UNIT 6 ECOLOGICAL RULES

Contents

Learning Objectives

After going through this unit, you would be able to:

- understand what is ecology, ecosystem and ecological adaptive processes;
- describe the modified ecosystems of man; and
- know the important features and characteristics of different ecological rules.

6.0 INTRODUCTION

Human ecology is the subdiscipline of ecology that focuses on humans. More broadly, it is an interdisciplinary and transdisciplinary study of the relationship

Contributor: Dr. Ajeet Jaiswal, Associate Professor, Department of Epidemiology and Public Heath, Central University of Tamil Nadu, Tamil Nadu.

between humans and their natural, social, and built environments. The term 'human ecology' appeared in a 1907 work on sanitary practices in the home and surrounding environments. The term also appeared in a sociological study in 1921 and at times has been equated with geography. The scientific philosophy of human ecology has a diffuse history with advancements in geography, sociology, psychology, anthropology, zoology, family and consumer science, and natural ecology (Jaiswal, 2013; 2015).

6.1 ECOLOGY

The two components of nature, organisms and their environment are not only much complex and dynamic but also interdependent, mutually reactive and interrelated. Ecology, relatively a new science, deals with the various principles which govern such relationship between organisms and their environment.

The term ethnology was proposed by St. Hilaire (French zoologist), i.e ethnology is the investigation of the relations of the organisms inside the family and society within the family and society in the aggregate and in the community. The term hexicology was coined by St. G J Mivart (English naturalist), i.e hexicology is committed to the investigation of the relations which exist between the living beings or and their environment as regards the nature of the locality they frequent, the temperatures and the amounts of light which suit them, and their relations to other organisms as enemies, rivals, or accidental and involuntary benefactors". The term ecology was coined by combining two Greek words, *oikos* (meaning 'house' or 'dwelling place') and *logos* (meaning 'the study of') to denote such relationships between the organism and their environment. Thus, literally, ecology is the study of organisms 'at home'. There is some controversy about the author who coined the term ecology and first used it in literature. For instance, Kormondy (1969) tried to give credit for the first use of the term ecology to Henry David Throreau in 1858. There are, however, references in literature in favour of German Biologist, H. Reiter also who is said to have used this term for the first time in 1868 (Reiter,1885; Macmillan,1897).

Although, there is uncertainty about the original coining of the term, there is consensus that the German biologist, Ernst Haeckel first gave substance to this term. Haeckel, although appears to have first used the term in 1886 and he regarded the ecology of an organism as "…. the knowledge of the sum of the relations of organism to the surrounding outer world, to organic and inorganic conditions of existence….". Ecology as a distinct discipline grew out of natural history early in this century as natural historians began to collect their observations into the historical theory of ecolgy. In this process, vital was the work of Charles Darwin. Although his book On the Origin of Species was published in 1859, before the term was coined it contained many seeds that could grow to dominate modern ecology. Ecology has been defined in various ways by different authors. Warming (1895, 1905), who actually employed this science for the study of plants, defined *oekology* as "the study of organisms in relation to their environment". American Ecologist Frederick Clements (1916) considered ecology to be "the science of the community," whereas Charles Elton (1927) explain ecology as "scientific natural history" concerned about the "sociology and economics of animals i.e humanism and financial aspects of creatures"

Woodbury (1954) treated ecology as "a science which investigates organisms in relation to their environment, and a philosophy in which the world of life is

interpreted in terms of natural processes." Taylor (1936) defined ecology as "the science of all the relations of all organisms to their environments." Andrewartha (1961), Petrides (1968) and Krebs (1972) defined it as "the scientific approach to the study of environmental interactions which control the welfare of living things; regulating their distribution, abundance, reproduction and evolution."

> However, the recent development in the study of ecology has been the recognition of the fact that the biotic (living) and abiotic (non-living) components of nature are not only interrelated but both these components function in an orderly manner as a definite system. Thus structure and function should be studied together for fuller understanding of this vast nature.

