## Estimation of pH of the given water samples

### Aim

To estimate the Hydrogen Ion concentration of the given water samples A and B.

### pH definition

The term pH was introduced in 1909 by Sorenson who defined pH as the negative logarithm of hydrogen ion concentration (Moles/Litre).

$pH = -\log(H^+)$

The pH scale ranges between pH of 1 and pH of 14. Pure distilled water has a pH of 7 at room temperature and is neutral (neither acidic nor alkaline). It has an equal concentration of H+ and OH-. The pH values less than 7 (low pH) denote an acidic solution with a high concentration of H+. The pH values more than 7(high pH) denote a basic solution with a low concentration of H+ . Thus pH scale is logarithmic and inverselyrelated to (H+).

### Principle

Any one of the following methods can determine the pH of a solution.

1. pH Paper, 2. pH Meter and 3. pH indicators. In all these three methods of pH estimation, certain Ionization reactions are involved which are governed by Law of Mass Action and Equilibrium constants.

### pH paper method

pH paper is impregnated with various dyes (indicators). The pH paper will develop different shades of colour at different pH values and thus pH of a solution is determined. This colour change is due to the Ionization of a corresponding dye in the paper depending on the pH of the solution.

### Materials required

Narrow range and wide range pH papers, watch glass, forceps and pH meter.

### Procedure

### pH paper method for the estimation of pH:

A small quantity of the sample A is taken in the watch glass. A small piece of paper from a narrow range booklet is removed with the help of forceps and dipped in the sample and the colour developed is matched with the colour marked on the narrow range booklet for accurate pH value. The same procedure is repeated for the sample B and pH value is recorded.

**Result**

pH of the water sample A = ___.

pH of the water sample B = ___.

**Discussion**

Water sample A has ___ pH value than water sample B. It may be inferred that sample A may be_____ water and sample B may be ____water. Because pH of fresh/pond water ranges between 6-7 and that of sea water or estuarine water ranges between 7-8.

## ESTIMATION OF CHLORIDES

**Aim:** To estimate the salt content of the given water Samples A and B.

**Materials required:** Burette with a stand, pipette, conical flask, measuring jar and porcelain tile.

**Reagents:** 2.725% Silver Nitrate solution (27.25 grams of $AgNO_3$ crystals dissolved in 1 litre of distilled water (adding a few drops of dilute nitric acid to dissolve the salt if necessary) stored in black bottle. 5% Potassium Chromate solution (5 grams of $K_2Cr_2O_4$ dissolved in distilled water and made up to 100 ml)

**Principle**

The salinity of the water sample has a definite and constant relationship with the chlorinity (chloride ions) Chloride ions form 55% of the dissolved solids. Hence Chlorinity is first determined by precipitating the chlorides present in the sample as Silver Chloride by titrating against $AgNO_3$ solution using Potassium Chromate solution as indicator. The slightest excess of $AgNO_3$produces a brick red colour reacting with Potassium Chromate, which is taken as endpoint. From the chlorinity salinity can be calculated by the equation.

Salinity ‰ = 0.03 + (1.805 x Chlorinity)

**Procedure**

1. A burette is cleaned with distilled water and rinsed in $AgNO_3$ solution. Then it is filled with 2.725% $AgNO_3$ solution and the initial reading is noted.

2. 5 ml of water sample A is taken in a conical flask and 3 drops of 5% Potassium

Chromate solution is added with it as indicator. As a result the colour of the sample changes into yellow. This is titrated against AgNO3 solution with constant shaking until the yellow colour of the solution turns to brick red colour. The first appearance of brick red colour is the end point. (The constant shaking of the sample while titration prevents the formation of lumps holding uncombined Chlorides). The final reading in the burette is taken. The difference between the final and initial reading gives the required amount of AgNO3 solution for titration.

2. The experiment is repeated until two concordant values are obtained. The experiment is repeated with Sample B. The readings are tabulated (Tale .

**Result**

Salinity of the Water Sample A = _____‰

Salinity of the Water Sample B = _____‰

**TABULATION AND CALCULATION**

| **S.No of the sample** | **Vol of Sample** | **BURRET READING** | | **Vol. Of $AgNO_3$ Consumed** |
|---|---|---|---|---|
| | | **Initial** | **Final** | |
| Sample A | 5 ml | | | |
| Sample B | 5 ml | | | |
| | | | | |

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Calculation of salinity for sample A= $\frac{19.381 \times \text{Vol. of } AgNO3 \text{ Consumed}}{17.15}$

Chlorinity = _____ gms/kg of water.

Salinity = 0.03 + (1.805 X _____)

= _____ ‰ (Parts per thousand).

## ESTIMATION OF CARBONATES

**AIM:** to determine the amount of carbonates in given water sample.

**Principle:** when pond water is titrated against an acid, the carbonates in the water are converted into bicarbonates.

$$2Na_2CO_3 + H_2SO_4 \longrightarrow 2Na_2HCO_3 + Na_2SO_4$$

When phenolphthalein is added to water the pink color shows the alkalinity, but becomes colorless on becoming slightly acidic.

**Apparatus and chemicals**:

Beakers, pippets, burette, burette stand, 250 ml conical flask, n/20 $H_2SO_4$, phenolphthalein indicator, measuring cylinder, funnels

**Procedure**

Take 50 ml of pond water in a conical flask and add 0.5 ml of phenolphthalein indicator, Pink color appears, indicating the presence of carbonates. Titrate this against N/20 sulphuric acid (In burette) till the pink color is disappeared which indicates the end point. Make a note of initial and final readings of sulphuric acid run down from the burette. From the difference in burette readings, calculate carbonates present in given water samples.

**Calculations**

| S.No of Sample | Amount of sample | Burette reading | | Amount of carbonates |
|---|---|---|---|---|
| | | Initial | Final | |
| Sample A | 50 ml | | | |
| Sample B | 50 ml | | | |

**Carbonates in ppm = Difference in burette reading x 2x 30.025 (eq.wt)**

## ESTIMATION OF BICARBONATES

**AIM:** to determine the amount of bicarbonates in given water sample.

**Principle:** Bicarbonates in the pond water, when titrated against an acid are converted into carbonic acid and salt.

$$2NaHCO_3 + H_2SO_4 \longrightarrow 2H_2CO_3 + Na_2SO_4$$

**Apparatus and chemicals**:

Beakers, pippets, burette, burette stand, 250 ml conical flask, n/20 H2SO4, Methyle Orange indicator, measuring cylinder, funnels

**Procedure**

Take 50 ml of pond water in a conical flask and add 0.5 ml of methyeorange indicator, observe the pond water in conical flask turning into yellow color. Titrate this against N/20 sulphuric acid (In burette) till the yellow color turns into orange colorwhich indicates the end point. If excess of acid is added to the sample it turns pink. Make a note of initial and final readings of sulphuric acid run down from the burette. From the difference in burette readings, calculate bicarbonates present in given water samples.

**Calculations**

| S.No of Sample | Amount of sample | Burette reading | | Amount of bicarbonates |
|---|---|---|---|---|
| | | Initial | Final | |
| Sample A | 50 ml | | | |
| Sample B | 50 ml | | | |

**BiCarbonates in ppm = Difference in burette reading x 61.016 (eq.wt)**

**ESTIMATION OF DISSOLVED OXYGEN IN GIVEN WATER SAMPLES:**

**AIM:** To estimate the unit oxygen consumption by fish with reference to its body weight.

**Apparatus and chemicals:** BOD bottles, burret, burret stand, pippet, beakers,

Winkler's reagent A&B, sodium azide, Sulphuric acid, starch solution, hypo.

**Principle:**

in this Iodometry free o2 is liberated by the action of water with manganese

sulphate and then alkali iodide and sulphuric acid. Liberated iodine is estimated by

titration with sodium thiosulphate. Starch is used as indicator.

2MnSO4+2KOH Mn(OH)2+K2SO4 1

2Mn(OH)2+H2O+1/2 O2 2Mn(OH)3 2

2Mn(OH)3+2NaI+3H2SO4 2MnSO4+Na2SO4+6H2O+I2 3

2I2 +4Na2S2O3 4NaI+2Na2SO4(O6)

**Procedure:**

Collect the water samples from the lake at a standard depth with the BOD bottles.

