

## UNIT V: Reproductive Behaviour

### Evolution of Sex

- Life originated without sex. So, sexual reproduction is something that had to evolve.
- Sexual reproduction is the production of haploid gametes by meiosis
- The fusion of these gametes produces a Zygote.
- It restores the full diploid complement of chromosomes.
- The evolution of sexual reproduction how sexually reproducing animals, plants, fungi and protists evolved from common ancestor.
- The first eukaryotes to engage in sex were Single-celled protists.
- These bacteria engaged in genetic exchange via processes conjugation, transformation and transduction.

There are two parts to the evolution of sex:

1. Origin of sexual reproduction
2. Evolution of sexual reproduction and recombination

#### 1. Origin of Sex

- Many single-celled organisms reproduce asexually.
- Asexual reproduction is the formation of new individuals from the cells of only one parent.
- They reproduce without gamete formation or fertilization.
- Asexual reproduction does not require the mating of an egg-producing parent and a sperm-producing parent.
- A single parent is required.
- Sporulation is one method of asexual reproduction.
- Sporulation is the formation of spores.

- A spore is a reproductive cell that produces a new organism without fertilization.
- Budding is a common form of asexual reproduction.

## **Evolution of Sexual Reproduction**

The following are the evolutionary theories on sex:

1. Lottery principle
2. Tangled bank hypothesis
3. Red queen hypothesis
4. DNA repair hypothesis.

### **1. Lottery Principle**

- The Lottery Principle was first suggested by an American biologist, George C Williams.
- Williams' idea was that sexual reproduction introduced genetic variety to enable genes to survive in changing or novel environments.
- He used the lottery analogy.

The lottery analogy is to get across the concept that:

- Asexual reproduction would be like buying a large number of tickets with the same number.
- Sexual reproduction would be like buying a small number of tickets, but each of them with a different number.

### **2. Tangled Bank Hypothesis**

- The tangled bank hypothesis suggests that sex evolved in order to prepare offspring to survive in the complicated world around them.
- The term "tangled bank" comes from the last paragraph of Darwin's 'Origin of Species'.
- In his book, he refers to a wide assortment of creatures all competing (or light and food on a 'tangled bank'.

### **3. Red Queen Hypothesis**

- Red queen hypothesis is also referred to as Red Queen 's, red Queen 's, race or the Red Queen effect.
- Red queen hypothesis was first suggested by Leigh Van Valen.
- It is an evolutionary hypothesis.
- It states that organisms must constantly adapt, evolve and proliferate, not merely to gain reproductive advantage but also simply to survive.

The hypothesis intends to explain two different phenomena:

1. Constant extinction rates by co-evolution between competing species
2. Advantage of sexual reproduction at the level of individuals.

### **4. DNA Repair Hypothesis**

- DNA repair hypothesis attempts to explain why sex exists now.
- It does not address the origin of sex.
- It explains something that already exists, but it is entirely based on another feature to develop a theory to explain how that specific phenomenon came into being.
- DNA can be damaged in two ways.
- Ionizing radiation or mutagenic chemicals Mutations
- Ionizing radiation or mutagenic chemicals alter the genetic code.

- Mutations occur via errors during the replication process.
- Most mutations are deleterious.
- Factors involved in Evolution of Sex

The following factors are involved in the evolution of sex:

- 1. Sex evolves when selection changes over time.

- 2. Sex evolves when selection changes over space.
- 3. Sex evolves when organisms are less adapted to their environment.
- 4. Sex evolves when populations are finite.

### **Reproductive Strategies**

- Reproductive strategy refers to the way in which an animal mates raises offspring.
  - Reproductive strategies are structural, functional and behavioural adaptations.
  - These adaptations improve the chances of fertilization.
  - Animal reproduction is essential for the survival of a species.
  - Reproduction is the biological process by which new offsprings produced from their parents.
  - Each individual organism exists as the result of reproduction.
- The known methods of reproduction are grouped into two main types:

1. Asexual reproduction
2. Sexual reproduction

#### **1. Asexual Reproduction**

- Asexual reproduction is a type of reproduction by which offspring arises from a single organism
- It occurs by means of mitosis.
- Offspring inherit only the genes of one parent.
- It does not involve the fusion of gametes and never changes the number of chromosomes.
- This type of reproduction occurs in prokaryotic micro-organisms (bacteria) and in some eukaryotic single-celled and multi-celled organisms.