In Haeckel's definition of ecology, he refers to the "surrounding outer world", which we now call the environment of an organism. His 'organic and inorganic conditions', we call biotic and abiotic environmental factors, respectively. Biotic factors are the other organisms and counter, whether of the same or different species. Abiotic factors are the physical and chemical conditions such as temperature, moisture, respiratory gases, and substrate. Odum (1963, 1969, 1971) with such an approach put forth a new definition of ecology, and in his own (1969) words "as you know ecology is often defined as the study of interrelationships between organisms and environment".

6.1.1 Scope of Ecology

Ecology is the science that need minimum time and labour for its introduction to a layman. Present day problems of varied nature in human life are directly or indirectly very much related to ecology, as their solution needs an ecological knowledge. These days ecology has been contributing very much to socio-economic, political, and other similar policies of the world. It is so common to find references of ecology in socio-economic writings, magazines, weeklies and daily newspapers. There are interdependencies not only between ecology and other areas of plant sciences, but also between ecology and physical as well as social sciences. Ecology indeed plays an important role in human welfare. This is primarily a field subject and modern ecology is concerned with the functional interdependencies between living things and their environment. Taylor (1936), in an attempt to define ecology, has very rightly pointed out the scope of ecology by stating that "ecology is the science of all the relations of all organisms to all their environments." Ecology plays an important role in agriculture (crop rotation, weed control etc.) management of grasslands (range management) , forestry, biological surveys, pest control, fisher biology, and in the conservation of soil, wildlife, forest, water supplies, etc. The international problem of environmental pollution also needs ecological assistance.

6.2 ECOSYSTEM

Ecological studies are made at ecosystem level, which is generally referred to as the most recent that commonly is referred to as the bioenergetics approach.

At ecosystem level, the units of study are comparatively very large. And there are indeed no practical units, if the nature is conceived as a single giant ecosystem-the biosphere. The overall view of this type of approach is that living organisms and their non- living environments are inseparably interrelated and interact with

each other. Keeping this view in mind, A.G. Tansley (1935) proposed the term ecosystem; ecosystem is the system coming about because of the integration of all living and non-living factors of the environment'.

Thus he regarded ecosystem that include the organism- complex and also the whole complex of physical factors that forms the environment. Though, the idea of ecosystem is by no means so recent, as allusions to the idea of unity of organism and environment can be traced back to late 1800's. we find in literature some such parallel terms as biocoenosis (Karl Mobius, 1877), microcosm (S.A. Forbes, 1877), geobiocoenosis (V.V. Dokuchaev, 1846-1903); G.F. Morozov; see Sukhachev, 1944), Holocene (Friederichs, 1930) biosystem (Thieemann,1939), bioenert body (Vernadsky, 1944) and ecosom etc. used for such ecological systems. However, the term ecosystem is most referred, where 'eco' implies the environment, and 'system' implies an interacting, inter- dependent complex.

Thus any unit that includes all the organisms i.e. the communities in a given area, interact with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle (i.e. exchange of material between living and non- living components) within the system, known as an ecological system or ecosystem. Keeping this in view, we may think of earth, we live upon as a giant ecosystem where abiotic and biotic components are constantly acting and reacting upon each other forth structural and functional changes in it. This vast ecosystem- biosphere is, however, difficult to handle and thus for convenience we generally study nature by making it artificial subdivisions into unit of smaller ecosystems (Terrestrial- forest, desert, grassland; man – engineered as a cropland; Aquatic- freshwater, marine etc.) of different sizes. An ecosystem may thus be as small as a pond, a cropland, or as large as ocean, desert or forest. It must be remembered, however, that these units ecosystem are simply separated from each other with time and space, but functionally they are all indeed linked with each other, forming as an integrated whole. There exist practically no functional boundaries between them.

The recent development in ecological studies has been to undertake besides structure, the similarity and differences in food and energy relationship among living compounds of ecosystem that is generally referred to as the bioenergetics approach in modern ecology. Modern ecology is thus, broadly defined as the study of ecosystem.