Carefully fill a 300-mL glass Biological Oxygen Demand (BOD) stoppered bottle brim-full with sample water.

2. Immediately add 2mL of manganese sulfate to the collection bottle by inserting the calibrated pipette just below the surface of the liquid. (If the reagent is added above the sample surface, you will introduce oxygen into the sample.) Squeeze the pipette slowly so no bubbles are introduced via the pipette.

3. Add 2 mL of alkali-iodide-azide reagent in the same manner.

4. Stopper the bottle with care to be sure no air is introduced. Mix the sample by inverting several times. Check for air bubbles; discard the sample and start over if any are seen. If oxygen is present, a brownish-orange cloud of precipitate or floc will appear. When this floc has settle to the bottom, mix the sample by turning it upside down several times and let it settle again.

5. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample. Carefully stopper and invert several times to dissolve the floc. At this point, the sample is "fixed" and can be stored for up to 8 hours if kept in a cool, dark place. As an added precaution, squirt distilled water along the stopper, and cap the bottle with aluminum foil and a rubber band during the storage period.

6. In a glass flask, titrate 201 mL of the sample with sodium thiosulfate to a pale straw color. Titrate by slowly dropping titrant solution from a calibrated pipette into the flask and continually stirring or swirling the sample water.

7. Add 2 mL of starch solution so a blue color forms.

8. Continue slowly titrating until the sample turns clear. As this experiment reaches the End point, it will take only one drop of the titrant to eliminate the blue color. Be especially careful that each drop is fully mixed into the sample before adding the next. It is sometimes helpful to hold the flask up to a white sheet of paper to check for absence of the blue color.

9. The concentration of dissolved oxygen in the sample is equivalent to the number of

milliliters of titrant used. Each mL of sodium thiosulfate added in steps 6 and 8 equals

1 mg/L dissolved oxygen.

Result:

## Problems on Hardy-Weinberg law of equilibrium:

The Hardy-Weinberg formulas allow scientists to determine whether evolution has occurred. Any changes in the gene frequencies in the population over time can be detected. The law essentially states that if no evolution is occurring, then an equilibrium of allele frequencies will remain in effect in each succeeding generation of sexually reproducing individuals. In order for equilibrium to remain in effect (i.e. that no evolution is occurring) then the following five conditions must be met:

1. No mutations must occur so that new alleles do not enter the population.
2. No gene flow can occur (i.e. no migration of individuals into, or out of, the population).
3. Random mating must occur (i.e. individuals must pair by chance)
4. The population must be large so that no genetic drift (random chance) can cause the allele frequencies to change.
5. No selection can occur so that certain alleles are not selected for, or against.

Obviously, the Hardy-Weinberg equilibrium cannot exist in real life. Some or all of these types of forces all act on living populations at various times and evolution at some level occurs in all living organisms. The Hardy-Weinberg formulas allow us to detect some allele frequencies that change from generation to generation, thus allowing a simplified method of determining that evolution is occurring. There are two formulas that must be memorized:

$$p^2 + 2pq + q^2 = 1 \textit{ and } p + q = 1$$

p = frequency of the dominant allele in the population
q = frequency of the recessive allele in the population
$p^2$ = percentage of homozygous dominant individuals
$q^2$ = percentage of homozygous recessive individuals
2pq = percentage of heterozygous individuals

### Problem:1:

There are 100 students in a class. Ninety-six did well in the course whereas four blew it totally and received a grade of F. In the highly unlikely event that these traits are genetic rather than environmental, if these traits involve dominant and recessive alleles, and if the four (4%) represent the frequency of homozygous recessive condition, please calculate the following

A. The frequency of the recessive allele.
B. The frequency of the dominant allele
C. The frequency of the heterozygous individuals.

**Solution:**

A. Answer: Since we believe that the homozygous recessive for this gene ($q^2$) represents 4% (i.e. = 0.04), the square root (q) is 0.2 (20%).
B. Since q = 0.2, and p + q = 1, then p = 0.8 (80%).
C. The frequency of heterozygous individuals is equal to 2pq. In this case, 2pq equals 0.32, which means that the frequency of individuals heterozygous for this gene is equal to 32% (i.e. 2 (0.8)(0.2) = 0.32).

**Problem:2:**

Within a population of butterflies, the color brown (B) is dominant over the color white (b). And, 40% of all butterflies are white. Given this simple information, which is something that is very likely to be on an exam, calculate the following:

A. The percentage of butterflies in the population that are heterozygous.
B. The frequency of homozygous dominant individuals.

Answers: The first thing you'll need to do is obtain p and q.

So, since white is recessive (i.e. bb), and 40% of the butterflies are white,

then bb = $q^2$ = 0.4. To determine q, which is the frequency of the recessive allele in the population, simply take the square root of $q^2$ which works out to be 0.632 (i.e. 0.632 x 0.632 = 0.4). So, q = 0.63. Since p + q = 1, then p must be 1 - 0.63 = 0.37. Now then, to answer our questions. First, what is the percentage of butterflies in the population that are heterozygous? Well, that would be 2pq so the answer is 2 (0.37) (0.63) = 0.47. Second, what is the frequency of homozygous dominant individuals? That would be $p^2$ or $(0.37)^2$ = 0.14.

**Pronlem: 3:**

Cystic fibrosis is a recessive condition that affects about 1 in 2,500 babies in the Caucasian population of the United States. Please calculate the following.

A. The frequency of the recessive allele in the population.
B. The frequency of the dominant allele in the population.
C. The percentage of heterozygous individuals (carriers) in the population.

**Solution:** Cystic fibrosis is a recessive condition that affects about 1 in 2,500 babies in the Caucasian population of the United States. Please calculate the following.

A. The frequency of the recessive allele in the population. Answer: We know from the above that $q^2$ is 1/2,500 or 0.0004. Therefore, q is the square root, or 0.02. That is the answer to our first question: the frequency of the cystic fibrosis (recessive) allele in the population is 0.02 (or 2%).

B. The frequency of the dominant allele in the population. Answer: The frequency of the dominant (normal) allele in the population (p) is simply 1 - 0.02 = 0.98 (or 98%).
C. The percentage of heterozygous individuals (carriers) in the population. Answer: Since 2pq equals the frequency of heterozygotes or carriers, then the equation will be as follows: 2pq = (2)(.98)(.02) = 0.04 or 1 in 25 are carriers.

**Problem: 4:**

**A very large population of randomly-mating laboratory mice contains 35% white mice. White coloring is caused by the double recessive genotype, "aa". Calculate allelic and genotypic frequencies for this population.**

**Solution: A very large population of randomly-mating laboratory mice contains 35% white mice. White coloring is caused by the double recessive genotype, "aa". Calculate allelic and genotypic frequencies for this population. Answer: 35% are white mice, which = 0.35 and represents the frequency of the aa genotype (or $q^2$). The square root of 0.35 is 0.59, which equals q. Since p = 1 - q then 1 - 0.59 = 0.41. Now that we know the frequency of each allele, we can calculate the frequency of the remaining genotypes in the population (AA and Aa individuals). AA = $p^2$ = 0.41 x 0.41 = 0.17; Aa = 2pq = 2 (0.59) (0.41) = 0.48; and as before aa = $q^2$ = 0.59 x 0.59 = 0.35. If you add up all these genotype frequencies, they should equal 1.**

## Spotters

### Study of Endangered species with Photographs/Specimens/diagrams

#### 1. Lion-tailed macaque (Macaca silenus)

**Identification characters and status:**

1. The lion-tailed macaque or the wanderoo, is an Old World monkey endemic to Western Ghats of South India.
2. Its hair is black. Its outstanding characteristic is the silver-white mane which surrounds the head from the cheeks down to its chin, which gives this monkey its German name Bartaffe -"beard ape". The hairless face is black in colour.
3. Its head-body length is 42 to 61 cm with a weight of 2 to 10 kg and tail length is 25 cm. Tail has a black tuft at the end, similar to a lion's tail. The male's tail-tuft is more developed than that of the female.
4. It is a diurnal rainforest dweller. It is a good climber and spends a majority of its life in the upper canopy of tropical moist evergreen forests.
5. Gestation is approximately six months. The young are nursed for one year. Sexual maturity is reached at four years for females, and six years for males. The life expectancy in the wild is approximately 20 years, while in captivity is up to 30 years.
6. Unlike other macaques, it avoids humans. In group behavior, it is much like other macaques.
7. Its behavior is characterized by typical patterns such as arboreal living, selectively feeding on a large variety of fruit trees. It primarily eats indigenous fruits, leaves, buds, insects and small vertebrates in virgin forest. In the forests of Kerala they were observed preying on nestling and eggs of pigeons.
8. Threats: A recent assessment for IUCN reports 3000-3500 of these animals live scattered over several areas in Kerala. The lion-tailed macaque ranks among the rarest and most threatened primates.