The types of asexual reproduction are as follows:

1. Binary fission
2. Budding
3. Fragmentation
4. Parthenogenesis

#### **1. Binary Fission**

- Binary fission is the process, in which a parent cell splits into two daughter cells of approximately equal size.
- Some unicellular eukaryotic organisms undergo binary fission by mitosis.
- In other organisms, part of the individual separates, forming a second individual.
- This process occurs in many asteroid echinoderms through splitting of the central disk.
- Some sea anemones and coral polyps also reproduce through fission.

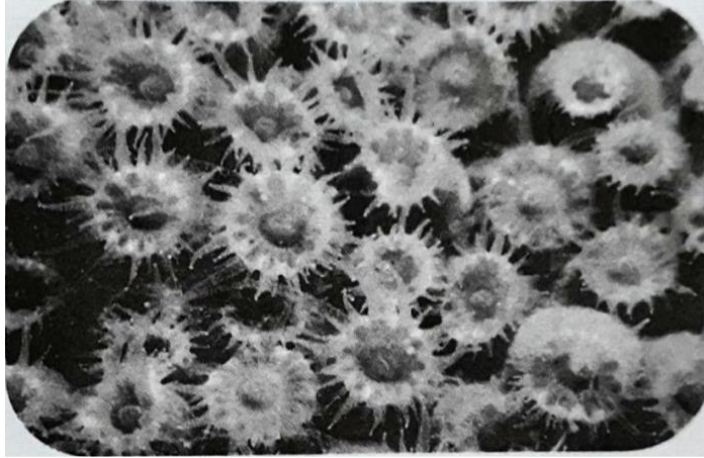


Fig: Coral polyps reproduce asexually by binary fission

## 2. Budding

- Budding is a means of asexual reproduction, whereby a new individual develops from an outgrowth of a parent, splits off and lives independently.
- Budding occurs commonly in some invertebrate animals such as corals and hydras.

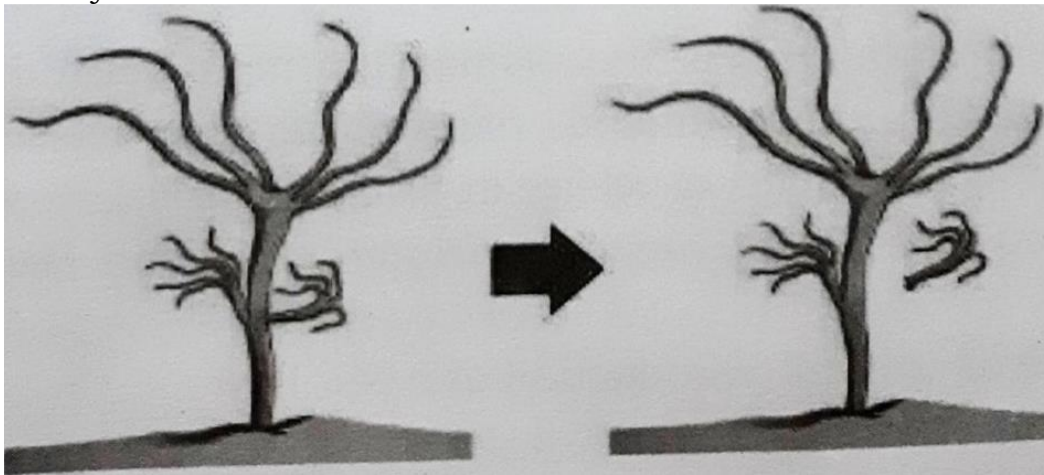


Fig :Hydra reproduces asexually through budding

## 3. Fragmentation

- Fragmentation is a form of asexual reproduction, where a new organism grows from fragment of the parent.
- Each fragment develops into a mature, fully grown individual.
- Many sea stars reproduce asexually by fragmentation.

Eg. If the arm of an individual sea star is broken off, it will regenerate a new sea star.