An ecosystem is overall integration of whole mosaics of interacting organisms and their environment. It is normally an open system with a continuous, but variable, influx and loss of material energy. It is a basic functional unit with no limits of boundaries, consisting of both biotic and abiotic components interacting with each other, both necessary for maintenance of life on earth. Thus, an ecosystem represents highest level of ecological integration which is energy based and this functional unit is capable of energy transformations, accumulation and circulation. Its main function in ecological sense is to emphasize obligatory relationships, interdependence and causal relations (Jaiswal, 2015).

Check Your Progress Exercise 1

1) Write short note on Human Ecology.

.....

.....

.....

.....

.....

2) What is Ecosystem?

.....

.....

.....

.....

.....

6.3 ECOLOGICAL ADAPTIVE PROCESSES

The environment is ever changing. In order to survive in the rigors of new circumstances, the organisms should either change accordingly or follow the path of extinction. Therefore, a succession of environmental changes is paralleled by the development of adaptation features: morphological and physiological including food and feeding behavior, way of living, reproductive and defensive mechanisms and protection against bad weather etc.

6.3.1 Kinds of Adaptations

Adaptations can be classified under the following four heads:

- ❖ Structural adaptations;
- ❖ Physiological adaptations;
- ❖ Protective adaptations and
- ❖ Animal association adaptations.

Structural Adaptations

These include changes in the structure (morphology and anatomy) induced by the physical environment. Mathew has differentiated following types of structural adaptations: -

a) Cursorial Adaptations: The territorial animals living in open plains have to depend on speed for searching their food and for escaping from their enemies. They exhibit the following types of structural adaptation; body contour, change in foot posture, lengthening of distal segments of limbs, loss of digits, reduction of ulna and fibula, loss of universal movement, musculature of limbs and development of spring ligaments, tail as a balancing organs, bipedality and mental precocity.

b) Fossorial Adaptations: The animals residing either permanently or for most of the time inside the burrows or under the earth surface are known as burrowing or fossorial (L. *fossorius* or *fossus* means adapted to digging) animals and their mode of existence is described as subterranean or underground. Fossorial animals exhibit three different grades:-

- Some animals dig for getting their food, but live above the ground. These animals exhibit minimum specialization except that they posses digging apparatus.
- Other group of subterranean animals includes those forms which dig for retreat but feed above the ground. These also exhibit modifications of the limb only.
- The last group includes those animals which permanently live in underground tunnels. These are the true or total fossorial animals. These have undergone maximum specialization for digging and burrowing, most common burrowing animals are *symbranchus* (fish) , *Apodon uraeotyohlus* (Amphibian).

These exhibit modifications on: body form, head, neck, tail, limbs, limb bones and girdle, vertebral column, skin, loss of eyes, disappearance of pinnae, tactile organs, skull, winter sleep, digging organs like snout, forelimbs, teeth and tusks.

c) Arboreal (Scansorial) Adaptations: Animals climbing trees or other vertical surface or stones are known as arboreal animals or scansorial animals. The animals are distinguished as three categories:-wall and rock climbers; terrestrio-arboreal forms and true arboreal forms these forms exhibit following modifications:- size, body contour, girdles, lengthening of proximal segments of the limbs, reduction in the number of digits, syndactylity and zygodactyly, tail, development of accessory organs.

d) Volant Adaptations: The animals which are capable of soaring or gliding in the air exhibit aerial mode of existence and are themselves known as Volant forms or aerial mode creatures or flying animals. Volant forms are found in both vertebrates and invertebrates. No doubt none of the Volant creatures are purely aerial mode of existence whereas others can glide in the air for a brief period. The former represents true or active flight and the latter passive flight. Volant adaptations, though exhibited by both gliders as well as true fliers, are different and can be dealt with separately.

