

TOPIC # 6

POPULATION AND POPULATION INTERACTIONS

Motivation

The results of modern biological sciences show the exceptional importance of the population level of the organization as an "elementary unit of the evolutionary process", "the form of existence of a species in a particular ecosystem", "units of rational nature management and management of animal and plant resources", "elementary object of nature protection", "units of structural and genetic biodiversity", etc. All this makes it possible to consider population ecology as a key link in modern evolutionary ecology and a subject of paramount importance in the formation of an ecocentric worldview necessary for the sustainable development of civilization. One of the means of forming ecological thinking and understanding the mechanisms of ecosystem stability is the knowledge of the relationships between individuals of different populations in the biocenosis. V.N. Beklemishev (1951) also noted that "... biocenosis ... is precisely the integration of species populations, not individuals."

The objective: to study the features of the organization and functioning of the population as a key unit of the species and biocenotic levels of the organization of biological systems.

Questions for oral questioning:

1. The concept of population.
2. The main characteristics of populations.
3. The population structure of the species (the degree of isolation of populations, biological, sexual, age, spatial and ethological structure of populations).
4. Population dynamics.
5. Interaction of species populations.

Students' classroom activities:

1. Situational problems. Reference material, tables and recommended literature may be used. The situational problems should be reported in writing.
2. Discussion report prepared by the students on an individual task of a teacher.

Plan of students' independent activities

" _____ " _____ 20 ____ .

Task 1. Choose the correct answer.

1. The most common type of population distribution is ____.

- A) clumped
- B) uniform
- C) random
- D) near-uniform
- E) semi-random

2. ____ is the study of interactions among organisms and between organisms and their environment.

- A) Environmentalism
- B) Demography
- C) Ecology
- D) Biogeography
- E) Paleontology

3. The most common form of population distribution arises from

- A) an uneven distribution of resources.
- B) limited dispersal ability.
- C) asexual reproduction.
- D) efforts to protect from predators.
- E) all of these.

4. What is the interaction between species in which the fitness of one overpowers the presence and fitness of another called?

- a) Competition
- b) Mutualism
- c) Parasitism
- d) Commensalism

5. Who gave the following sentence “Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior will be eliminated eventually”?

- a) Gause’s competitive exclusion principle
- b) Mutation Theory
- c) Theory of Special Creation
- d) Theory of Organic Evolution

6. Where the interference competition does occur directly between individuals?

- a) Two species have a common prey
- b) One individual prevents the reproduction of others
- c) Organism compete for space
- d) Two separate species compete for the same resources and space

7. Where exploitation competition does occur indirectly?

- a) One individual prevents the survival and reproduction of others
- b) Two species have common prey
- c) Two separate species compete for different resources and space
- d) Organisms compete for common space

8. In which two species apparent competition occurs indirectly?

- a) Compete for space
- b) Fight for the same resources and mate
- c) Have a common prey

d) Share the same resources in a territory

9. What is a competition between the individuals of two separate species for sharing the same resources in the same area known?

- a) Apparent competition
- b) Interspecific competition
- c) Interference competition
- d) Intraspecific competition

10. What is a biological interaction between organisms of different species in which each individual receives benefit known?

- a) Parasitism
- b) Competition
- c) Commensalism
- d) Mutualism

11. What happens to two species in mutualism?

- a) Only one is benefited
- b) Both live differently
- c) Both are benefited
- d) Only one is harmed

12. What kind of interaction is mutualism?

- a) Negative Interspecific
- b) Positive Intraspecific
- c) Negative Intraspecific
- d) Positive Interspecific

Task 2. Answer the questions.

1 Question:

Explain why most species with a high capacity for population growth (such as bacteria, flies, and cockroaches) tend to have small individuals, while those with a low capacity for population growth (such as humans, elephants, and whales) tend to have large individuals.

2 Question:

Three different species of animals, baboons, lions, and giraffes, living in a particular ecosystem called Serengeti National Park, constitute a _____.

3 Question:

The maximum rate at which a population could increase under ideal conditions is known as its:

- a) total fertility rate
- b) survivorship
- c) intrinsic rate of increase
- d) doubling time
- e) age structure

4 Question:

What is the difference between population size and population density? How do the different patterns of patterns of population distribution affect size and density?

Population

Population is devised for a given area. It is the group of individuals, of the same species, living and interbreeding in the same area. Population is influenced by both abiotic and biotic factors.

5 Question:

Which of the following is an example of a density-independent factor for population growth?

a. Fire.

b. Predators.

c. Competition for nesting sites.

d. Food availability.

Population:

Population refers to the number of specific organisms living in an area. However, the population of a region is influenced by a number of factors that can be classified as density-dependent or density-independent. These factors are not the only ones affecting a population, however.