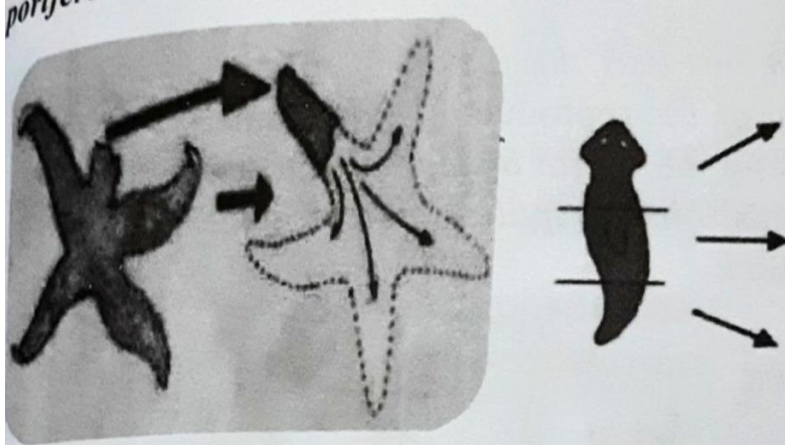


Fig: Starfish fragmentation

#### 4. Parthenogenesis

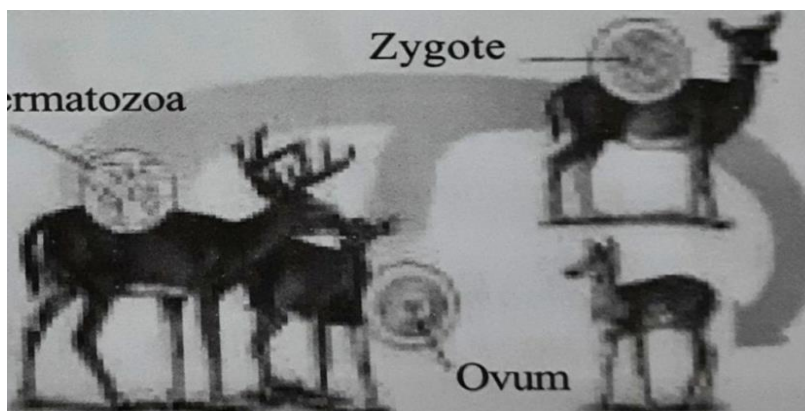
- Parthenogenesis is a form of agamogenesis, in which an unfertilized egg develops into a new individual
- Parthenogenesis occurs naturally in many plants, invertebrates (water fleas, rotifers, aphids, stick insects, some ants, bees and parasitic wasps) and vertebrates (some reptiles, amphibians, rarely birds).

#### 2. Sexual Reproduction

- Sexual reproduction is the process in which new organisms are created, by combining the genetic information from two individuals of different sexes.
- It occurs by means of meiosis.
- This type of reproduction occurs in fish, mammals, amphibian% birds, reptiles, insects and crustaceans.
- It occurs by the following by two ways:
  1. Internal fertilization
  2. External fertilization

#### 1. Internal Fertilization

- Internal fertilization involves the fusion of the male and female gametes inside the body of the reproducing individuals.
- The egg is fertilized by the sperm inside the female.
- It occurs in mammals, birds, reptiles, insects, spiders, etc. Internal Fertilisation



Male                  Female  
 Fig:1 internal fertilization in deer

**2. External Fertilization**

- External fertilization involves the fusion of the male and female gametes outside the bodies of the reproducing individuals.
- The egg is fertilized by sperm outside the female.
- The female lays the eggs and then the male fertilizes them. It occurs in fish and some amphibians.

**Mating System**

- Mating system refers to the way in which individuals are grouped in relation to mating and / or characteristics of male acquisition and mating behaviour.
- It is a way in which a group is structured in relation to mating.
- Animal mating systems are highly variable within and between taxonomic groups.
- They are dynamic and change through time.
- Mating systems are influenced by many factors.

The factors include the following:

- Spatial and temporal distribution of sexually receptive males and females.
- Resource availability and distribution
- Life history of animals male and female.
- Sexual selection
- Parental care.

**Types of Mating System**

The types of mating system are as follows:

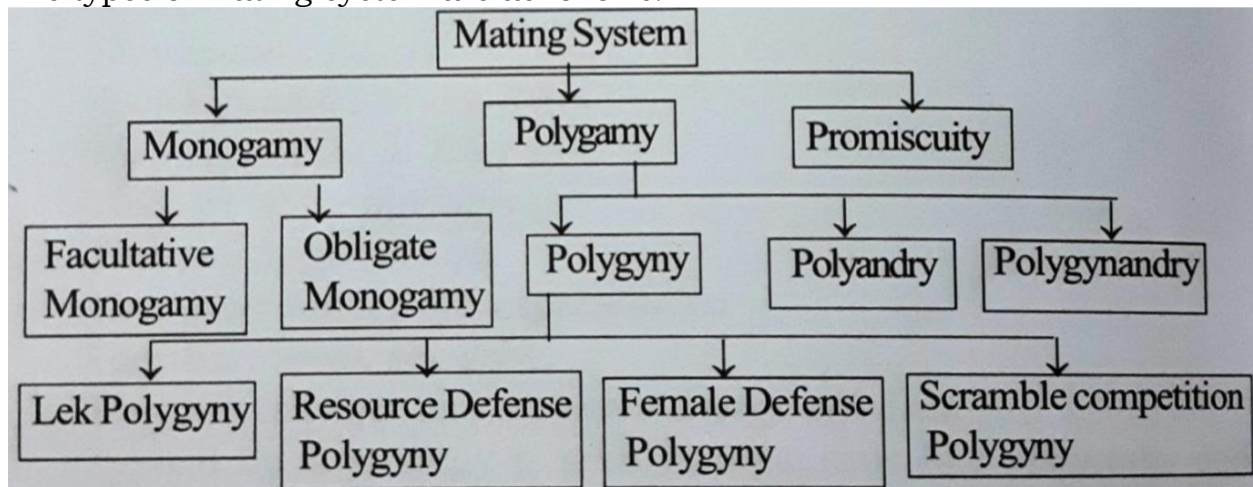


Fig: Types of mating system



1. Monogamy
2. Polygamy
3. Promiscuity

### 1. Monogamy

- Monogamy is a mating system in which a male and a female mate themselves only.
- Monogamy comes from a Greek word "mono" means and "gamy" refer to number of partners or characteristics of gametes.
- It is one male and one female have an exclusive mating.
- The key factor of monogamous pairing is group living.
- It is common in birds.

There are two types of monogamy:

1. Facultative monogamy
2. Obligate monogamy

#### 1. Facultative Monogamy

- Facultative monogamy is also called Type I monogamy.
- It occurs when the male is not fully committed to one female.
- But, he chooses to stay with her because there are no other mating opportunities available to him.
- It occurs because of low density.

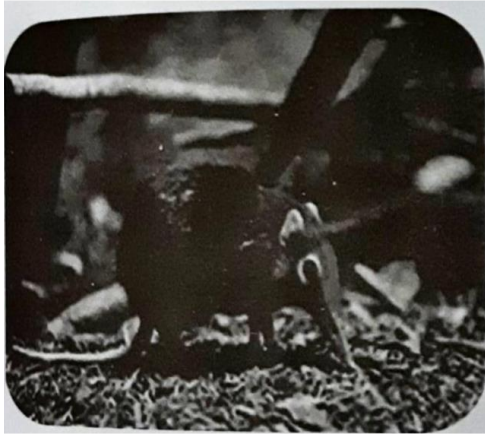


Fig: Elephant shrew



Fig:Agouti

- The species rarely spend time with their families.
- There is a lack of paternal care for the offspring.
- Elephant shrews, Agoutis, Grey duikers and Pacaranas are the most common examples of facultative monogamous animals.

#### 2. Obligate Monogamy

- Obligate monogamy is also called Type II monogamy
- It is practiced by species that live in overlapping territories
- It occurs females cannot rear their young without the help of their partners.





Fig. 106.4: Indri Fig. 106.5:African dormice

- Animals such as Indris, Night monkeys, African dormice and are the examples of obligate monogamous animals.

The factors associated with Type II monogamy are as follows:

- High paternal investment
- Delayed sexual maturation in juveniles
- Juveniles contributing greatly to the rearing of their sibling

## 2. Polygamy

- Polygamy is a mating system in which the animals in a mate with multiple partners.
- The term polygamy comes from a Greek word "poly" means many and "gamy" refer to number of partners or characteristics of gametes.
- In polygamy, a male or female animal mates with many partners.

## Social behaviour: Aggregation

- Aggregation is any form of gathering of organisms and the process of coming together.
- Aggregation is also called group formation.
- It is the widespread phenomena in animal groups.
- It represents a collective dynamic response to environmental conditions.

Animals may aggregate by the following ways:

- \* Mutual attraction to each other
- \* Mutual attraction to limited resources.

- In some cases, more than one mechanism of attraction is involved. Eg. Bark beetles form large aggregations by mutual attraction to the bark of a fallen log and also to the odours of other members of their species.
- Some aggregations are based on mating.
- Aggregation based on mating includes the following:
  - Explosive breeding assemblages of frogs and toads.
  - Aggregations of male birds and mammals at leks.
  - Insect aggregations including bees and wasps, flies and butterflies.

- Aggregation helps the young to learn the following:
  - \* Correct mate recognition skills
  - \* Necessary social skills
  - \* Traditional foraging techniques

### **Types of Aggregation**

There are two types of aggregations, namely

1. Temporary aggregation
2. Permanent aggregation

#### **1. Temporary Aggregation**

- In temporary aggregation, animals live in a group temporarily either at the time of breeding, migration or hibernation.
- It is the simplest kind of animal society.
- It occurs widely in the animal kingdom.
- It was studied by W.C. Allee.
- It is based on shelter or comfort-seeking behaviour, sexual behaviour.
- Locusts and many solitary birds form large groups during migration.