Active flight or true flight: - Presence of wings, stream-lined bodies, reduction of body weight, lightness of the skeleton, sternum bears a median scale, additional surfaces for the attachment of strongly developed flight muscles, strongly developed flight muscles, high rate of metabolism and specially developed sense organs.

6.3.1.1 Physiological Adaptations

Endoskeleton- The endoskeleton is light and provides larges for attachment of muscles. *Muscles and flight*- The muscles on the back are much reduced and the flight muscles on the breast are strongly developed. *Digestive Organs*- The high rate of metabolism necessitates high food requirements and quick rate of digestion. *Respiratory system*- To meet the extensive rate of metabolism greater amount of

oxygen is needed by the body tissues. Hence the respiratory system is highly developed. *Circulatory*- Rapid metabolism requires large oxygen supply to the tissues, which can be achieved by an efficient circulatory system. *Warm bloodedness*- The perfect aeration of blood is responsible for high temperature of the body, which is very essential for flight. The constant body temperature enables the bird to take flights at high altitudes and also facilitates activeness in every season. *Efficient excretion and retention* of water, *Brain and sense organs* highly developed, and *Modification in Reproductive* organs.

6.3.1.2 Cave Adaptations

Characteristics of Cave Environment- Caves are natural hollows under earth surface or in mountains formed by the underground rivers of the past. Caves are characterised by the absence of bright light and nearly uniform temperature, high humidity, feeble fluctuations of temperature and absence of air currents. But the light is plenty at the mouth of the caves and penetrates for a short distance inside. Therefore, the cave environment is separated by LULL in to three distinct regions, namely:- Twilight or dysphotic or transitional region, Region of fluctuating temperature, The inner cave region.

The inner cave region represents true cavern environment having no light, relatively high humidity and absence of air currents. The absence of light has a pronounced effect on the inhabitants of this region. The body organization of permanent cave dwellers has undergone marked changes, but these are mostly towards degeneration. Therefore, cave animals are known for their primitive organization and defenseless nature like: loss of pigmentation, slender body and reduced appendages, weak exoskeleton, absence of visual organs, tactile organs, retrogression of endocrine system.

6.3.1.3 Aquatic Adaptation

The animal species living in sea, rivers, lakes, ponds, pools and ditches are known as Aquatic Animals. These are broadly divided into two types:

- Primary aquatic animals are those which have never lived on land and even their ancestors were also aquatic. These live permanently in water and have evolved from more primitive aquatic forms e.g fishes.

  The primary aquatic adaptations are observed in fishes, which have evolved from some aquatic ancestor and live permanently in water like: body contour, presence of fins, musculature, respiratory organs, air bladder, lateral-line and skin.

- Secondarily aquatic animals are those aquatic animals which live in water but their ancestors were terrestrial. That means that these animals have secondarily taken to aquatic existence. These include turtles, crocodiles, hippopotamus, whales, porpoises, sea lions and dolphins etc.

  The secondary aquatic animals live permanently in water but most of them are amphibious in nature. Moreover, reptiles and birds come out of water to deposit their eggs on the earth. The exhibition following adaptations to live in water:- body contour, shortening of neck, integument, limbs, fins, skeleton, sense organs-eye and teeth.

6.3.1.4 Desert Adaptations

Desert have low rainfall, high evaporation and a wide range in temperature. It is unobscured by vegetation and paradoxically partially shaped by water. The chief adaptations of desert are as scarcity of water, extremes of temperature, dust storms.

