1-4: Energy flow and trophic structure:……..Week 5

Ecology is concerned with the sources of energy in ecosystems and the transformations of this energy in living organisms . An important aspect of energy , therefore, is to try to measure the pathways and efficiencies of energy transfer , to understanding the structure and function of ecosystems .

Two basic physical laws which relate to energy are the first and second laws of thermodynamics . The first law states that " **the energy on earth is neither created nor destroyed ; it is transformed from one type to another "**, as for example , from light to heat to motion. The second law states that **" no energy process occurs spontaneously unless it is a degradation or dissipation from concentrated form to a dispersed form ". Thus , since some energy is always dispersed at each transformation , no transformation of energy is 100 percent efficient .**

The source of energy:

The ultimate source of energy for living organisms is the sun . It supplies an incredible amount of energy to the earth's surface . The intensity of solar radiation averages 15000 calories per square meter per minute . **For example , the solar energy striking the surface of the united states (USA) every 20 minute is sufficient to meet the country's entire power needs for one year , if it could be harnessed .** Most of this solar energy is scattered or transformed into heat . Of the light striking terrestrial green plants , 98% is reflected and approximately 2% is absorbed . Of the 2% absorbed , only 1% is in the wavelengths utilized by chlorophyll in photosynthesis . **Thus , The ecological efficiency of terrestrial green plants is usually 1% or less . In water bodies , usually more higher percentage of light is scattered , so that the ecological efficiency of aquatic plants is only 0.18% (about 0.2 %) .**

Food chains and trophic structure:

" Food chain " is a term refers to the transfer of energy from plants through a series of other organisms . However , **the term " trophic level " refers to the parts of a food chain in which a group of organisms secures food in the same general way .** Thus , all animals which obtain their energy by directly eating grass , such as grasshoppers and cattle , would be a part of the same trophic level . **The particular group of trophic levels within an ecosystem is known as the "trophic structure ".** Typically ecosystems have 3 – 6 trophic levels through which energy and organic materials pass . So , food chains usually have 3 – 6 " links " or groups of organisms with the same general way of nutrition .

An example of a short food chain on land would be grass → cattle → man .

In aquatic ecosystems ; algae , phytoplankton and aquatic plants occupy the same trophic level as grass on the land , and herbivorous animals including crustacea , insect larvae and fish occupy the same trophic level as the cattle on land .

The shorter the food chain , the greater the biomass which can be produced from a given amount of energy . The reason for this is that some energy is lost at each transfer according to the second law of thermodynamics , thus a 5 link food chain (such as algae crustacea → insect → fish→ man) is considerably less efficient than a 3 link food chain (such as algae → fish → man) . **" Food chain efficiency " refers to the organic material production within the chain , which may be measured in form of individuals , total biomass or energy flow in calories .**

These considerations help us to understand why the antarctic seas , are among the most productive oceans in the world during summer . This fact is due to the reason that they typically have short and simple food chains of two links ; for example from phytoplankton → baleen whales . They also have a 24 hour energy input from sunlight during summer with an upwelling of nutrients from the bottom to the surface , which stimulates the growth of phytoplankton . Finally , their organisms have a low respiratory rate and little energy lose through respiration , therefore , higher net productivity is resulted in relation to gross productivity in these seas . Figures 8 and 9 show the relative simplicity of food chains in both terrestrial and aquatic ecosystems in the polar regions .

Trophic structures tend to be simple in the polar regions , but they become more complex in progressing through the temperate regions into the equatorial tropics . **Thus it is more appropriate to call the trophic structures in temperate and tropical regions " food webs " rather than " food chains " , because the patterns of energy flow become so complicated that is difficult or impossible to diagram all of the possible links** (Fig . 10) .