6 Question:

How would population decline affect the environment?

Population:

The number of people on earth has doubled in the past 70 years, from about 3 billion in 1950 to over 7 billion today. The population explosion has both costs and benefits.

7 Question:

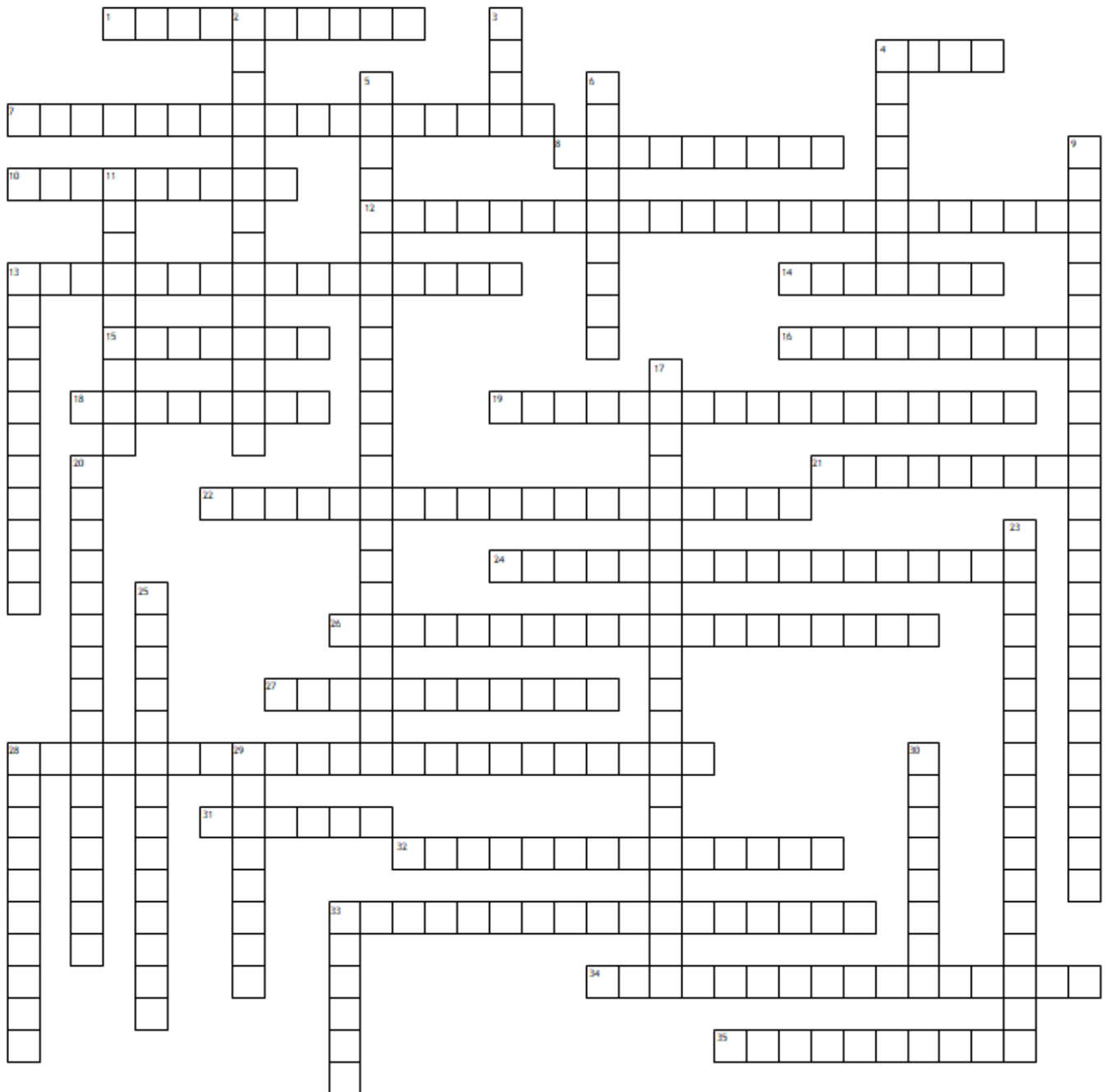
What are the dangers of small populations of a species from a genetic and evolutionary standpoint?

Population Genetics:

Population genetics is a field of study in genetics that deals with genetic variations in a population. It is used to study the differences between individual populations by examining traits like habitat, inherited traits, and adaptations.