Adaptations:

- **Conservation of Body water**: To avoid evaporation through body surface or to avoid loss of moisture during respiration or to avoid loss of water during excretion. A variety of adaptation examples can be seen in desert biome animals. Desert sheep, goats, camels and donkeys retain insulating fur on the tops of their bodies but have sparsely covered abdomens and legs that radiate excess heat. Jack rabbits have long legs that carry them well above the heated ground and large ears well-supplied with blood vessels. Blood flow to the ears increases to lose heat to cooler air and flow decreases when air is hotter than body temperature to avoid overheating. To save water ordinarily lost in excretion, another common desert adaptation in animals is dry feces and concentrated urine.
- **Protection against scorching sun:** In desert temperature of the air may boost up upto 45°C and that of the sand at 57-58°C. For protection against scorching sun and burning sand, desert animals have developed protective armours and several defensive mechanisms.
- **Protection against sand storms:** The nostrils, ears and eyes are protected from the dry sand of the deserts.
- **Swift running or speed:** Since desert animals have to move far and wide in search of food and water, majority of them have great speed. In addition, for protection against enemies these have to rely on speed only. The limbs are specialized and adapted to walk on sand.
- **Colour:** The colouration in desert animals is found to match with the sand dunes. The body hues are often grey, brown or red, which is often in the harmony with the ground. This blending colouration furnishes protection from the attack of predators. Warning colouration is exhibited by poisonous animals like lizard, rattle snake, spiders and red ants. In general, desert animals are less heavily pigmented and are comparatively small in size (Gloger's rule)
- **Spinescence:** The spine studded body is characteristic feature of desert animals. The most conspicuous example is flat spiny lizard, horn toad and horn lizard.
- **Venom**: Possession of venom is another attribute to desert animals for self protection. *Heloderma punctatum* is the only poisonous lizard and is found in the arid zone of Mexico. Rattle snakes, trap door spider and Tarantula spider are poisonous creatures of the desert.
- **Sense organs and intelligentia**: Organs of sight, smell and hearing are specially developed. Certain desert animals exhibit very intelligent behaviour. Puff lizard when attacked, darts into a crevice between two rocks and inflates the body to such an extent, that it cannot be pulled out. Kangaroo rat when attacked by a rattle snake, throws sand and gravel in the face of the snake with the help of its hind legs.

6.3.1.5 Deep Sea Adaptations or Adaptations to Deep Sea Life

Characteristics of Deep Sea Environment-Deep sea is remarkable for its stability or changelessness in the climatic conditions, low temperature, scarcity of food, unrelieved darkness, absence of water currents and immense pressure.

6.4 ECOLOGICAL RULES

Several ecologists have tried to explain the interaction between organism and their environment in a different perspective of analysis. In this section, let us have a look at some major concepts which laid the foundation of close observation of environment and the impact of the environment on the living organisms residing in the *milieu*.

6.4.1 Allen's Rule

"Joel Allen in 1877 posited a biological rule called Allen's rule. It expresses that the tail, snout, ears and legs of mammals are relatively shorter in colder part than in the warmer areas. Allen's rule or endotherms (Birds and Mammals) from low temperature or colder climatic condition generally have shorter appendages or limbs than the alike animals from higher temperature or warm climatic condition. The hypothesis behind Allen's rule is that endothermic creatures with a similar volume may have contrasting surface areas, which will help or hinder their temperature regulation (Weinstein and Karen, 2005).

6.4.2 Bergmann's Rule

Christian Bergmann gave a biological rule called as Bergmann's Rule. Indeed, Bergmann's Rule declares that temperature also affects the absolute size of an animal and the relative proportions of various body parts. Birds and mammals attain greater body size in cold regions than in warm areas. But poikilotherms are smaller in cold region".

"Human population living near the arctic poles like Inuit, Aleut, Sami individuals are by and large heavier than populaces from mid-scopes is predictable with Bergmann's standard. They additionally will in general have shorter appendages and trunks which approve the Allen's standard (Holliday et al., 2010). Marshall T Newman in his report in the Journal of American Anthropologist in 1953, referenced that Native American populaces are commonly reliable with Bergmann's rule and he likewise included that populaces of Eurasia additionally holds with Bergmann's rule (Marshall, 1953)".

6.4.3 Cope's Rule

"Cope's rule, postulated by the American paleontologist Edward Drinker Cope, states that the lineages of the population tend to increase in body size over evolutionary time i.e bodies get larger over time i.e population genealogies will in general increment in body size over evolutionary time.