#### **Advantages of Aggregation:**

1. Aggregation helps to find mate•.
2. It provides protection from predators.
3. It helps to locate food.
4. It helps in the transmission of information.
5. It provides thermoregulation.
6. Animals conserve heat by huddling together.
7. It reduces predation risk.
8. It increases the chances of survival
9. It decreases individual displacement enero,
10. Fecundity and fertility are high.
11. It maintains social bonds in large group.
12. It protects against climatic adversities.
13. It increases movement efficiency.

#### **Disadvantages of Aggregation**

The following are the disadvantages of aggregation

1. Aggregation increases competition.
2. Conflict between sub-groups within the larger pup.
3. Fewer defenses against predators.
4. It increases risk of infection.
5. Exploitation by other animals.

### **Schooling in Fish**

- Schooling in fish is the aggregation, staying and swimming together the same direction in a coordinated manner.
- Schooling is a kind of collective animal behaviour of fish.
- Schooling behaviour is a trade-off between the anti-predator and the costs of increased competition for food.
- Fish Schools are the best example of aggregation in animals.
- Schools are groups of fish that act as a single unit.
- They are characterized by a streamlined structure.
- It ranges from few fishes to thousands of fishes.

### **Schooling in Forage Fish**

- Forage fish are small fish which are preyed on by larger fish, seabirds and marine mammals.
- Small fish form schools.
- They swim with their mouths open to filter feed on plankton.
- These schools are extremely large.
- They move along the coastlines.
- Herrings have excellent hearing.
- Herring schools react very fast to a predator.
- They keep a certain distance from a moving scuba diver or cruising like a killer whale.

- Many species of large predatory fish also school.

### **Factors For Schooling**

The following are the factors for swimming in a school:

1. Fish feels safer from predators when in group.
2. Higher chance of finding food.
3. Easier to find a mate while in schools.
4. Higher hydrodynamic efficiency while swimming long distance.

### **Benefits**

The following are the benefits of schooling in fish:

1. Schooling helps the fish to escape from predators.
2. It helps the fish to find food.
3. It helps the fish to find mate.
4. The schools help the fish to swim faster than a lone fish.
5. Fish can better defend their territory in a group.
6. It reduces friction.
7. It allows fish to conserve energy while swimming.
8. It helps in foraging.

### **Flocking in Birds**

- Flocking is the aggregation of birds in an area to live, travel, or feed together
- The word flock refers to a group of birds that have congregated together.
- Many birds fly in flocks.
- It may be very coordinated (Eg. Shore birds) or very loose (Eg. sparrows, robins).
- The birds are more or less coordinated in one or more flight parameters.
- The flight parameters are timing, spacing, velocity, flight direction etc.
- Many bird-species are gregarious and form flocks for different reasons
- Flocks may be of different sizes.

### **Reasons for Flocking**

The following are the reasons for flocking:

1. Reproduction
2. Protection from predators
3. Communication
4. Navigation
5. Territoriality
6. Foraging
7. Scoping out nesting sites and mates

8. Roosting
9. Migration

### **Flocking Rules**

The basic models of flocking behaviour are controlled by three simple rules:

1. Separation - avoid crowding neighbours
2. Alignment - steer towards average heading of neighbours
3. Cohesion - steer towards average position of neighbours.

With these three simple rules, the flock moves in an extremely realistic way, creating complex motion and interaction.

### **Flocking in V-shape**

- Some birds such as swans, geese, cranes, pelicans and flamingos form tight, V-shaped patterns.
- V-shaped formations help birds conserve energy.
- It also enhances communication and coordination within the flock
- This allows birds to improve orientation and follow their route more directly.

### **Advantages**

The following are the advantages of flocking:

1. Flocking helps in foraging.
2. It helps in predator detection.
3. It increases the selection of mates.
4. It protects the birds from the predators.
5. It helps to use the surrounding air in the most energy efficient way.
6. It shares the benefit of communal warmth to survive severely cold temperatures.
7. It helps to raise families.

### **Disadvantages**

The disadvantages of flocking are as follows:

1. Flocking attracts the predators.
2. There is a competition for food and mates.
3. It increases the risk of disease transmission

### **Herding in Mammals**

- Herding is the process of bringing individual animals together into a group (herd), maintaining the group and moving the group from place to place.
- Herding is the practice of caring for roaming groups of livestock over a large area.

- It was developed about 10,000 years ago.
- It is the collective animal behaviour.