Task 3. Population Ecology Crossword Puzzle

Population Ecology Crossword Puzzle



Across

1 A group of individuals of the same species

- that live in the same area at the same time.
- 4 The organism that a predator feeds upon.
 - 7 This term refers to the number of individuals per unit area. (2 words)
 - 8 The interaction between two different organisms in which one captures and feeds upon the other.
 - 10 The number of deaths occurring in a given period of time. (2 words)
 - 12 This term describes the range of area that is inhabited by a population. (2 words)
 - 13 The number of individuals the environment can support over a long period of time. (2 words)
 - 14 This survivorship curve indicates a constant death rate over the organism's life span. (2 words)
 - 15 This survivorship curve indicates a low death rate in the early and middle stages of life, and a high death rate at the later stages of life. (2 words)
 - 16 The study of human populations.
 - 18 An organism that captures, kills, and eats another living organism.
 - 19 This occurs when the members of a population are reproducing at a constant rate. (2 words)
 - 21 This survivorship curve indicates a high death rate among the young. (2 words)
 - 22 This is a graphical representation that shows the population of a country broken down by gender and age group. (3 words)
 - 24 In this type of dispersion, the individuals are clustered together in groups. (2 words)
 - 26 In this type of reproduction, an organism produces all of its offspring in a single event. (3 words)
 - 27 The movement of individuals into a population.
 - 28 A limiting factor that depends on population size. (3 words)
 - 31 This type of curve on a graph represents exponential growth. (2 words)
 - 32 The length of time an individual is expected to live. (2 words)
 - 33 Patterns on a graph that show the likelihood of survival at different ages throughout the lifetime of an organism. (2 words)
 - 34 In this type of dispersion, the location of one individual is independent of the location of the other individuals. (2 words)
 - 35 The movement of individuals out of a population.

Down

- 2 A model of population growth in which growth slows or stops following a period of exponential growth. (2 words)
- 3 The organism that a parasite feeds on is called the _____.
- 4 An organism that lives in or on another living organism.
- 5 A term used to describe a dramatic change in birth and death rates in a country. (2 words)
- 6 The number of births occurring in a given period of time. (2 words)
- 9 A factor that affects all populations in similar ways, regardless of the size of the population. (3 words)
- 11 A space that an animal defends against encroachment by other individuals.
- 13 The interaction that occurs between organisms as they struggle to obtain the same limited resources.
- 17 In this type of reproduction, the organism produces a few offspring each year for several years. (2 words)
- 20 The amount by which a population's size changes in a given time. (2 words)
- 23 In this type of dispersion, individuals are separated by a fairly even distance. (2 words)
- 25 A factor that causes population growth to decrease. (2 words)
- 28 This term refers to the spatial distribution of individuals within the population.
- 29 Death rate and emigration will _____ the size of a population.
- 30 Birth rate and immigration will _____ the size of a population.
- 33 This type of curve on a graph represents logistic growth. (2 words)

Reference information

Term descriptions

Population ecology is a sub-field of ecology that deals with the dynamics of species populations and how these populations interact with the environment.

Term “population” comes from Latin word *populus* (people) and in translation means “population”. Ecologists usually define a population as a group of individuals of a single species inhabiting a specific area. A population of plants or animals might occupy a mountaintop, a river basin, a coastal marsh, or an island, all areas defined by natural boundaries.

Population - this is the group of one species individuals inhabiting certain territory and characterizing by this or other level of genetic information exchange (panmixture), morphobiological type and system of sustainable functional ties.

Ecologists study populations for many reasons. Population studies hold the key to saving endangered species, controlling pest populations, and managing fish and game populations. They also offer clues to understanding and controlling disease epidemics.

According to statistical (in 2023) data on the territory of living Earth Over 8,1 billion people. The largest population of the world is China (1.43 billion people), India (1.42 billion), USA (333 million), Indonesia (282 million), Brazil (213,9 million).

Dynamics of change of the world population was different throughout history humanity. Since the appearance of man on Earth for many thousands of population growth was negligible, then began to rise and now again decreases.

Populations, as groups, have a number of specific features that are not inherent in a single species.

MAIN CHARACTERISTICS OF THE POPULATION:

Abundance: Absolute number of individuals in population. The abundance of an organism, often considered as total population size or the number of organisms in a particular area (density), is one of the basic measures in ecology. Organisms generally are more abundant where conditions are favorable, such as locations with sufficient quantity and quality of food or nutrients, fewer herbivores or predators, fewer competitors, and optimal physical features. The physical features that affect abundance could be substrate type, moisture, light, temperature, pH, salinity, oxygen or CO₂, wind, or currents.

Density of population is the number of individuals per unit area or volume. It is expressed when the size of individuals in the population is relatively uniform.

Fertility (natality) refers to the rate of reproduction or birth per unit time. It is an expression of the production of new individuals in the population by birth, hatching, germination or fission.

Mortality: the number of deaths in a population per unit time. The loss of individuals due to death in a population under given environmental conditions is called mortality. Mortality as well as fertility especially of higher organisms varies widely with age.