6.4.4 Gloger' Rule

"Gloger's Rule states that some insects, birds and mammals in warm humid climates bear dark or pigment than the races of same species present in cool and

dry climates. This phenomenon is known as Gloger rule. It was named after the zoologist Lambert Gloger".

Mammalian species including human additionally demonstrated the inclination to have a darker skin shading living in central and tropical districts. This can be clarified as far as better adjustment against over the top sun based bright (UV) radiations at lower scopes. A few special cases have been seen among Tibetans who have darker skin shading living in the colder locale and in their local scope far away from the equator. This is obviously an adjustment towards the very high UV light because of ice crystal on the Tibetan Plateau (Ember et al., 2001)".

6.4.5 Gause's Hypothesis

"Gause's law or Gause's Hypothesis is often referred to as competitive exclusion principle (Hardin, 1960) or a principle where complete competitors cannot coexist. As indicated by the law two species vieing for a similar asset can't exist together at steady populace esteems, if other biological elements stay consistent or in less difficult terms when two contending species endeavor to involve a similar specialty, just a single result is conceivable; one species will drive out the other. When one animal group increase even the scarcest bit of leeway over different species one will beat the other prompting either the elimination of this contender or build up a developmental or social move toward an alternate biological specialty. Accordingly, the standard can be proposed into "Complete Competitors cannot coexist" (Gause, 1934; Hardin, 1960)".

6.4.6 Dollo's Law

"Dollo's law also called as Dollo's law of irreversibility given by Louis Dollo, This law states that evolution is irreversible it means that once the complex traits is lost than that traits will not revert back "a living being stays away for the indefinite future precisely to a previous state, regardless of whether it winds up put in states of presence indistinguishable from those in which it has lately lived ... it for the most part keeps some trace of the transitional stages through which it has passed (Louis, 1893; Gould, 1970; Goldberg, and Boris, 2008)".

6.4.7 Foster's Rule

"Foster's rule also called as the island rule, or the island effect states little species get bigger, enormous species littler, in the wake of colonizing islands (Juan and Andy, 2004; Jean and Patrick, 2007; Lomolino, 1985). J. Bristol Foster stated rule in the journal Nature, in an article titled "The evolution of mammals on islands"called as Foster's rule (Foster, 1964)".

6.4.8 Hamilton's Rule

Hamilton's rule is a well-known concept in evolutionary biology. It is usually perceived as a statement that makes predictions about natural selection in situations where interactions occur between genetic relatives. Hamilton's rule states that natural selection favours genetic success, not reproductive success *per se*. It recognizes that individuals can pass copies of their genes on to future generations through direct parentage (the rearing of offspring and grand-offspring) as well as indirectly by assisting the reproduction of close relatives (such as nieces and nephews) through altruistic behaviour (behaviour that benefits other

individuals at the expense of the one performing the action) (Queller and Strassman, 2002)".

6.4.9 Hennig's Progression Rule

"Hennig's progression rule states that in cladistics, the crudest species are found in soonest or earliest, focal or central, and part of gathering's territory or group area. This rule was developed and named by Willi Hennig (Centers of Origin, 2016)".

6.4.10 Lack's Principle

David Lack (1954) proposed a principle called "Lack's principle, this principle states that "the clutch or grash size of each species of bird or feathered creature has been altered by common determination to relate with the biggest number of youthful for which the guardians can, on average, by and large, give enough food " (Lack, 1954)".

6.4.11 Rensch's Rule

"Rensch's rule given by Bernhard Rensch in 1950 states that, sexual size dimorphism (SSD) increases with body size (hyperallometry) in taxa in which males are the larger sex and decreases with body size (hypoallometry) in those in which females are larger., (Rensch, 1950)".

6.4.12 Schmalhausen's Law

Ivan Schmalhausen proposed a law called as "Schmalhausen's law (Lewontin, 2000). According to this law, population at breaking point of resistance i.e at limit of tolerance in one angle is helpless against little contrasts in some other perspective or susceptible to little differences in some other viewpoint.