The herd may be formed by two ways:

1. Herd formed by natural by wild animals.
  2. Herd formed by human intervention- domestic animals like cattle.
- Some animals instinctively gather together as a herd.
  - Herd is a large group of mammals, living and feeding together.  
Eg. A group of cattle, sheep, etc.
  - Goats, Sheep and Llamas live in herds for their protection.
  - Herding is used in agriculture to manage domesticated animals.
  - Herding can be performed by people or trained animals.

Eg. Herding dogs control the movement of livestock that are under the direction of a person.

- Predators such as lions, wolves and coyotes pose major risks to domestic herds.
- Herders provide protection for the animals.
- Herders also keep the herd together.
- They guide the herd towards the most fertile grassland.
- Herders often specialize in a particular type of livestock.

Mass Behaviours in a Herd

- The individual animals in the herd copy or imitate the behaviour of the other animals in the herd.
- As a result, all the herd members behave in a related fashion.
- This allows the entire herd to respond to an external circumstance in a similar way.
- The herd, then functions together as a single entity.

Types of Herding Types of herding are as follows:

1. Nomadic herding
2. Semi-nomadic herding
3. Transhumance
4. Ranches

### **1. Nomadic Herding**

- Nomadic herding is a type of farming in which herdsmen move from place to place with their animals (herds) of sheep, camel, yak and goats in search of fodder and water along defined routes.
- It is the most ancient form of herding.
- It is practiced in the semi-arid and arid regions of Sahara, Central Asia and some parts of India like Rajasthan and Jammu and Kashmir
- The nomads move from place to place due to the restraints of the climate and land.
- Sheep, camel, yak and goats are most commonly reared by the nomads.
- These animals provide milk, meat, wool, hides and other products to the herders and their families.

## **2. Semi-Nomadic Herding**

- Semi-nomadic herders live a more settled life than the nomads.
- They still follow their herds for long periods of time.
- They traditionally herd sheep, goats, horses and Bactrian camels



### **3. Transhumance**

- Transhumance is the seasonal movement of livestock from one grazing land to another grazing land.
  - Transhumance herders follow a seasonal migration pattern.
4. Ranches
- A ranch is a large farm used for raising animals, especially cattle, horses or sheep.
  - Most large-scale livestock herds live on ranches.
  - Ranching involves raising livestock on a single, large tract of land,

### **Benefits**

1. The herd provides companionship to the members.
2. It provides protection to the members,
3. It provides better foraging opportunities.
4. It gives more chances for mating and reproduction.
5. It offers more protection against predators.

### **Group Selection**

- Group selection is a type of natural selection that acts at the of the group.
- Group selection may also be defined as selection, in which traits according to the fitness
- It is the selection, in which overall group fitness is higher than the mean of the individual members' fitness value.
- The group under selection is a small cohesive social unit and members' interactions are of an altruistic nature.
- V.C.Wynne Edwards used group selection as a popular for adaptation in 1962.
- It describes natural selection operating between groups Of organisms.
- This would produce adaptations that benefit the group, rather the individual.
- Darwin's theory of evolution was based on individual selection he rejected the idea of group selection.

#### **Concepts of Group Selection**

- Group selection is defined as a selection which evolves according to the fitness of groups.

It has two concepts:

1. Old concept
2. New concept

#### **1. Old Concept**

- Old group selection theory worked on the concept between-population (interdemic) group selection.
- It is also called interdemic group selection.
- Wynne Edwards (1960) argued that individual selection could not explain subordination of selfish interests to promote group wellbeing.

Eg. In groups consisting of selfish individuals, who reproduce at the maximum rate would over exploit their resources and hence, the groups go extinct.

- In groups consisting of co-operative individuals, who restrict their birth rate would not over exploit their resources and so, will not go extinct.
- This came to be known as the old concept of group selection.

## **2. New Concept**

- New group selection theory works on the concept, within-population (intrademic) group selection.
- It is also called trait-group selection or demic selection or intrademic selection.
- Maynard Smith (1976) showed that group selection would not work if the number of individuals who disperse and reproduce elsewhere is greater than one per group.
- The basic idea behind this concept is that at certain stages of an organism's life cycle, interactions take place between only a small number of individuals.

Group Selection Revisited

## **1. Multilevel Selection Theory (MLS)**

- Multi-level selection theory explains the evolution of altruism by considering the action of natural selection on a group level.
- In 1994, David Sloan Wilson and Elliott Sober argued that the argument against group selection had been overstated.
- They do not posit evolution on the level of the species.

## **Criticisms of Group Selection**

The following are the arguments against group selection:

1. The fact that a trait evolves in the total population.
2. If a trait increases the absolute fitness of an individual, it does not require group selection to evolve.
3. Conceptualizing the group as the social environment of the individual.
4. Frequency-dependent selection.
5. The fact that a trait can be measured in individuals means that it is evolved by individual-level selection.
6. Group selection is theoretically implausible.
7. There is little empirical support for group selection.
8. Group selection requires limited dispersal among groups.