Population growth - the difference between fertility and mortality.

Population growth can be either positive or negative.

Growth rate - is the amount or speed of increase in size of population (per unit time).

The population has a certain organization. The distribution of species in the territory, correlation of groups according to sex, age, morphological, physiological, behavioral and genetic characteristics represent **the structure of the population**. It is formed, on the one hand, on the basis of the general biological features of the species, and on the other hand - under the influence of abiotic factors of the environment and populations of other species.

Biological structure of populations

The structure of the population is not stable. Growth and development of organisms, birth of new organisms, death from various causes, changing environmental conditions, increasing or decreasing number of enemies - all these lead to a change in various relations within the population. The direction of further changes in population largely depends on what structure of the population in a given period of time is.

Sexual structure of populations

The sex ratio of species and especially the proportion of proliferative females in the population are of great importance for the further growth of its numbers. The sex ratio in the population is established not only by genetic laws, but also under the influence of the environment. In some species, sex is initially determined not by genetic, but by environmental factors. For example, in the case of red forest ants (*Formica rufa*), the eggs laid at temperatures below +20°C develop males, at a higher level - almost exclusively females. The sex of *Arisaema japonica* plants depends on the accumulation of nutrients in the tubers. Plants with female flowers grow from large tubers, and from small tubers - males.

Age structure

Age distribution is another important characteristic of population, which influences natality and mortality. Mortality usually varies with age, as chances of death are more in early and later periods of life span. Similarly, natality is restricted to certain age groups, as for example, in middle age-groups in higher animals. According to Bodenheimer (1958), the species of a population can be divided into pre-reproductive, reproductive and post-reproductive groups. The species of pre-reproductive group are young, those of reproductive group are mature and those in post-reproductive group are old. The ratio of various age groups in a population determines the reproductive status of the population. Rapidly increasing population contains a large proportion of young species, a stable population shows even distribution of species in reproductive age-group and a declining population contains a large proportion of old species.

The age state of the species is the stage of its ontogeny, at which it is characterized by definite relations with the environment. With age, the requirements of the species to the environment and the resistance to its individual factors naturally change very substantially. At different stages of ontogeny, habitat changes, changes in the type of nutrition, the nature of movement, and the overall activity of organisms can occur. Often the age-related ecological differences within the species are expressed to a much greater extent than the differences between species. For example, grass frogs on land and their tadpoles in water bodies, caterpillars, gnawing leaves, and winged butterflies sucking nectar are just different ontogenetic stages of the same species.

Three ecological age groups can be distinguished in the population:

- ✓ Preproductive
- ✓ Reproductive
- ✓ Post-productive

The duration of these ages in relation to the overall life expectancy varies greatly among different organisms.

In plants, the age structure of the cenopopulation, i.e., the population of a particular phytocenosis, is determined by the ratio of age groups.

For example, trees have both multiple life stages (seed, plant) and age classes within the plant stage (i.e., seedling, sapling, mature tree).

Analysis of the age structure helps to predict the population size during the life of the next generations.

Spatial distribution of populations

Organisms do not occur randomly in space. Any species of plant or animal may be found in some

areas, while they are completely absent from others. Likewise, the individuals of any species are distributed in relation to each other in distinct patterns. The reasons for the readily apparent nonrandomness of the spatial distribution patterns of organisms are numerous, and the patterns result from processes acting throughout the whole life cycle of the organism, and on various spatial scales. Interactions between individuals and across species all take place in space as well as in time, and an understanding of spatial patterns is basic to understanding real- life ecological processes. Indeed, patterns of spatial distribution play an important role in shaping a wide range of ecological dynamics, such as intra- and interspecific competition, mating systems, predation, population genetics, and the spread of contagious diseases.

While there are few environments on earth without life, no single species can tolerate the full range of earth's environments. For each species, some environments are too warm, too cold, too saline, or unsuitable in other ways. At some point, the metabolic costs of compensating for environmental variation may take up too much of an organism's energy budget. Partly because of these energy constraints, the physical environment places limits on the distributions of populations. The environmental limits of a species are related to its niche. To the ecologist, the niche summarizes the environmental factors that influence the growth, survival, and reproduction of a species. In other words, a species' niche consists of all the factors necessary for its existence — approximately when, where, and how a species makes its living.

Three basic patterns of distribution: random, regular, or clumped.

A random distribution is one in which individuals within a population have an equal chance of living anywhere within an area.

A regular distribution is one in which individuals are uniformly spaced.

In a clumped distribution, individuals have a much higher probability of being found in some areas than in others (fig. 1).

