseshoe" dam, built on plateau areas of ridges. Uses as for saddle dams.

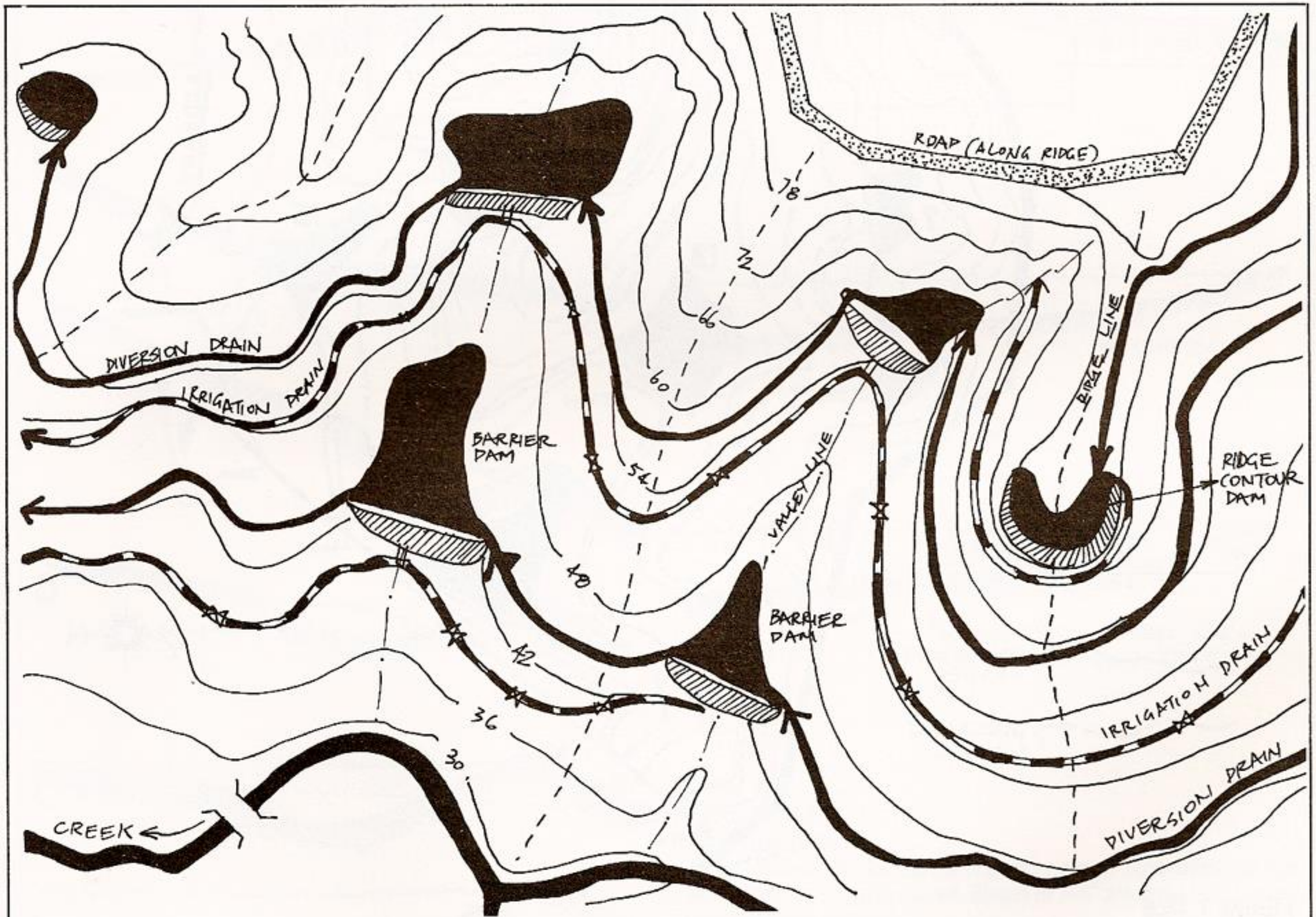


FIGURE 7.16.A

P. A. Yeomans' "Keyline" system provides drought–proofing for farms with very low maintenance and operating costs; his was the first book in English on total water design for foothill farms, access, tree belts, soil creation, low tillage, and creative water storage.