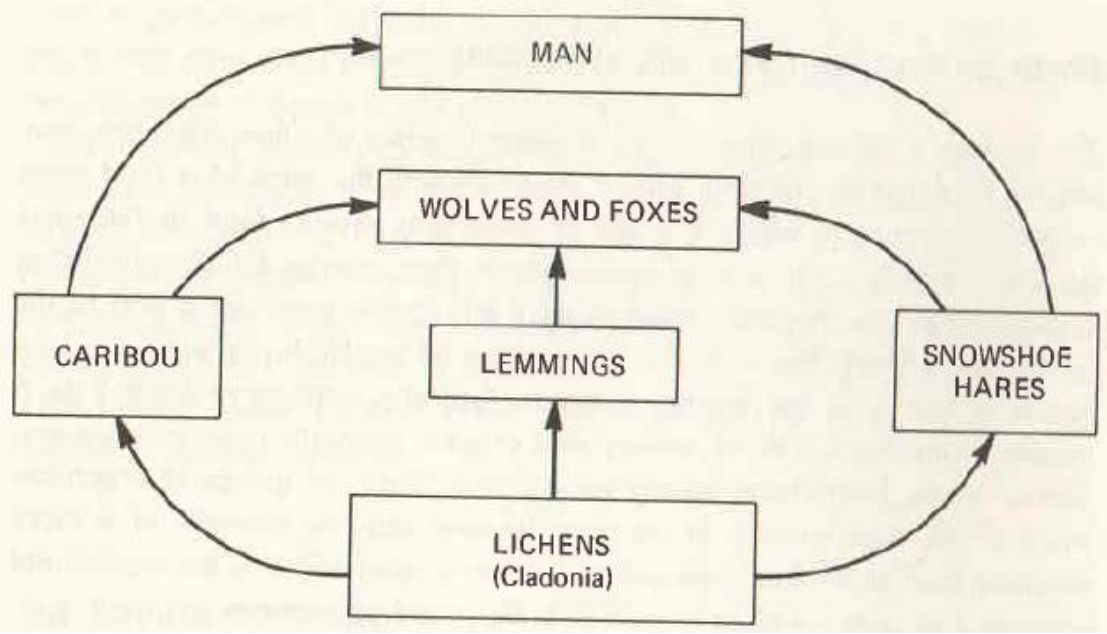

Fig . 8 : A simplified food chain for an arctic terrestrial ecosystem

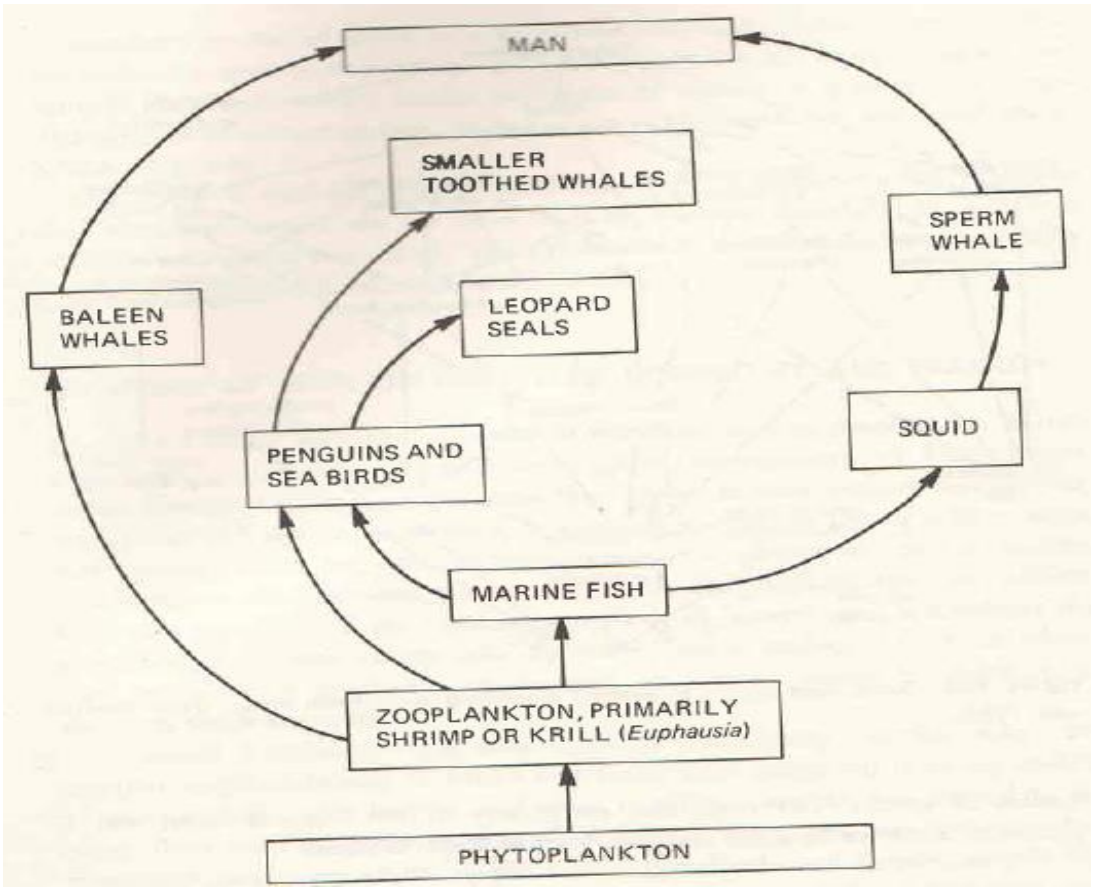

Fig . 