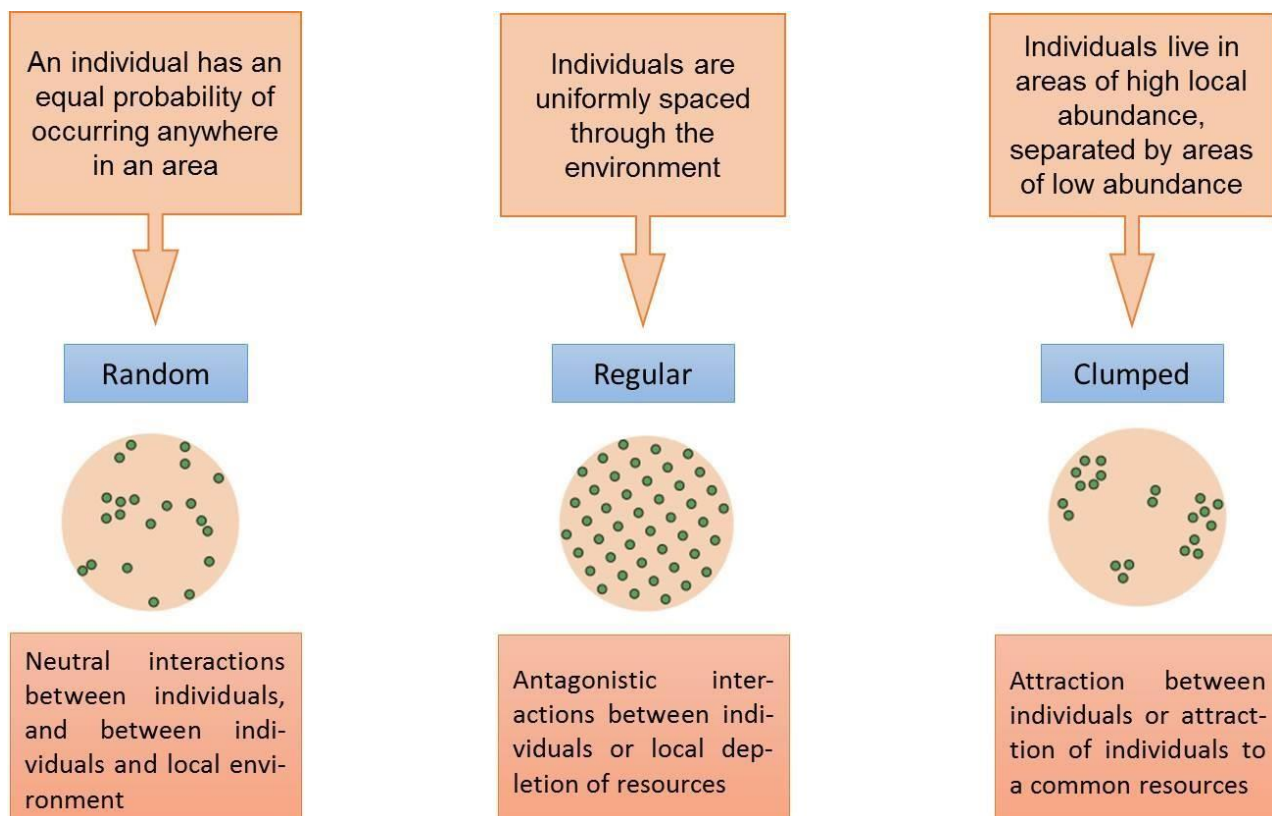


Figure 1 - Spatial distribution of populations

These three basic patterns of distribution are produced by the kinds of interactions that take place between individuals within a population, by the structure of the physical environment, or by a combination of interactions and environmental structure. Individuals within a population may attract each

other, repel each other, or ignore each other. Mutual attraction creates clumped, or aggregated, patterns of distribution. An environment with patchy distributions of nutrients, nesting sites, water, and so forth fosters clumped distribution patterns. An environment with a fairly uniform distribution of resources and frequent, random patterns of disturbance (or mixing) tends to reinforce random or regular distributions.

Ethological structure of populations

The ethological or behavioral structure of the population is the system of relationships between members of one population.

Behavior of animals in relation to other members of the population depends primarily on whether a single or group way of life is peculiar to the species. The forms of joint existence of species in the population are extremely different.

A single way of life, at which the species of a population are independent and separate from each other, is typical for many species, but only at certain stages of the life cycle. Completely solitary existence of organisms in nature does not occur, since in this case it would be impossible to carry out their basic life function - reproduction. However, some species are characterized by very weak contacts between cohabiting individuals. These are, in particular, individual aquatic inhabitants with an external method of fertilization, in which there is no need to directly meet partners, for example, single actinia.

Family way of life. In the family way of life, the ties between parents and their generation are strengthened. The simplest kind of such connection is the care of one of the parents about the laying eggs: protection of the egg laying, incubation, additional aerating, etc.