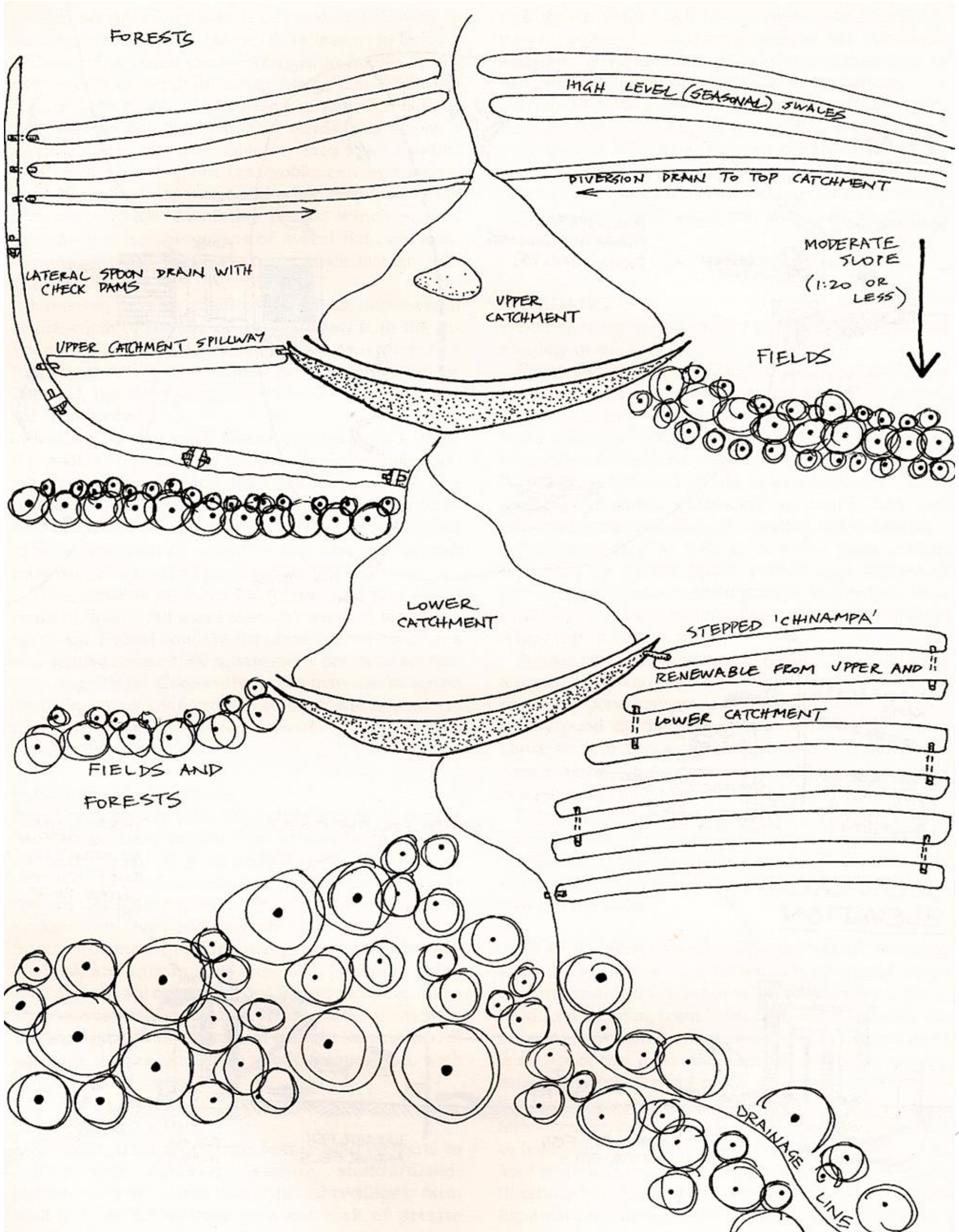


FIGURE 13.16
SOME COMMON STRUCTURES IN POND LANDSCAPES.
Riplines, swales, diversion drains, irrigation canals, and tree lines ensure that over-land flow is conserved in sub–humid landscapes.