## **Kin Selection**

- Kin selection is the evolutionary strategy that favours the reproductive success of an organism's relatives, even at a cost to the organism's own survival and reproduction.

- Kin selection is a type of natural selection, in which an individual attempts to ensure the survival of its own genes by protecting closely related individuals.
- Natural selection, working at the level of the family rather than the individual, is called kin selection.
- Charles Darwin discussed the concept of kin selection in 1859.
- R.A. Fisher in 1930 and J.B.S Haldane in 1932 set out the mathematics of kin selection.
- Kin selection was proposed by Hamilton in 1964.
- The term, kin selection was coined by John Maynard Smith in 1964 It is a type of natural selection.
- Kin altruism is altruistic behaviour whose evolution is driven by kin selection.

### Hamilton's Rule and Kin Selection

- Hamilton's Rule is a formal representation of the logic whereby a which favours altruism may increase infrequency in a population.
- Hamilton proposed a quantitative measure for predicting when natural selection would favour altruistic acts among related individuals.
- The three key variables in an altruistic act are the following:
  1. Benefit to the recipient
  2. Cost to the altruist
  3. Coefficient of relatedness

### Mechanisms of Kin Selection

- Hamilton proposed two mechanisms for kin selection:
  1. Kin recognition
  2. Viscous populations
- Kin recognition allows individuals to be able to identify their relatives.
- In viscous populations, the movement of organisms from their place of birth is relatively slow, and so, local interactions tend to be among relatives by default.

### Examples of Kin Selection

#### 1. Florida Scrub Jay

- Florida scrub jay is one of the best-studied example of kin selection
- Florida scrub jay is a bird species, in which some members of the
- The helpers do not involve in mating.
- Instead of mating, the helpers forgo reproduction.
- The helpers assist other breeding pairs in gathering food.

#### 2. Colonies of Social Insects

- Large colonies of ants, bees and wasps are other examples of kin selection.
- In many of these colonies, the queen is the only female that reproduces
- The mass of sterile female workers handle every other task in the colony.

#### 3. Alarm calls of Squirrels and Apes

- Alarm calls are another example of altruistic behaviour motivated by kin selection.
- In certain groups of closely related animals, such as squirrels and apes, members of the extended family will call out an alarm signal when a predator is seen within the striking range.
- This warning call allows family members to flee from danger.
- This alarm call draws dangerous attention to the caller itself.

#### 4. Vervet Monkeys

- Vervet monkeys display kin selection between siblings, mother and offspring and between grandparent and grandchild.
- These monkeys utilize allomothering, where the allomother is typically an older female sibling or a grandmother.
- Allomother is an individual other than the biological mother of an offspring that performs the functions of a mother.

#### Limitations of Kin Selection

The following are the limitations of kin selection:

- 1. Kin selection does not explain why an individual helps individual who are not related to themselves

#### **Altruism**

- Altruism refers to an animal behaviour that benefits other animals of the same species at its own expense.
- It refers to the act of an individual, in such a way that will its own survival chances, but improves the survival chances of another individual.
- Altruistic behaviour is any behaviour that reduces an individual animal's fitness but increases the fitness of other individuals in the population.
- The term altruism was coined by Auguste Comte.
- He derived it from an Italian word 'altrui', which in turn was derived from a Latin word, 'alteri', meaning "other people".
- It occurs in social animals or in closely knit populations.
- It is common throughout the animal kingdom, particularly in species with complex social structures.
- It is considered a paradox of natural selection theory.

#### Theories of Altruism

The following are the theories of altruism:

1. Kin selection
2. Reciprocal altruism

#### Kin Selection

- Kin selection is a type of natural selection in which an individual attempts to ensure the survival of its own genes.
- Kin was proposed by Hamilton in 1964.

## Examples of Altruism

### 1. Examples in Vertebrates

#### Mammals

- Wolves and wild dogs bring meat back for the members of the pack who were not present at the time of hunting.
- Though in harsh conditions, the breeding pair of wolves takes the greatest share to continue to produce pups.
- Mongooses support elderly, sick, and injured animals.
- Meerkats have one standing guard to warn the other meerkats in case of predator attack.
- Meerkats are small carnivorous mammals that live underground in Africa.
- Meerkats stand tall on the ground.
- When a predator hawk approaches, one meerkat will call out an alarm.
- Raccoons inform conspecifics about feeding grounds through their droppings left on commonly shared latrines.
- Male baboons threaten predators and cover the rear as the troop retreats.
- Gibbons and chimpanzees that have food, can share their food with others of the group.
- Chimpanzees will help humans and conspecifics without any reward in return.