In the family way of life the territorial behavior of animals is obviously expressed: various signals, marking, ritual forms of threat and direct aggression ensure possession of a site sufficient for rearing generation.

The larger groups of animals are flocks, herds and colonies. At the heart of their formation lies the further complication of behavioral links in populations.

Colonies. These are group settlements of sedentary animals. They can exist for a long time or arise only for the period of reproduction, as, for example, with many birds - rooks, gulls, loons, puffins, etc. The complexity of the interrelationships between species of the colony of animals is extremely varied - from simple territorial aggregations of single forms to associations, where individual members perform, as organs in a coherent organism, different functions of species life.

The most complex colonies of social insects - termites, ants, bees. They arise on the basis of a greatly expanding family. In such colonies-families

insects perform together most of the basic functions: reproduction, protection, provision of food for themselves and their generation, construction, etc.

Flocks (shoals, packs). These are temporary associations of animals that exhibit a biologically useful organization of actions. Flocks facilitate the performance of any function in the life of the species: protection from enemies, getting food, migration. The aggregating behavior is common among birds and fish, as for mammals it is common for many canids. Imitative reactions and orientation toward neighbors are highly developed in the flocks.

Herds. These are longer and more permanent animal associations than flocks. In herd groups, as a rule, all the basic functions of the life of the species are realized: foraging, protection from predators, migration, reproduction, rearing of young animals, etc. The basis of group behavior of animals in herds is the relationship of dominance-subordination based on individual differences between species.

Optimization of physiological processes leading to viability increase in the joint existence, was

called the effect of the group. Life in the group through the nervous and hormonal systems is reflected in the course of many physiological processes in the animal's body. Isolated species have changes in metabolic rate, faster usage of reserve substances, viability decrease; they haven't a number of instincts.

Population Dynamics

In nature populations are in continuous flux and their patterns of distribution and abundance result from a dynamic balance between factors that add species to populations, and factors that remove species from populations.

The dynamic population processes underlying distribution and abundance are the subject of ecology population dynamics, which is concerned with the factors influencing the expansion, decline, or maintenance of populations.

General changes in population size are due to four phenomena: fertility, mortality, immigration and emigration of species.

The distinction is made between the absolute and specific fertility. The first one is characterized by the total number of born species. For example, if in a reindeer population of 16,000 animals, 2,000 deer appeared during the year, this number also expresses the absolute fertility. The specific one is calculated as the average change in the number of species per specific time interval (in this case, it is one newborn per 8 members of the population for the year).

The size of the fertility depends on many factors. Great importance is given to the proportion of species capable to reproduction at a given period that is determined by the ratio of sexes and age groups.

Mortality in populations also depends on many factors: the genetically programmed life expectancy of species, their genetic and physiological usefulness, the impact of unfavorable physical conditions of the environment, the impact of predators, parasites, diseases, etc. These factors are different at different stages of the life cycle of each generation.

Emigration: It is one way movement of species out of the population. This movement is permanent and causes spread of a species to new areas. Emigration under natural conditions occurs when there is overcrowding in the population and is generally regarded as an adaptive behaviour that regulates the population on a particular site and prevents over-exploitation of the habitat.

This type of dispersal offers new opportunity to the species of a population to interbreed with those of the other population leading to more genetic heterozygosity and adaptability.

Immigration: This is one way movement of species into the population. It leads to rise in density of population. It may result in decreased mortality among the immigrants or decreased reproductive capacity of the species.

There are two fundamentally different aspects of population dynamics: modification and regulation.

Modification is a random deviation of numbers resulting from a variety of factors not related to population density.

Regulation is the return of population after deviation to the initial state, which occurs under the influence of factors determined by population density.

Modifying factors, causing changes in the number of populations, do not themselves experience the impact of these changes. Thus their action is one-sided. These factors include all the abiotic influences of the environment on organisms, the quality and quantity of their food, etc.

Favorable weather conditions can cause a massive outbreak of species reproduction and overpopulation of the territory occupied by it, as, for example, in the case of herd locusts. The negative impact of modifying factors, on the contrary, reduces the population size sometimes to its complete disappearance.

Regulatory factors do not simply change the population size, but smooth out its fluctuations,

bringing after regular deviation from the optimum to the previous level. This happens because the effect of their impact is more stronger if population density is higher. The regulatory forces are inter-specific and intraspecific interactions of organisms.

The study of factors that affect growth, stability and decline of populations is population dynamics.

All populations undergo three distinct phases of their life cycle:

- growth;
- stability;
- decline.