## 2. Indian wild ass (Equus hemionus khur)

**Identification characters and status:**

1. This is also called as Baluchi wild ass or ghadkhar in the local Gujarati language, is a subspecies of the onager (race of the Asian wild ass native to northern Iran) native to Southern Asia.
2. As of 2016, listed as near threatened by IUCN.
3. As of 2015, the current census, population has increased to than 4,800 more than individuals in and outside of the Wild Ass Wildlife Sanctuary of India. First census of the wild ass was done in 1940, when there were an estimated 3,500 wild asses. But, by the year 1960, this figure fell to just 362, it was then classified as a highly endangered species.
4. the coat is usually sandy, but varies from reddish grey, fawn, to pale chestnut. The animal possesses an erect, dark mane which runs from the back of the head and along the neck. The mane is then followed by a dark brown stripe running along the back, to the root of the tail.
5. These graze between dawn and dusk. The animal feeds on grass, leaves and fruits of plant, crop, Pravopis pods, and saline vegetation. It is one of the fastest of Indian animals, with speeds clocked at about 70-80km. per hour.
6. Threats: It is unknown how the Indian wild ass disappeared from its former haunts in parts of western India and Pakistan, since the animal was never a hunting target of Indian Maharajas and colonial British officials of the British Raj.
7. Conservatiuon: In the last century, the Indian wild ass lived all over the dry regions of northwestern India and western Pakistan including Jaisalmer, Bikaner, Sind and Baluchistan. Today, it survives only in the Little Rann, and a few stray towards the Great Rann of Kutch with some reaching bordering villages in the Jalore district of the Indian State of Rajasthan.

**Cuon alpines(Dhole)**

**Identification characters and status:**

1. It is native to Central, South and Southeast Asia and called as Asiatic wild dog, Indian wild dog, whistling dog, red wolf, red dog, and mountain wolf.
2. It is a highly social animal, living in large clans without rigid dominance hierarchies and containing multiple breeding females.
3. It is listed as Endangered by the IUCN, as populations are decreasing and estimated at fewer than 2.500 adults.
4. The color of the fur is reddish, with the brightest hues occurring in winter.
5. It produce whistles of red foxes. How this sound is produced is unknown.
6. It is "cat-like" with long backbone and slender limbs and almost hyena-like appearance. The rostrum is shorter than that of domestic dogs and most other canids. The species has six rather than seven lower molars.
7. Adults may weigh over 18 kg, with females usually weighing 4.5 kg less than males. It stands 17-22 inches at the shoulder and measures three feet in body length. Like the African wild dog, its cars are rounded rather than pointed. It has 6-7 pairs of teats, sometimes eight.
8. Threats: It rarely takes domestic livestock. Methods used for dhole hunting included poisoning, snaring, shooting and clubbing at den sites. Native Indian people killed dholes primarily to protect livestock. Factors contributing to this decline include habitat loss, loss of prey, competition with other species, persecution and disease transfer from domestic dogs.
9. Conservation: It is protected under Schedule 2 of the Wildlife Protection Act, 1972. The creation of reserves under Project Tiger provided some protection for dhole populations sympatric with tigers. In 2014, the Indian government sanctioned its first dhole conservation breeding centre at the Indira Gandhi Zoological Park (IZP in Visakhapatnam

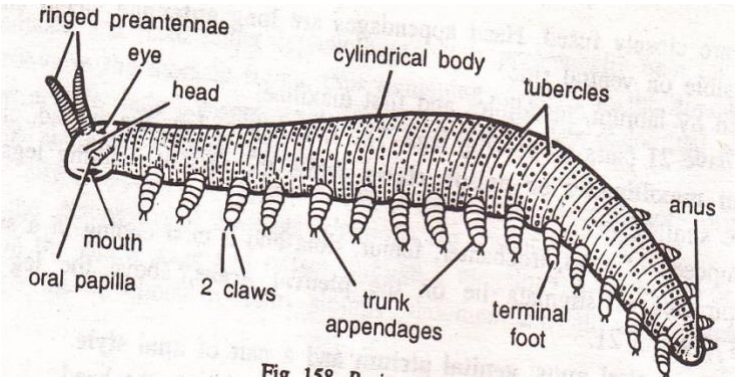
## Museum study of fossil animals

1. **Peripatus**

Phylum- **Arthropoda**

Class- **Onychophora**

Type- **Peripatus**




- It is commonly called **<u>Walking worm</u>**
- Body of the animal is caterpillar like enclosed in a thin chitinous cuticle.
- It is cylindrical and elongated measuring 4-6cm in length.
- Outer covering of the body is velvety, shows transverse wrinkles, bearing numerous small papilla or tubercles.
- Peripatus is said to a connecting link between annelida and arthopoda.
- It does not show external segmentation.
- It bears 14-43 pairs of unjointed legs.
- Each leg is triangle with claws shaped and has a pair of retractile claws.

**<u>ANNELIDIAN CHARACTERS</u>**

- The veriform body, dermo-muscular body wall, simple eyes, unjointed, hollow stumpy appendages on annelidan pattern.

**<u>ARTHROPODIAN CHARACTERS:-</u>**

- Antenne, chitin in cuticle, haemocoal, trachea, general structure, development and peculiar salivary glands like arthropods.

## 2. Coelacanth fish:

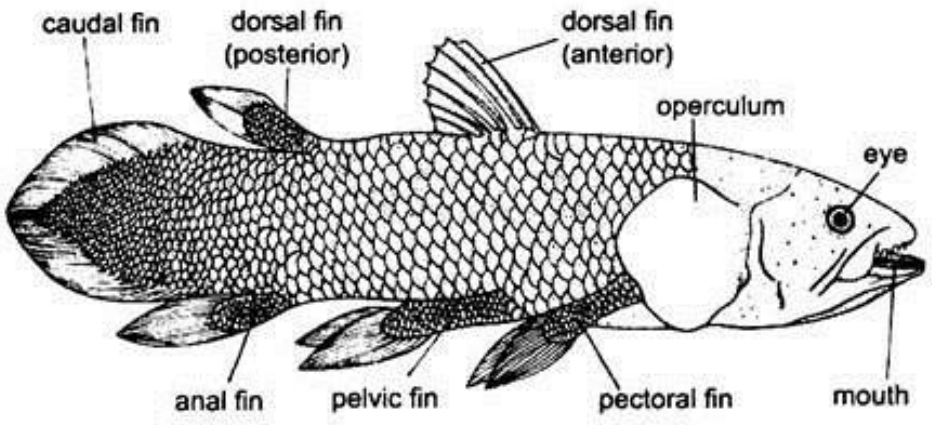



**Fig. 16.2** *Latimeria chalumnae*. The living coelocanth.

1. The coelacanth was long considered a "living fossil" because scientists thought it was the sole remaining member of a taxon otherwise known only from fossils, with no close relations alive
2. Coelacanths are a part of the clade Sarcopterygii, or the lobe-finned fishes. Externally, several characteristics distinguish the coelacanth from other lobe-finned fish.
3. They possess a three-lobed caudal fin, also called a trilobate fin or a diphycercal tail. A secondary tail extending past the primary tail separates the upper and lower halves of the coelacanth.
4. Cosmoid scales act as thick armor to protect the coelacanth's exterior.
5. Several internal traits also aid in differentiating coelacanths from other lobe-finned fish. At the back of the skull, the coelacanth possesses a hinge, the intracranial joint, which allows it to open its mouth extremely wide.
6. Coelacanths also retain an oil-filled notochord, a hollow, pressurized tube which is replaced by the vertebral column early in embryonic development in most other vertebrates.
7. The coelacanth heart is shaped differently from that of most modern fish, with its chambers arranged in a straight tube.