#### Reciprocal Altruism

- Reciprocal altruism is an animal behaviour used to describe the phenomenon that is observed in two animals, acting in ways which mutually benefit one another.
- It is the behaviour of an organism that temporarily reduces its fitness and increases another organism 's fitness, with the expectation that the other organism will also act in a similar manner at a later time.
- The concept was initially developed by Robert Trivers in 1971.
- The concept is close to the strategy of 'titfor tat' used in game theory.
- It explains costly co-operation between non-relatives.

#### Example

- A wolf may offer food to another wolf even though they share no kinship.
- Such behaviour can be adaptive if the aided individual returns the favour in the future.
- Reciprocal altruism requires the following three conditions
  - ❖ The cost benefit to actor is less than that of the recipient.
  - ❖ Cheaters must be punished.
  - ❖ Repeated interactions over time are required.

- Reciprocal altruism between non-related individuals needs the following:
  1. Long term association of group members.
  2. Donorship can be predicted from past helping.
  3. Roles of donors and recipients reverse.
  4. Benefits of the recipients outweigh donor costs.
  5. Donors can detect cheaters.

## **Examples of Reciprocal Altruism**

### **1. Cleaner Fish**

- Cleaning symbiosis between cleaner fish and its hosts is an example of reciprocal altruism.
- The cleaners include shrimps and birds.
- The clients include fish, turtles, octopuses and mammals.
- The host fish allows the cleaner fish free entrance and exit.
- The host fish does not eat the cleaner, even after the cleaning is done.
- The host signals the cleaner to depart the cleaner's locality.
- The host sometimes chases off possible dangers to the cleaner.
- The cleaning by cleaners is essential for the host.
- In the absence of cleaners, the hosts leave the locality or suffer injuries inflicted by ectoparasites.

### **2. Warning Calls in Birds**

- Warning calls are frequently given by birds, which are in danger.
- The predators specialize individually on prey types and hunting techniques.
- Alarming another bird by giving a warning call tends to prevent predators.
- A bird of prey, on detecting a predator, calls to signal other birds prey, that it has detected a predator.

### **3. Nest Protection**

- Male red-winged blackbird helps defend neighbour's nests.
- Males only defend other nests which contain their extra-pair offspring. Extra-pair offspring are juveniles which may contain some of the male bird's DNA.
- Another is the tit-for-tat strategy of reciprocal altruism. Males help only other closely related males.

### **4. Vampire Bats**

- Vampire bats also display reciprocal altruism.
- It was described by Wilkinson.
- The bats feed each other by regurgitating their blood.
- Bats that feed only on blood, may die after just 48 hours, if they do not have blood meal.

## **Social Organisation In Insects**

In insects social life has evolved only in two orders, namely, Isoptera (termites) and Hymenoptera (bees, wasps and ants) which make a nest and live in colonies of thousands of individuals that practice division of labour and social interaction.

## **SOCIAL LIFE IN TERMITES**

Termites were the first animals which started living in colonies and developed a well organised social system about 300 million years ago, much earlier than honey bees, ants and human beings. Although termites do not exceed 3-4 mm in size, their **queen** is a 4 inch long giant that lies in the royal chamber motionless, since its legs are too small to move its enormous body. Hence workers have to take care of all its daily chores.

Termite queen is an egg-laying machine that reproduces at an astonishing rate of two eggs per second. Generally the queen of a termite colony can lay 6,000 to 7,000 eggs per day, and can live for 15 to 20 years. The other castes, **workers** and soldiers are highly devoted to the colony, working incessantly and tirelessly, demanding nothing in return from the society.

**Soldiers** have long dagger-like mandibles with which they defend their nest and workers chew the wood to feed to the queen and larvae and grow fungus gardens for lean periods.

**Nasutes** are specialized soldiers which specialize in chemical warfare. They produce a jet of highly corrosive chemical from their bodies that can dissolve the skin of enemies and can also help in making galleries through the rocks.

## **SOCIAL STRUCTURE OF A BEE COLONY**

The population of a healthy bee hive in spring and honey flow period may contain 40,000-80,000 individuals but the population declines in winter and extreme summer. There is remarkable order in the hive and no conflicts are seen among the members.



**Queen** is one and a half times larger than the workers and is the only fertile female in the hive. Queen keeps the colony together by secreting a pheromone called queen substance from its mandibular glands. In multiqueen colonies, young queens after emergence attempt to sting and kill the rival