Population growth occurs when available resources exceed the number of species able to exploit them. Reproduction is rapid, and death rates are

low, producing net increase in the population size. Population stability is often preceded by «crash» since the growing population eventually outstrips its available resources. Stability is usually the longest phase of population's life cycle. Decline is the decrease in the number of species in population, and eventually leads to population extinction. Nearly all populations will tend to grow exponentially as long as there are resources available. Most populations have the potential to expand at an exponential rate, since reproduction is generally a multiplicative process.

Two of the most basic factors that affect the rate of population growth are the birth rate, and the death rate. The intrinsic rate of increase is the birth rate minus the death rate.

Two modes of population growth (fig. 2).

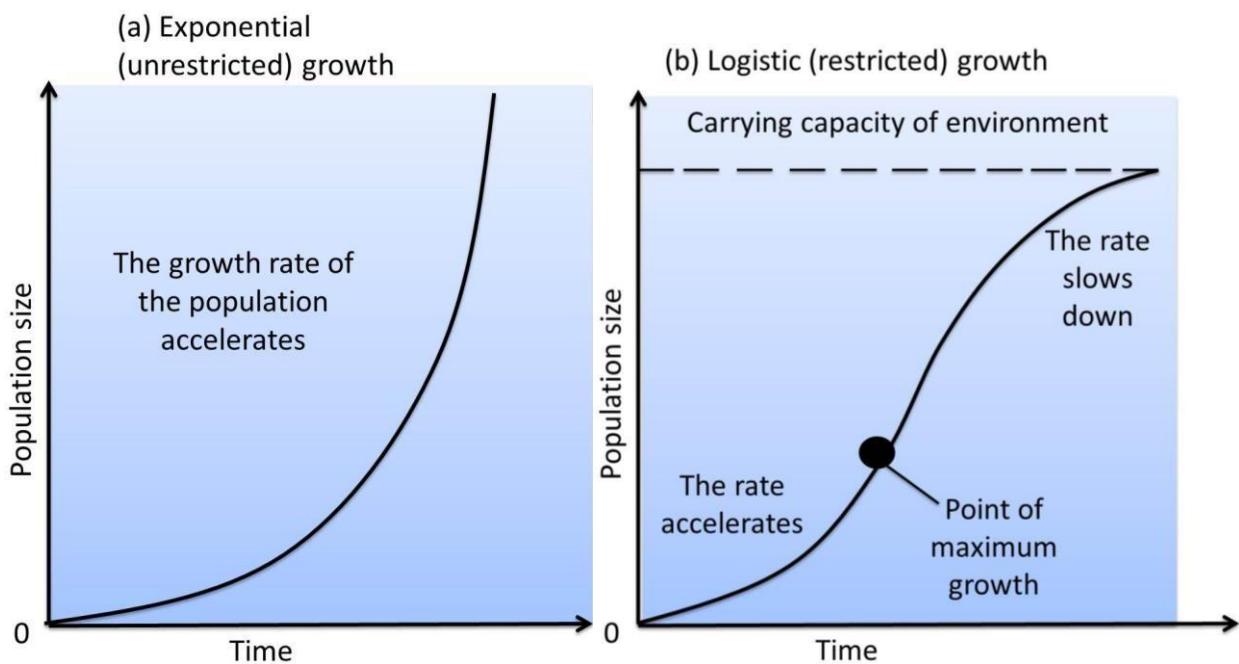


Figure 2 - Population growth

The Exponential curve (also known as a J-curve) occurs when there is no limit to population size. The Logistic curve (also known as an S-curve) shows the effect of a limiting factor (in this case the carrying capacity of the environment).

The environment is the ultimate cause of population stabilization.

Two categories of factors are commonly used: **physical environment** and **biological environment**.

Three subdivisions of the biological environment are competition, predation, and symbiosis.

Physical environment factors include food, shelter, water supply, space availability, and (for plants) soil and light.

One of these factors may severely limit population size, even if the others are not as constrained.

The Law of the Minimum states that population growth is limited by the resource in the shortest supply.

Extinction is the elimination of all individuals in a group. **Local extinction** is the loss of all individuals in a population. **Species extinction** occurs when all members of a species and its component populations go extinct.

Scientists estimate that 99 % of all species that ever existed are now extinct.

The ultimate cause of decline and extinction is environmental change.

Changes in one of the physical factors of the environment may cause the decline and extinction; likewise the fossil record indicates that some extinctions are caused by migration of a competitor. Dramatic declines in human population happen periodically in response to an infectious disease. Bubonic plague infections killed half of Europe's population between 1346 and 1350, later plagues until 1700 killed one quarter of the European populace. Smallpox and other diseases decimated indigenous populations in North and South America. Human populations have continued to increase, due to use of technology that has disrupted natural populations.

Destabilization of populations leads to possible outcomes:

—population growth as previous limits are removed;

— population decline as new limits are imposed.