## 3. Lepidosiren:

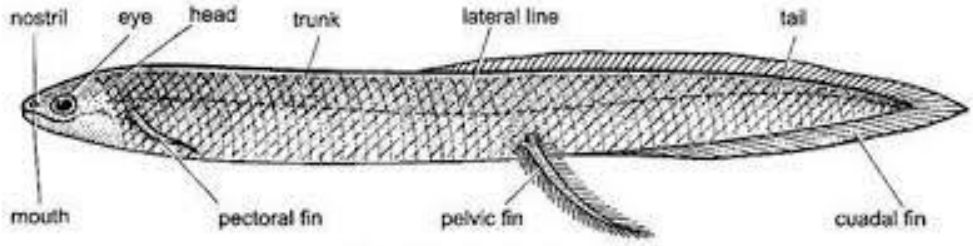



Fig. 16.5. *Lepidosiren.*

**1. Distribution:**Tropical; South America.

**2. Habitat:** it lives in the muds and also aestivates during summer.

**3. Feeding habit:**Mostly carnivorous and sometimes feeds on plant materials. It is not exclusively carnivorous.

**4. Length:**1.80- 2.10m in length

**5. Paired appendages:** Elongated and slender with extremely reduced radials**.**

**6. Eyes:**Moderate in size and well-developed.

**7. Skull:**Fontanel les are present.

**8. Lower jaw:**True splenials and dentaries are present.

**9. Lungs:**Two lungs are present

**10. Hyoidean gill:**It is a hemi branch like that of Protopterus.

**11. External gills and suckers:**Four pairs of external gills and suckers exist in the larva. These are totally absent in the adult.

**12. Accessory respiratory organ:**During breeding season, vascular filaments are developed in the pelvic fins of male which serve as accessory respiratory structure besides the gills and lungs.

**13. Abdominal vein:**Absent.

**15. Optic lobes:**Unpaired.

**16. Later line senses organs:**The sense organs are placed inside the canals in the skin.

**19. Testes:**The tests are elongated narrow bodies and round in cross- section.

**20. Sexual dimorphim:**Present only during breeding season when the male developed vascular filaments in the pelvic fins.

**21. Pinku's organ:**Present.

# 4. Neoceratodus:

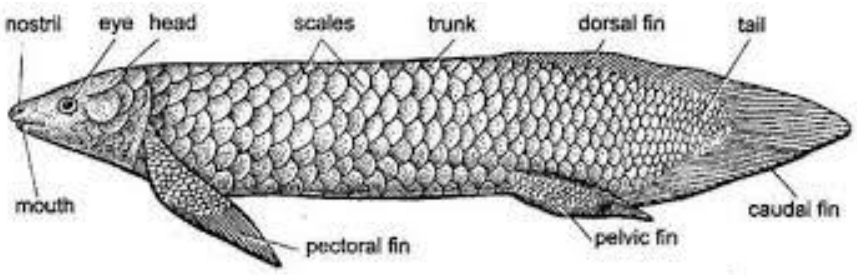



Fig. 16.3. *Neoceratodus.*

**1. Distribution:**Australia

**2. Habitat:**It lives in the river which becomes shallow in summer, but never dries up completely. It lives in that toxic water by adopting aerial respiration.Aestivation is absent the lungs work in conjunction with the gills.

**3. Feeding habit:**Carnivorous fish which devours molluscs, crustaceans and various worm.

**4. Length:**1.50 m in length.

**5. Paired appendages:**Broad and leaf-like with highly developed radials.

**6. Skull:**Fontanelles are absent.

**7. Lower jaw:**The splenials and dentaries are vestigial.

**8. Lungs:**Only one lung is present which is possibly due to the suppression of the original left lobe.

**9. Hyoidean gill:**It is a pseudo branch which is supplied by an artery from the first efferent branch.

**10. External gills and suckers:**As the opercula develop earlier than the formation of the gills, external gills are absent in the larval stage.

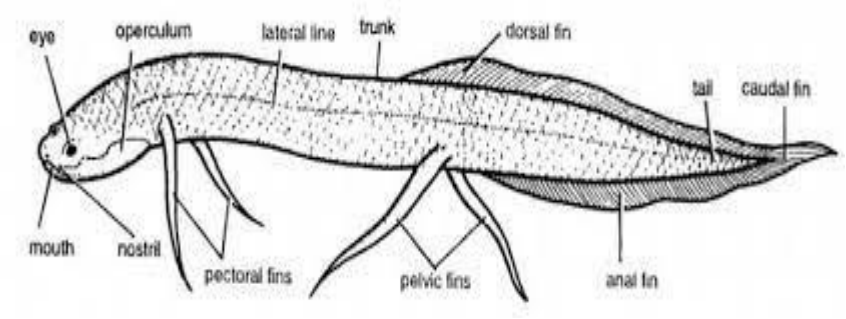
11. **Optic lobes**: Slightly separated and form paired lobes

12. **Tests:** The testes are thick and triangular in cross-section

13. **Sexual dimorphism:** Absent

**14.Pinku's organ:** Absent.

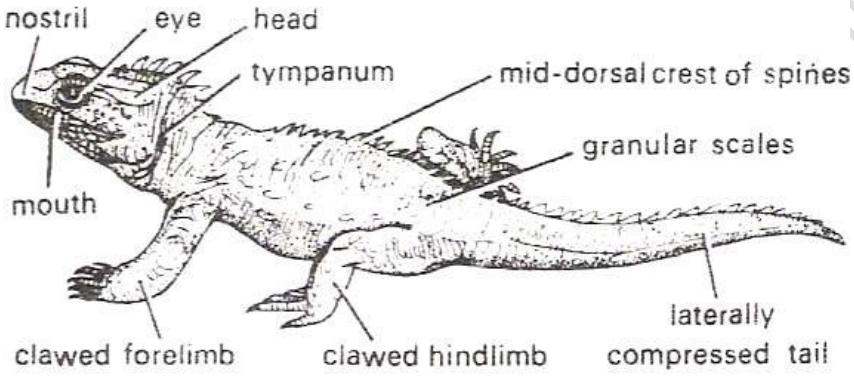
**5. Protopterus**




1. ***Protopterus*** is the genus of four species of lungfish found in Africa
2. African lungfishes are elongated, eel-like fishes, with thread-like pectoral and pelvic fins.
3. They have soft scales, and the dorsal and tail fins are fused into a single structure.
4. They can either swim like eels, or crawl along the bottom, using their pectoral and pelvic fins. The largest species reach about 200 cm (6.6 ft) long
5. African lungfishes generally inhabit shallow waters, such as swamps and marshes.
6. They are also found in larger lakes such as Lake Victoria.
7. They can live out of water for many months in burrows of hardened mud beneath a dried stream bed.
8. They are carnivorous, eating crustaceans, aquatic insect larvae, and molluscs

## 6. Sphenodon:

Phylum……...: Chordata
Group…….: Craniata
Subphylum...: Vertebrata
Division……...: Gnathostomata
Super class…: Tetrapoda
Class……...: Reptilia
Sub class……: Diapsida
Order……: Rhynchocephalia
Genus……: *Sphenodon*
Genus……: *punctatum.*




**Salient features**

1. *Sphenodon* is commonly called as Tuatara.

2. Animal is lizard-like having dull olive-green colour with white and yellow spots and measuring about-75 cm. Body divided into head, trunk and tail.

3. It contains scaly skin, long tail and four pentadactyl limbs adapted for walking. Several crest-like, spiny scales extend along mid-dorsalline.

4. Skull contains two complete fossae, quadrate is fixed, post frontals are separate (only in *Sphenodon*) and upper jaw has beaks. Teeth acrodont. Mandibles joined by ligament. Between skull and atlas is proatlas. Sternum present and vertebrae amphicoelous. Caudal vertebrae have chevron bones.