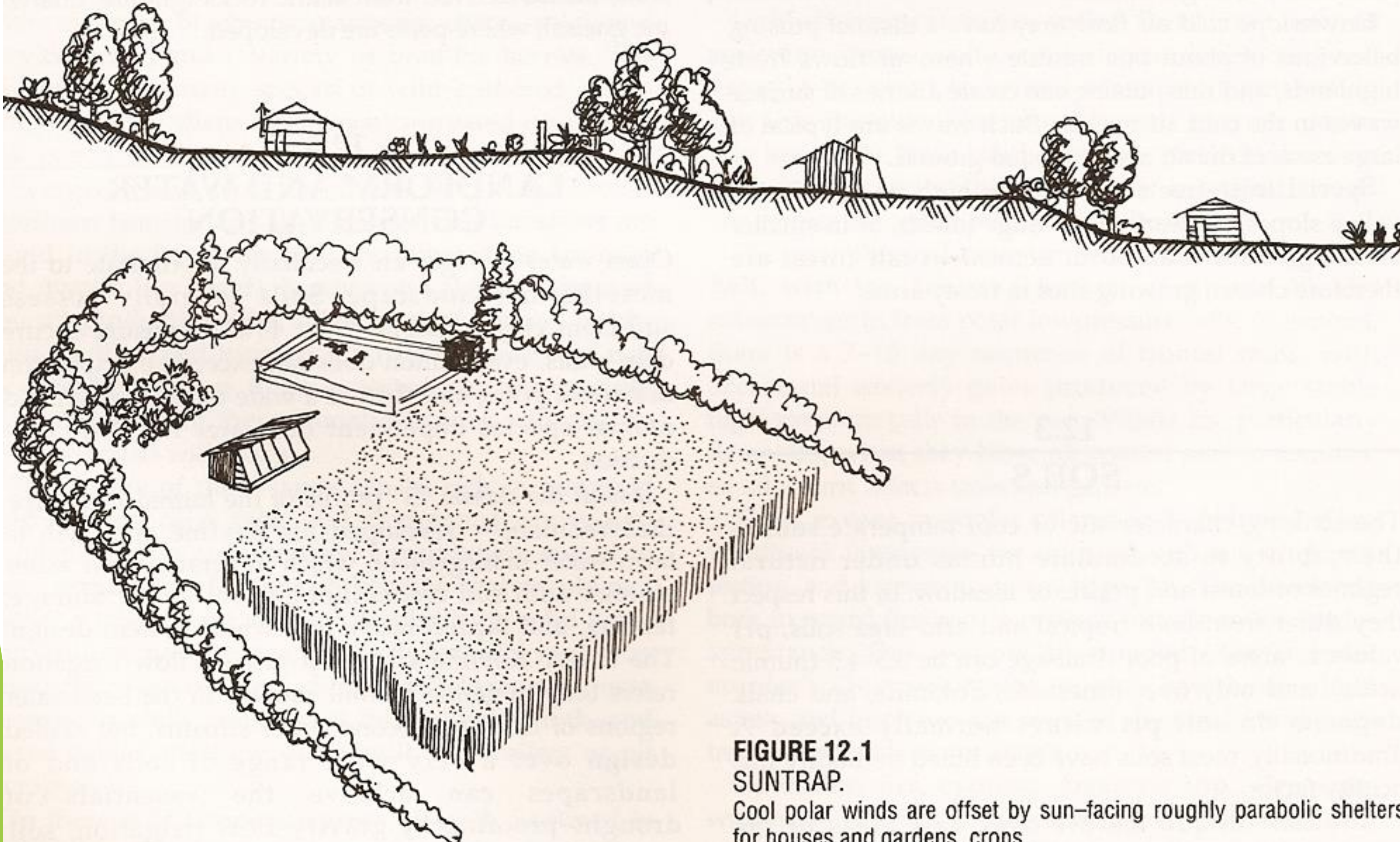


FIGURE 12.1
SUNTRAP.
Cool polar winds are offset by sun–facing roughly parabolic shelters for houses and gardens, crops.