6.4.13 Von Baer's Law

Karl Ernst von Baer gave a law called as "Von's laws. Von Baer's law states that Embryos start from a typical structure i.e common form and form into progressively specific structures or start from a typical structure and form into progressively specific structures, so the enhancement of embryonic structure reflects the ordered and phylogenetic tree. In this way, all animals in a phylum share a near early nascent living being; animals in smaller taxa (classes, orders, families, genera, species) share later and later early stage stages. This was in sharp contrast to the rundown theory of Johann Friedrich Meckel (and later of Ernst Haeckel), which declared that incipient organisms experienced stages taking after grown-up living beings from progressive phases of the scala naturae from evidently most minimal to largest amounts of organisation (Opitz,et.al, 2006; Garstang, 1922)".

6.4.14 Williston's Law

Williston's Law states that parts in a living being gotten diminished in number and had worked in working (Williston, 1914)".

Check Your Progress Exercise 2

3) Write short note on Cope's rule.

.....

.....

.....

.....

.....

4) What is Gause's hypothesis?

.....

.....

.....

.....

.....

5) Write in brief about Dollo's law of irreversibility.

.....

.....

.....

.....

.....

6.5 SUMMARY

Human ecology is the sub discipline of ecology that focuses on humans. It is an interdisciplinary and transdisciplinary study of the relationship between humans and their natural, social, and built environments. Ecology, relatively a new science, deals with the various principles which govern such relationship between organisms and their environment. The term ecology was coined by combining two Greek words, *oikos* (meaning 'house' or 'dwelling place') and *logos* (meaning 'the study of') to denote such relationships between the organism and their environment. Woodbury (1954) treated ecology as "a science which investigates organisms in relation to their environment, and a philosophy in which the world of life is interpreted in terms of natural processes." In Haeckel's definition of ecology, he refers to the "surrounding outer world", which we now call the environment of an organism. Ecology is the science that need minimum time and labour for its introduction to a layman. Ecological studies are made at ecosystem level and it has been one of the most recent developments in ecology, which is generally referred to as the most recent developments in ecology that commonly is referred to as the bioenergetics approach. The recent development in ecological studies has been to undertake besides structure, the similarity and differences in food and energy relationship among living compounds of ecosystem that is generally referred to as the bioenergetics approach in modern ecology. An

ecosystem is overall integration of whole mosaics of interacting organisms and their environment. Adaptations can be classified under the four heads. Several ecologists have tried to explain the interaction between organism and their environment in a different perspective of analysis. In this unit, we had look at some major concepts like Allen's Rule, Bergmann's Rule, Cope's Rule, Gloger' Rule, Gause's Hypothesis, Dollo's Law, Foster's Rule, Hamilton's Rule, Hennig's Progression Rule, Lack's Principle, Rensch's Rule, Schmalhausen's Law, Von Baer's Laws and Williston's Law

6.6 REFERENCES

Allen, J. A. (1877). The influence of Physical conditions in the genesis of species". *Radi. Revi.* 1: 108-140.

Burtt, E. H. Jr.; Ichida, J.M. (2004). "Gloger's Rule, feather-degrading bacteria, and color variation among Song Sparrows" *The Condor* 106 (3): 681–686.

Christensen, V., & Pauly, D. (1992). ECOPATH II—a software for balancing steady-state ecosystem models and calculating network characteristics. *Ecological Modelling*, *61*(3-4), 169-185.

Collin, R., & Miglietta, M. P. (2008). Reversing opinions on Dollo's Law. *Trends in Ecology & Evolution*, *23*(11), 602-609.

Foster, J. B. (1964). Evolution of mammals on islands. *Nature*, *202*(4929), 234-235.

Garstang, W. (1922). The theory of recapitulation: a critical re-statement of the biogenetic law. *Zoological Journal of the Linnean Society*, *35*(232), 81-101.