5. There is a prominent parietal eye with retina, lens and nervous connection to brain. It is photosensitive.

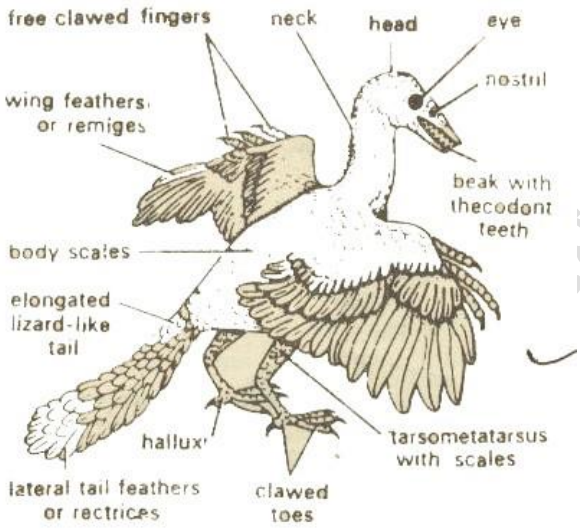
7. Anal opening transverse. Male without copulatory organ. About 10 eggs with hard white shell are laid in holes in the ground. Eggs require 13 months to hatch.

8. Special features: *Sphenodon punctatus* is an important living fossil. It has survived from pennian and is fast approaching towards extinction. It is protected by law. The tuatara contains several primitive features, such as two temporal fossae, amphicentrous vertebrae, pineal eye, uncinate processes in the rib, vomerine teeth in young, horny beak on upper jaw and absence of copulatory apparatus in males. Tuatara is close to the type from where all diapsid reptiles might have originated.

*9.* Identification: Since this reptile has rows of spines on the back and above features, hence is *Sphenodon.*

## 7. Archaeopteryx

Phylum : Chordata
Sub Phylum : Vertebrata
Super Class : Gnathostomata
Class : Aves
Super Class : Neornithes




The fossil of Archaeopteryx lithographica belonging to late Jurassic period (140 millions ago), was discovered in 1861 from Bavaria, Germany. It has both reptilian as well as avian characters.

**A. Reptilian characters:**

1) Epidermal scales over body and limbs.
2) Simple brain, cylindrical cerebral hemispheres and unexpanded cerebellum.
3) Jaws with peg-like homodont teeth lodged in sockets.
4) Vertebrae amphicoelous.
5) Sternum poorly developed, without keel.
6) Cervical vertebrae few (9 or 10).
7) Tail long, tapering lizard-like with free 20 caudal vertebrae.
8) Carpals and metacarpals free.

**B. Avian characters:**

1) Presence of feathers. Forelimbs modified as wings for flight bearing remiges and 3 digits each.
2) Two jaws like beak.

# Study homology and analogy with the help of preserved specimens, of organs of animals

## Apparatus and Materials Required:

Preserved specimens of different organs of animals, compound microscope

## Theory

In animals, organs that are functionally dissimilar but anatomically, or structurally, similar are called homologous organs. Different modes of life have created the differences, i.e, modified the organs to enable them to survive. Analogous organs are those which are functionally similar but structurally dissimilar.

## Observation:

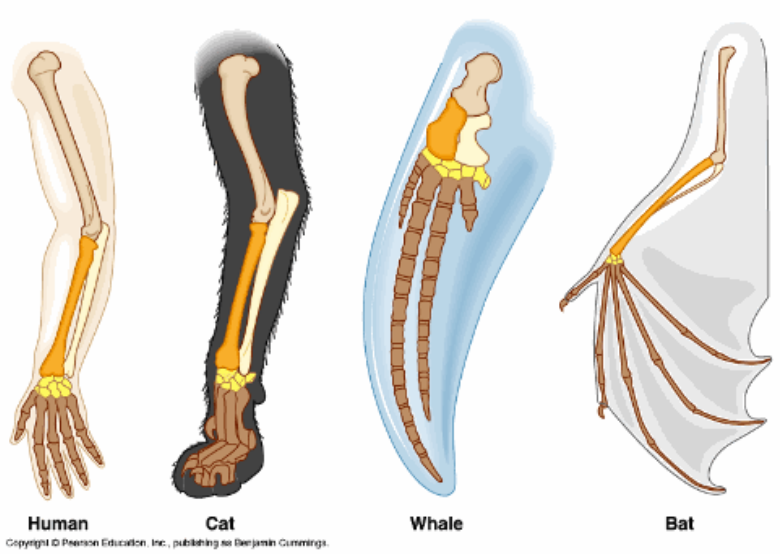
### Homologous organs:

If you externally examine the wings of the flying mammal bat and the forelimb of a man, you will not find any similarity.

But examining the bones one by one, you will find that each of them has arm bone (humerus), hand bones (radius-ulna), wrist bones (carpals), palm bones (metacarpals), and fingers (phalanges). Of course, in terms of proportions of growth of each constituent bone, there are differences.

For example, the fingers of bat are much longer. What this comparative study suggests is that basically the forelimbs of these two creatures are made up of the same parts, that is, they are anatomically similar.

These organs need not perform the same function, as you see that bat uses it for flying and man uses it for handling tools. Hence, the forelimb of man and the wing of bat are homologous organs. Similarly, forearms of cat and man are homologous.

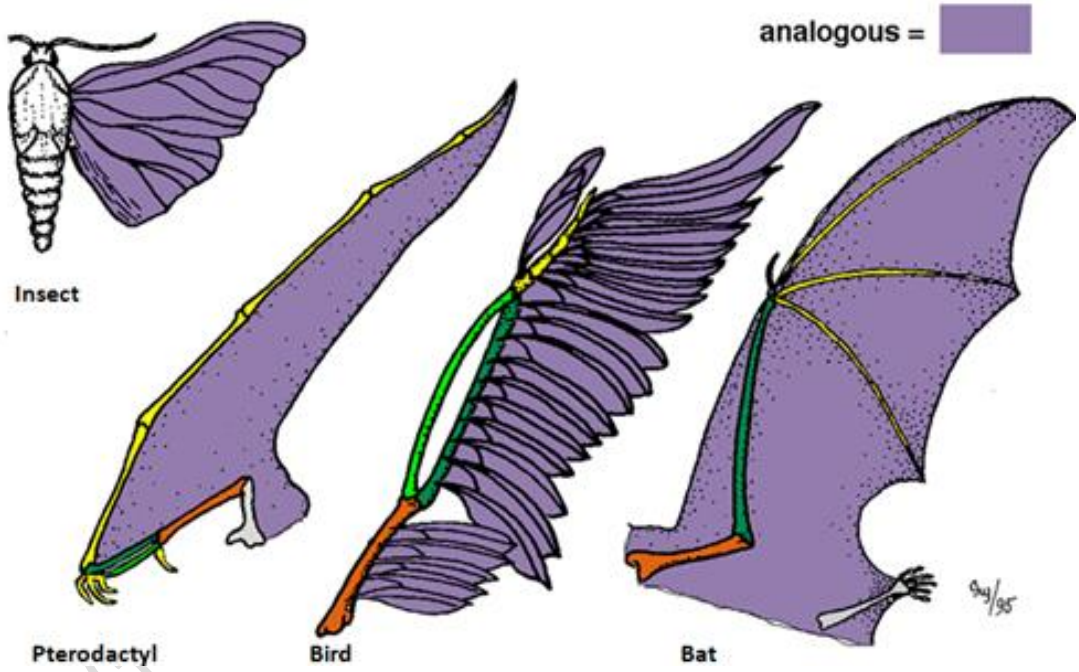


## Analogous organs:

Observe the internal structure of the wings of butterfly, or see its preserved specimen, observe the shape and size. You will find that it is membranous and is made up of thin cuticle.

There are veins in the wing but there is no skeleton. Now, take the preserved specimen of a bat and a bird, and examine their wings. You will find skeletal support. What does this type of comparative study indicate?

It shows that the basic structures of wings of butterfly, bird and bat are different. In other words, they are anatomically different, although externally they look alike. Wings in these animals are used for flying. Such organs that differ anatomically and in embryonic mode of origin but perform similar function are said to be analogous organs.