9 : A simplified food chain for an Antarctic aquatic ecosystem

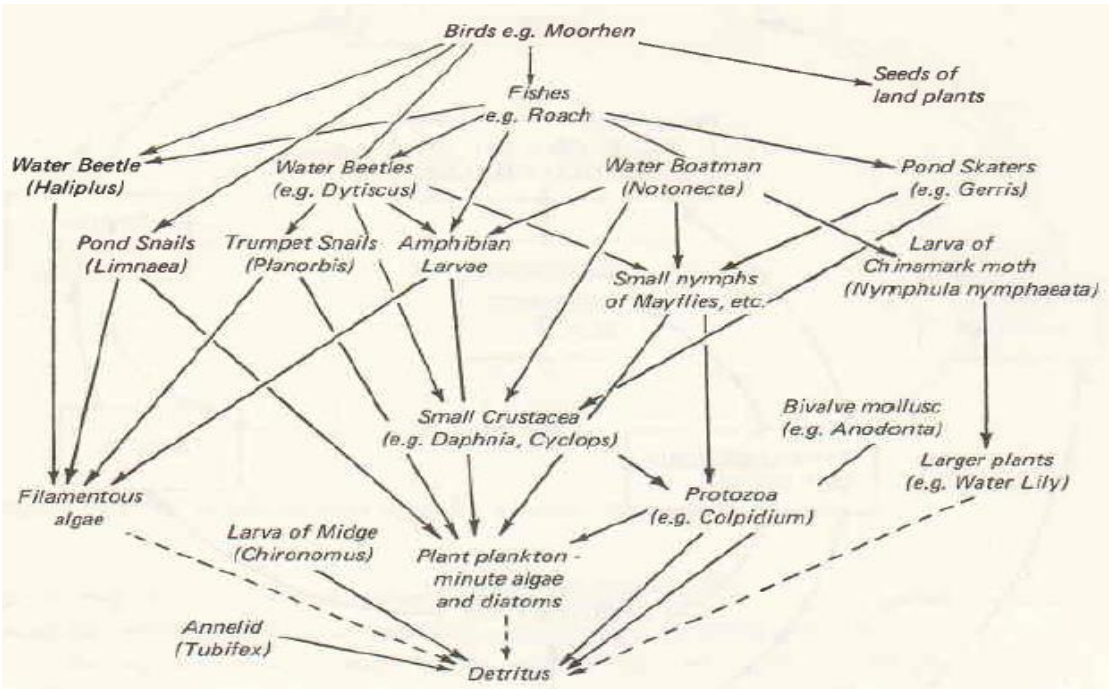

Fig . 10 : Some food chains of animals inhabiting an aquatic fresh water ecosystem in temperate regio