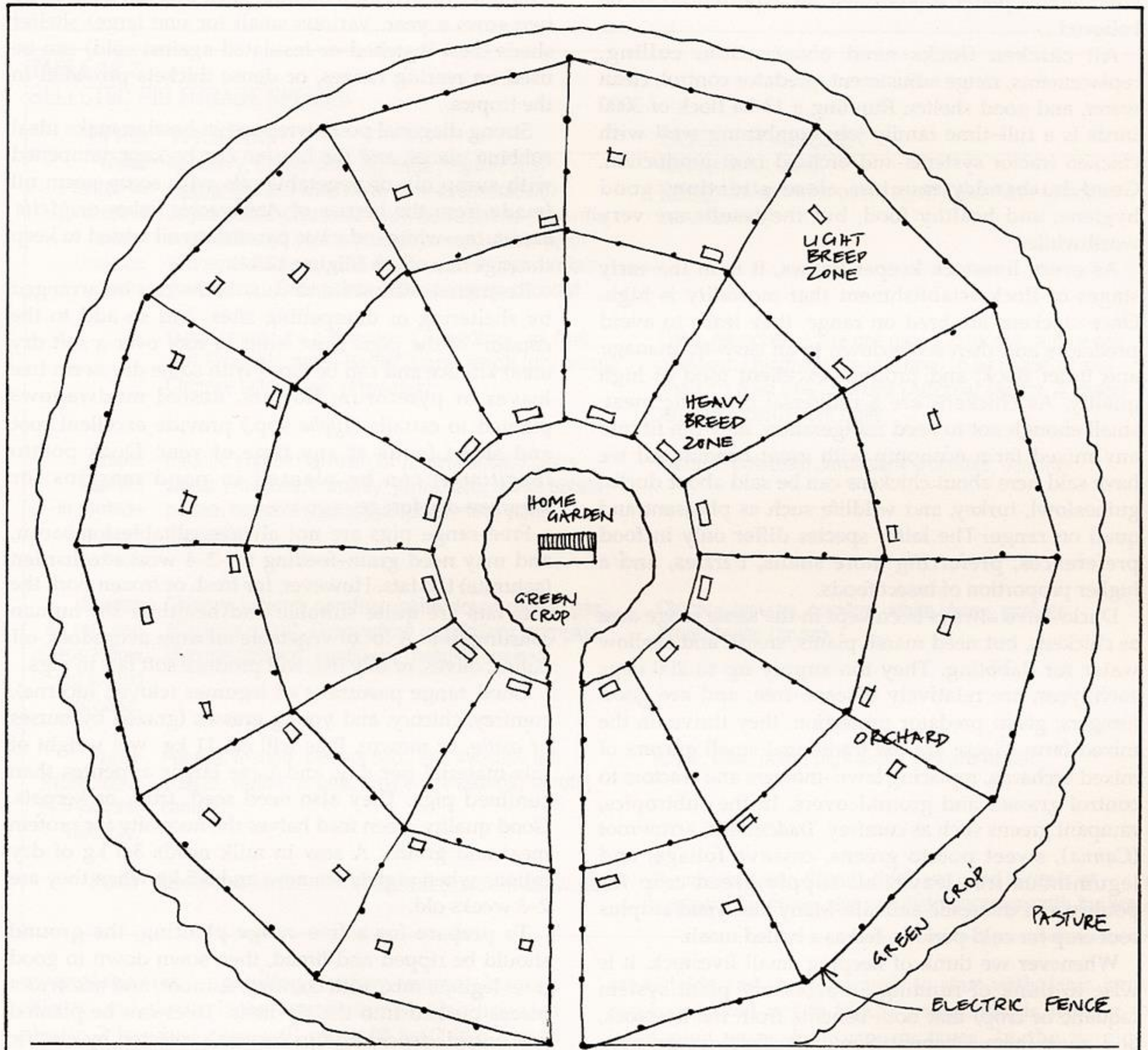


FIGURE 12.13
CHICKEN/ORCHARD PENS.
Idealized free-range layout; heavy breeds close to house, some pens always rested, limed, sown to forage crop. Fruit and forage trees omitted.

Thank you
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