## Project question

### Identification of Zooplanktons from a nearby lake

### INTRODUCTION

Zooplankton are heterotrophic (sometimes detritivorous) planktons. Planktons are mini organism drifting in oceans and fresh water bodies. Zooplanktons are usually microscopic but some (such as jellyfish) are larger and visible with the naked eye, large groups in a water body are seen with their body colour.

Zooplankton play vital role in a lake's ecosystem and food chain. Unlike algae, or phytoplankton, zooplankton that do not produce their own food. They are responsible for eating millions of little algae that may otherwise grow to an out-of-control state. In t these filter feeders, a community of zooplankton can filter through the volume of an entire lake in a matter of days.

Zooplanktons are valuable food source for plantivorous fish and other organisms. The presence or absence of healthy zooplankton populations can determine some commercial fisheries success in both fresh and salt water bodies. By ensuring that the lower parts of the food chain are healthy, we can protect the higher ordered organisms, like fish, whales and even humans. The biggest zooplanktons are only five millimeters long and the smallest and just one thousandth of this size. They float, drift or weakly swim in the water.

Ecologically important protozoan zooplankton groups include the foraminifera, radiolaria and dinoflagellates. Important metazoan zooplanktons include cnidarians such as jellyfish and physalia: crustaceans such as copepods, ostracods, isopods, amphipods, mysids and krill: chaetognaths (arrow worms); molluses (pteropods), and chordates (salps and juvenile fish).

### AIM

To identify zooplanktons from a nearby water body.

### OBJECTIVES

After this experiment you will be able to

- Understand the importance in zooplanktons in water systems. Know their importance in food chain and food web
- Identify that these are micro organisms Understand that presence of zooplanktons favors for better living of fishes and other organisms.

## ZOOPLANKTONS

Rotifers are found more than 2000 species in freshwater. They are named for their distinct mouth, called a corona. It is used for both locomotion and filter feeding. Rotifers serve as a food source for larger organisms, including other zooplankton Most of them do not swim and simply drift along with water current, like many planktons But some species are better at moving. They are very efficient reproducers and can multiply asexually in good conditions. They eat bacteria, detritus, other rotifers, algae and protozoa.

Cladocerans are small crustaceans characterized by a two-valve carapace or outer shell, covering most of their body he.. Daphnia, Bosmina, Ceriodaphnia, and Diaphanosoma all look very similar except with very small differences in body shape. They feed on algse detritus and bacteria. As filter feeders, use legs to create a flow of water to pass into mouth, then to suck for food particles..

Daphnia, known as the water flea, able to move in water, in a very unique, jerky manner by moving appendages in a paddling motion. Several different genera of Cladocerans are seen in most lakes and abundance of Daphnia longiremis among many other zooplankton genera. Daphnia and several other zooplankton exhibit "diurnal migration. This is a daily routine of migrating between the darker, deeper waters of the lake during the day and the more food dense surface waters during the night. These avoid the bright, sunny surface waters during the day, and can avoid predators, feed at the surface safely under cover of night.

Two Copepods are calanoids and cyclopoids. As larva they are known as nauplit As suspension feeders, they feed mainly on phytoplankton and protozoans, but some species are predatory, Copepods can be good swimmers and also undergo diurnal migration. They are important link for food webs between small, algal cells all the way up to large fish and even whales.

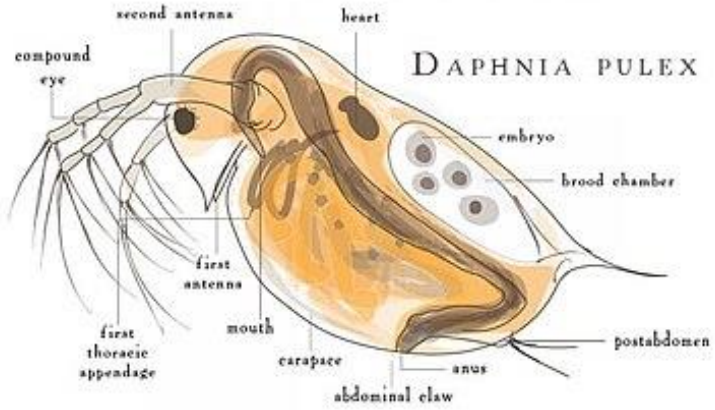
### APPARATUS

Sample bottles, microscope, dissection microscope, watch glasses, petri dishes, cover glasses, brushes, slides, droppers, filter papers, droppers.

### PROCEDURE

1. Sample water is collected from pond in a reagent bottle with a plankton collecting net.
2. Reverse the net into the bottle and add 4% formalene.
3. add rose Bengal stain to the sample and allow it for 24 Hrs.
3. Get the sample bottle to lab and transfer bottom water in to watchglass.
4. Transfer a drop of water using dropper on to a slide.
5. Keep cover glass and observe under dissection microscope for bigger zooplanktons and use microscope for smaller zooplanktons.
6. Identify the zooplanktons and count
7. Make a table of observations as per species, phylum.

**Daphnia( water flea)**




**Identification Characters:**

1.It is freshwater branchiopod, cosmopolitan commonly found in ditches and ponds

2. Body is bilaterally compressed, and enclosed in a bivalved carapace, ending into caudal spine and anteriorly into rostrum pointing downwards, measures 1-2mm, in length.

3. Head is rounded and bears large biramous antennae which help in swimming, small jointed antennules, mandibles, maxillulae, and large sessile eyes are very distinct.

4. Abdominal appendages are absent and thoracic appendages are 5 pairs and leaf-like.

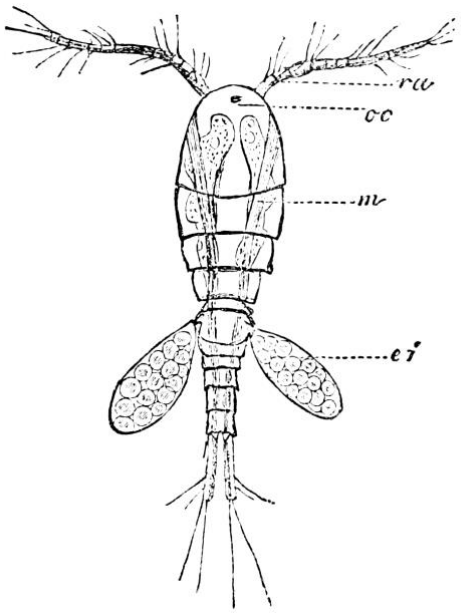
5. The female carries eggs in brood pouch, which is found near the back.

6. In a stained slide heart, gut, sex organs, gut diverticulum and eggs are seen.

7. Thoracic appendages form efficient food-catching organs.

8. Sexes are separate. Brood pouch is absent in male.

**Cyclops**




**Identification Characters:**

1. Most common freshwater copepod, found in ponds, ditches and in brackish water. 2. Body is elongated with somewhat broad anterior and narrow posterior end, measures 1.7-5.5mm in length.

3. Body is differentiated into cephalothorax and abdomen. The head and first thoracic segment fused to form cephalothorax, which is covered by carapace.

4. A median eye is present over carapace.

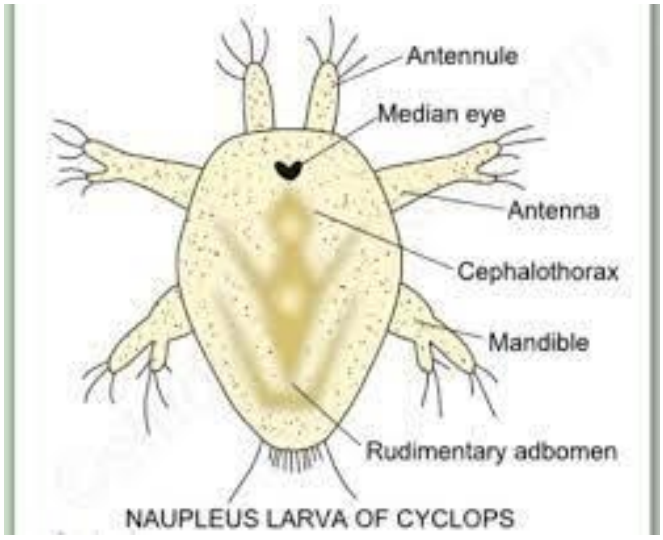
5. There are 5 thoracic and 4 abdominal segments. Fourth abdominal segment bears a caudal style or forked tail and anus dorsally.