Gause, G. F. (1934). The struggle for existence. Baltimore: Williams and Wilkins. 163 p.

Gould, S. J. (1970). Dollo on Dollo's law: irreversibility and the status of evolutionary laws. *Journal of the History of Biology*, *3*(2), 189-212

Huggett, R. J. (1999). Ecosphere, biosphere, or Gaia? What to call the global ecosystem: ECOLOGICAL SOUNDING. *Global Ecology and Biogeography: Ecological Surroundings*, *8*(6), 425-431.

Jaiswal, A. (2013). Human Origin and Variation: A Comparative Treatment of Biophysical Anthropology, Heritage Publishers, New Delhi, India.

Jaiswal, A. (2013). Human Genetics and Applied Biophysical Anthropology: A Comparative Treatment of Biophysical Anthropology, Heritage Publishers, New Delhi, India.

Katzmarzyk, P. T.; Leonard, W. R. (1998). "Climatic Influences on Human Body Size and proportions: ecological adaptations and secular trend Am J.Phys. Anthropo: 106(4): 489-503.

Lack, D. (1954). The natural regulation of animal numbers. Clarendon Press, Oxford 1.1:11-15

"Leigh V. V. 2010, Evolutionary theorist and paleobiology pioneer, 1935-2010". University of Chicago, Press. 1,3:104-114.

Lewontin, R., Levins, R. (2000). "Schmalhausen's Law". Capitalism, *Nature*, Socialism. 11 (4): 103–108.

Lindeman, RL (1942). "The trophic-dynamic aspect of ecology". *Ecology* 23: 399–418.

Lomolino, M. V. (1985). Body size of mammals on islands: the island rule reexamined. *The American Naturalist*, *125*(2), 310-316.

Molles M.C (2003) "Ecology: Concepts and Applications" New York: McGraw Hill

6.7 ANSWERS TO CHECK YOUR PROGRESS

1) Human ecology is the sub discipline of ecology that focuses on humans. More broadly, it is an interdisciplinary and transdisciplinary study of the relationship between humans and their natural, social, and built environments. The term 'human ecology' appeared in a 1907 work on sanitary practices in the home and surrounding environments. The term also appeared in a sociological study in 1921 and at times has been equated with geography. The scientific philosophy of human ecology has a diffuse history with advancements in geography, sociology, psychology, anthropology, zoology, family and consumer science, and natural ecology.

2) Ecosystem may be defined as the interrelationships between a biotic community and its physical environment. Again Ecological Niche or Econiche or simply Niche is a distinctive way of life of an organism acquired by the interactions occurring between the organism and its environment, both biotic and abiotic.

3) "Cope's rule, postulated by the American paleontologist Edward Drinker Cope, states that the lineages of the population tend to increase in body size over evolutionary time i.e bodies get larger over time i.e population genealogies will in general increment in body size over evolutionary time.

4) "Gause's law or Gause's Hypothesis is often referred to as competitive exclusion principle (Hardin, 1960) or a principle where complete competitors cannot coexist. As indicated by the law two species vieing for a similar asset can't exist together at steady populace esteems, if other biological elements stay consistent or in less difficult terms when two contending species endeavor to involve a similar specialty, just a single result is conceivable; one species will drive out the other. When one animal groups increase even the scarcest bit of leeway over different species one will beat the other prompting either the elimination of this contender or build up a developmental or social move toward an alternate biological specialty. Accordingly, the standard can be proposed into "Complete Competitors cannot coexist".

5) "Dollo's law also called as Dollo's law of irreversibility given by Louis Dollo, This law states that Evolution is irreversible it means that once the complex traits is lost than that traits will not revert back "a living being stays away for the indefinite future precisely to a previous state, regardless of whether it winds up put in states of presence indistinguishable from those in which it has lately lived ... it for the most part keeps some trace of the transitional stages through which it has passed.

ignou
THE PEOPLE'S
UNIVERSITY