Agriculture and animal domestication are examples of population increase of favored organisms.

Interactions Between Populations

The traditional approach to population interactions has been to consider just the direct pairwise interactions. In this simplistic view of things, two populations may or may not affect each other; if they do, the influence may be beneficial or adverse. By designating a detrimental effect with a minus, no effect with a zero, and a beneficial effect with a plus, all possible population interactions can be conveniently classified. When neither of two populations affects the other, the interaction is designated as (0, 0). Similarly, a mutually beneficial relationship is (+, +) and a mutually detrimental one is (–, –). Other possible interactions are (+, –), (–, 0), and (+, 0), making a total of six fundamentally different ways in which populations can interact (Table 11.1).

Table 11.1 Summary of Direct Pairwise

Interactions Between Two Populations		
Species		
Type of Interaction	A B	Nature of Interaction
Competition	– –	Each population inhibits the other

Predation, parasitism, and Batesian mimicry	+ -	Population A, the predator, parasite, or mimic, kills or exploits members of population B, the prey, host, or model
Mutualism, Müllerian mimicry	+ +	Interaction is favorable to both (can be obligatory or facultative)
Commensalism	+ 0	Population A, the commensal, benefits whereas B, the host, is not affected
Amensalism	- 0	Population A is inhibited, but B is unaffected
Neutralism	0 0	Neither party affects the other

Competition (–, –) takes place when each of two populations affects the other adversely. Typically, both require the same resource(s) that is (are) in short supply; the presence of each population inhibits the other. If the resource is another population (a prey species), competition is indirect and mediated by means of resource depression — this type of competition is termed **exploitation competition**. Other kinds of competition also occur. For example, competition can also be direct, as in agonistic encounters such as allelopathy or interspecific territoriality (known as **interference competition**). Predation (+, –) occurs when one population affects another adversely but benefits itself from the interaction. Usually a predator kills its prey and consumes part or all of the prey organism. (Exceptions include lizards losing their tails to predators and plants losing their leaves to herbivores.) Parasitism (+, –) is essentially identical to predation, except that the host (a member of the population being adversely affected) is usually not killed outright but is exploited over some period of time. Thus, parasitism can in some ways be considered as a “weak” form of predation; Batesian mimicry and herbivory could be placed here. Interactions that benefit both populations (+, +) are classified as mutualisms. In some mutualisms, the association is obligatory (neither population can exist without the other), but in others the interaction is facultative because it is not an essential condition for survival of either population (Müllerian mimicry). When one population benefits while the other is unaffected, the relationship is termed commensalism (+, 0). Amensalism (–, 0) is said to occur when one population is affected adversely by another but the second is unaffected. Neutralism (0, 0) occurs when the two populations do not interact and neither affects the other in any way whatsoever; it is thus of little ecological interest. True neutralism is likely to be very rare or even nonexistent in nature because there are probably indirect interactions between all the populations in any given ecosystem, although their significance may be minimal.

Three of the six population interactions, competition, predation, and mutualism, are of overwhelming importance; an entire chapter is devoted to competition and another to predation. Mutualisms are considered later in this chapter.

Mutualistic Interactions and Symbiotic Relationships

Symbiosis means “living together.” Usually the term is used only to describe pairs of organisms that live together without harming one another, thereby excluding parasitism (+, –) and amensalism (–, 0), in which one party is affected adversely. Hence, symbiotic

relationships include mutualism (+, +), commensalism (+, 0), and neutralism (0, 0). Obligate mutualisms can be distinguished from facultative ones. As pointed out before, these various types of interactions can change in evolutionary time and grade into one another.

Although mutualism is a symmetric relationship, there may nevertheless usually be an asymmetry in costs versus benefits to each of the parties concerned (a conflict of interests arises even in mutualistic relationships!). Mutualisms may evolve from parasitic relationships.

Commensalism occurs when one population is benefited but the other is unaffected (+, 0). Small epiphytes such as bromeliads and orchids, which grow on the surfaces of large trees without obvious detriment to the tree, might be an example. A well-documented case of commensalism is the association between cattle egrets and cattle. These egrets follow cattle that are grazing in the sun and capture prey (crickets, grasshoppers, flies, beetles, lizards, frogs) that move as cattle approach. The number of cattle egrets associated with cattle is strongly dependent on the activities of the cattle; thus, Heatwole observed fewer egrets than expected on a random basis near resting cattle, but nearly twice as many egrets as expected (if the association were entirely random) accompanied cattle that were actively grazing in the sun. Since the birds seldom take prey (such as ticks and other ectoparasites) directly from the bodies of the cattle, the mammals probably benefit little from their relationship with egrets. Moreover, egret feeding rates and feeding efficiency are markedly higher when these birds are associated with cattle.