6. The body appendages are uniramous antennules, short antennae, mandibles, maxillulae, maxillipedes and legs.

7. Mature females carry two lateral ovisacs attached to upper abdominal segment.

8. This animal serves as food and intermediate host for various helminth worms.

**Nauplius larva**




**Identification characters:**

1. In crustacean development includes various larval stages. After cleavage, egg hatches into first larva, called as nauplius larva.

2. It is a free-swimming, minute, conical and microscopic creature with broad anterior and narrow posterior end.

3. The body is divided into indistinct head, trunk and bilobed anal region.

4. It contains three pairs of appendages, namely uniramous antennules, biramous antennae and biramous mandibles, which assist in swimming.

5. It also contains a median eye and gut.

6. Larva is unsegmented without ventral nerve cord and heart.

7. This larva has great phylogenetic significance and is supposed to be arthropodised trochophore.

# Identification of Zoogeographical realms with the Map and specific fauna

## Aim

To study zoogeographical realms and identify specific fauna in respective regions.

**OBJECTIVES**

After this experiment you will be able to

- Identify that some animals are confined to certain parts of the globe. > Understand the nature of different animals and their habitats..
- Identify different zoogeographical realms and their animal fauna. Know island fauna.
- Know about discontinuous distribution of certain animals.
- Understand and identify animals and their respective realms.

**ZOOGEOGRAPHICAL REALMS**

Zoogeographical region is the number of major areas of the earth having a characteristic fauna (especially mammals). The areas include the Palaearctic, Ethiopian, Oriental, Australian, Nearctic, and Neotropical regions. Zoogeography is the branch of the science of biogeography concerned with geographic distribution (present and past) of animal species. Biogeographic realms are large spatial regions within which ecosystems share a broadly similar biological evolutionary history. Eight terrestrial biogeographic realms are typically recognized.

**Meaning of Zoogeographical Realms**

On the basis of presence and absence of several organisms, the earth can be divided into some regions which are called realms. Several scientists proposed several scheme of realm P. L. Sclater (1857) divided the geographical areas of the Earth into six parts, on the basis of the distribution of birds.

After that, Alfred Russel Wallace in 1876 published a paper on zoogeographical realms. He retained the 'six area concept of Sclater, but included in his study all the terrestrial vertebrates and invertebrates. The only change, he made was in renaming the Indian region of Sclater to Oriental region.

The details of the above realms are given below:

**1. PALAEARCTIC REALM:**

**A. Geographical Boundary:** Geographically this realm consists of whole of Europe, Northern part of Africa and Asian Himalaya and Nan ling range of China.

**B. Characteristic Vertebrate Fauna:**

**i Fish:** Carp, Salmon, Pike, Sticklebacks are common in freshwater of this region.

**ii. Amphibia:** European Salamander, Proteius, Hynobius, Bombinator, Alytes, Didocus.

**iii. Reptiles:** Sand boa, lizard-Trigonophis and Alligator.

**iv. Birds:** Arctic temn, pheasant, wrens, finches, warblers, geese etc.

**v. Mammals:** Among 39 families of characteristic mammals, family - Seluinidae and Ailuropodie are endemic. Other mammals are porcupine, dog wild ass European bison, polar cat, deer, etc.

## 2. NEARCTIC REALM:

**A. Geographical Boundary:** This region consists, on its north the entire of North America, in south up to Mexico, in East Greenland and in west Aleutian islands.

**B. Characteristic Vertebrate Fauna:**

**i. Fishes:** Lepidosteus, Polydon, Acipenser and varieties of perches.

**ii. Amphibia**: Siren, Amphiuma, Cryptobranchus, Ambystoma, Ascaphys Axolotl larva. Most of them belong to caudate.

**iii. Reptiles**: Conophis, Chilomeniscus, Pituophis, Farancia are prominent snakes Phrynosoma, Uta are lizards and Aromochelys and Chelydra are turtles

**iv. Birds:** Turkey, Pelican, Crow, Cuckoo, Pigeon, Saras, Swan, Kite, Rel. Owl. Hawk, etc. Most of them are migratory birds.

**V. Mammals:** Didelphis, Armadillo, Caribou, pronghorn, srew, mole, bear, wolf, monkey, deer, bat, goat, mask ox, bison, etc. The mammalian family Aplodontidae and Pronghorn are endemic.

## 3. NEO-TROPICAL REALM:

**A. Geographical Boundary:** South and central America lower Mexico and West Indies are the constituents of this region. This region is connected with Nearctic region by central American isthmus and other parts are bordered by the sea.

**B. Characteristic Vertebrate Fauna:**

**i. Fishes:** 120 genus of the three families (Polycentridae, Gymnotidae and Trigodicae) are present in this region. The prominent fishes are Lepidosiren, Eel, Catfish etc.

**ii. Amphibia:** Caecilia, Siphonopsis, Hyla, Salamander, frog, toad, etc.

**iii. Reptiles:** Dromicus, Boa, Epicrates, snakes, Gecko, Alligator, Chelys, etc.

**iv. Birds:** Total 700 genus of birds are recorded in this region. Among these Rea, Tenemus, Screamus, Whatgin, Wean, Thrush, Parakeet.

**v. Mammals:** Total 32 families are recorded of which opossum, caenolestes, sloth, armadillo, rodents, American tapir, bat, spider monkey, lama, etc.

## 4. ETHIOPIAN REALM:

**A. Geographical Boundary:** It consists of southern part of the Tropic of cancer, most of the African mainland, southern part of Arabia and Madagascar.

**B. Characteristic Vertebrate Fauna:**

i. **Fishes:** Cat fishes, lung fishes (Protopterus, Polypterus) and several fresh water fishes are present.
ii. **Amphibia:** Xenopus and several species of cacilians are present. caudata is completely absent.
iii. **Reptiles:** Among snakes, Leptorhynchus, Ramnophis, etc.; among lizards, Monotrophis, Cordylus, Agama, Chameleon, etc. are prominent species.

iv**. Birds:** 67 families of Aves are recorded. Some important species, are Ostrich, Cuckoo, Parakeet, Eagle, Kite, Pigeon, Hornbill, etc.

**V. Mammals:** The recorded families are 51 of which 15 are endemic. The remarkable species are Zebra, Gorilla, Antilope, Leopard, two horned Rhinoceros, Hippopotamus, Lemur, Gnu, Baboon, Lion, Giraffe, Chimpanzee, Loxodonta, etc.

**5. ORIENTAL REALM:**

**A. Geographical Boundary:** Most of the Asian countries which are situated at the southern side of Himalaya is included in this realm. India, Burma, Indo-China, Malay, Sumatra, Java, Bali, Borneo and Filippines, etc. are within this realm.

**B. Characteristic vertebrate fauna:**

**i. Fishes:** Different types of carp, catfish, notopteridae, osteoglocid, cipriniformes

**ii. Amphibians**: Varieties of anurans, some salamanders and caecilians.

**iii. Reptiles**: Various types of snakes like, Viper, Pit Viper, Kraits, Lizards- like, Gecko, Aagamid, Varanus, Chamellion, Crocodiles, Gavialis. Platysternidae

iv. **. Birds:** Pigeons, Owls, Finches, Pheasants, Peacock, Saras, etc., are present.

v. **Mammals:** Srew, Rabbit, Dog, Cat, Boar, Rodents, flying Lemur, Elephants, Ox, Tiger, orangutan, gibbon, tapir, pangolin, Rhinoceros unicorns, etc., are important members. Out of 30 families only 4 are endemic.

**6. AUSTRALIAN REALM**:

**A. Geographical Boundary:** Australia, New Zealand, New Guinea, Tasmania and some islands of adjacent areas are included in this realm.

**B. Characteristic Vertebiate Fauna:**

**i. Fishes:** Neoceratodus Lung fish, Osteoglocidos, Gadopcidae, etc.

**ii. Amphibia:** Xenorhinidae family is present in New Guinea only. Pseudophryne, Pachybatrachus, Helioporus, Pelodyrus are other important members. Total 11 families are recorded.

**iii.Reptiles:** Important snake families are Phithonidae and Elapidae: Pizopidae, Apracidae, Liadidae are prominent lizards. Sphenodon of Rhynchocephalidae family is the famous relict of reptiles present in New Zealand.

**iv. Birds:** Casuary, Liar bird, Magpie, Emu, Kiwi, Scrab, Bawar are important members of this region. Nine hundred and six species of birds are recorded from this region.

**v. Mammals:** Ornithorhynchus (a marsupial), Tachyglossus (ant eater), Kangaroo, Dasyures, Dendrolagus (climbing kangaroo), Petaurus (flying opossum), wolf are the remarkable members.


## Study of Macroevolution with pictures of Darwin finches

**Macroevolution** is genetic change that occurs over long time scales, resulting in large changes in heritable traits in a population; changes large enough that we consider this population a unique taxonomic group, or species. Macroevolution is sometimes also termed **speciation** (the process by which a new species arises). This is the scale of evolutionary change that most people think of when someone mentions 'evolution'. For example, the medium ground finch is not the only finch species in the Galápagos Islands. The genus *Geospiza* contains nine species, all of which are found exclusively in the Galápagos Islands. Approximately 2 million years ago, the ancestor of these species migrated to the Galápagos Islands from South America. Between then and now, the birds migrated throughout the Galápagos Islands and across generations experienced different microevolutionary changes. Eventually, these small differences accumulated to the point that individuals of different populations are genetically distinct, no longer interbreed with one another, and perform different ecological roles in the habitat (for instance, some feed on seeds, while others feed on insects). Consequently, we now consider them different species. *Geospiza* is not the only group of finches on the Galápagos Islands - Figure 1.3.2 illustrates differences in head and beak shape between several finch groups on the Islands.

It is important to note that microevolution and macroevolution are not different processes. Both relate to genetic changes in a population across generations; the only difference is the timescale on which the two operate. Macroevolution is the accumulation of microevolutionary changes over a long period of time to the point that the population is unique from other populations, and is considered a distinct species.

**A medium ground finch, Geospiza fortis. Image from Wikimedia Commons**

**Beak and head shape of two Geospiza finches and two other Galápagos finch species. Clockwise from top left: *Geospiza magnirostris, Geospiza fortis, Certhidea olivacea, Camarhynchus parvulus*. Image from Wikimedia Commons.**

# Project work

## Study of Pond Ecosystem – Report submission

### INTRODUCTION

Ponds are natural water bodies found in the world and they can be manmade. An ecosystem is the technical term for a community of organisms. For such a community to form an ecosystem, it needs to be a distinct system where the organisms live and interact. Pond Ecosystem differs from other water ecosystems. Unlike the river ecosystem, which is categorized under the Lotic systems, pond ecosystem falls under the Lentic ecosystem for the reason that the water remains stagnant in ponds relatively for longer period time.

Pond ecosystem is an enclosed body of water that houses numerous different creatures. It is a biological system that includes water and plant and animal life interacting with each other.

### AIM

To study pond ecosystem and submission of report on its status

### OBJECTIVES

After this experiment you will be able to

- Understand about pond ecosystem and its components.
- Realize importance of abiotic and biotic factors.
- Identify biotic factors.
- Know about the food chain and food web of pond ecosystem.
- Appreciate various organisms living together with cooperation in stagnated water.

### APPARATUS

Hand lens, collection net, meshes of different sizes, collection tubes, iron hook, scissor, forceps and centrifuge

### COMPONENTS OF POND ECOSYSTEM

Components are of pond ecosystem

(A) Abiotic component

(B) Biotic component

**(A) Abiotic component:** It consists of water, dissolved minerals, acidity, alkalinity, inorganic nutrients, oxygen and carbon dioxide, light, rainfall, temperature, pressure sunlight, gravity, soil types.

**(B) Biotic component:** It includes the following

(i) Producers

(ii) Consumers

(iii) Decomposers and transformers.

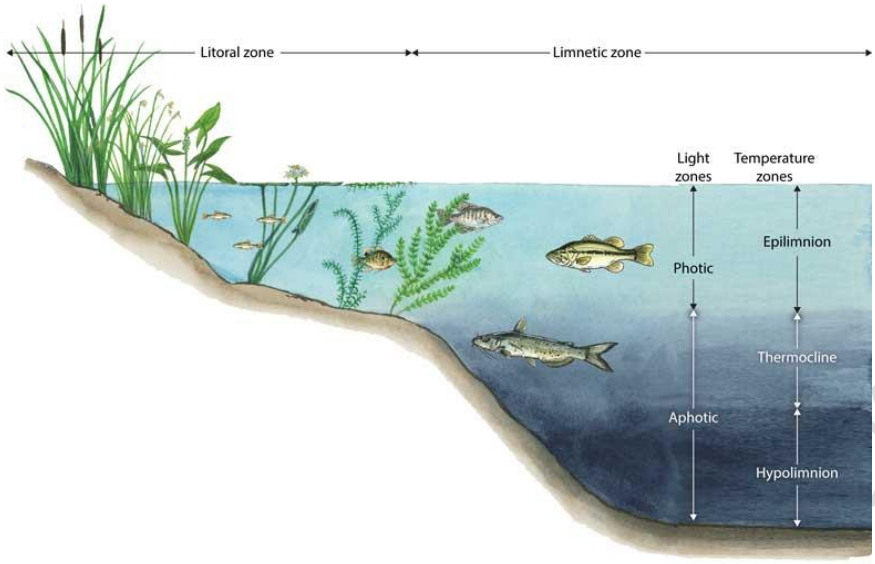
On the basis of water depth, types of vegetation, and animals there are three zones in a lake or pond i.e., littoral, limonitic and pro-fundal. The littoral zone is the shallow water region which is usually occupied by rooted plants. The limonitic-zone ranges from the shallow to the depth of effective light penetration and associated organisms are small crustaceans rotifers, insects, and their larvae and algae. The pro-fundal zone is the deep water zone where there is no effective light penetration. The associated organisms are sails, mussels, crabs and worms.

**(i) Producers:** Pond or lake ecosystems are formed by algae and other aquatic plants, such as Azolla, Hydrilla, Potamogeton, Pistia, Wolffia, Lemna, Eichhornia, Nymphaes, Jussiaca, etc., These are either floating or suspended or rooted at the bottom. The green plants convert the sun radiation energy into chemical energy through photosynthesis. The chemical energy stored in the form of food is utilized by all the organisms. Oxygen evolved by producers in photosynthesis is utilized by all the living organisms for respiration.

**(ii) Consumers:** In a pond ecosystem, the primary consumers are tadpole larvae of frog fishes and other aquatic animals which consume green plants and algae as their food. These herbivorous aquatic animals are the food of secondary consumers. Frogs, big fishes, water snakes, crabs are secondary consumers. In pond ecosystem, besides the secondary consumers, there are consumers of highest order, such as water-birds, turtles, etc.,

**(iii) Decomposers:** When aquatic plants and animals die, a large number of bacteria and fungi attack dead bodies and convert the complex organic substances into simpler inorganic compounds and elements. These micro-organisms are called decomposers.

Chemical elements liberated by decomposers are again utilized by green plants in their nutrition.




**Types of pond ecosystem**

**1. Salt ponds:** Salt ponds contain brackish(i.e.Salty) water and can occur close to the sea shore where waterlogged ground creats natural pools. Salt ponds can also occur in rocky areas

**2. Garden ponds:** These are artificially created ponds can contain omamental plants and different animal species.

**3. Freshwater pools:** Freshwater pools can be formed on land with rainfall. They can also be created by rivers flowing in to a depression in the ground. They can be home to fish, birds, amphibians, crustaceans and much other, wildlife.

**4. Vernal pools:** These are seasonal ponds. They are formed in depressions in the ground, but only when the rainfall is heavy. As a result, they will attract certain types of animals and birds for drinking water, and at other times of the year will be relatively deserted. In other terms seasonal oasis formed in the desert.

**5. Underground ponds:** Formed in the rocky environment of caves. It can accommodate animals including fish, different bacteria, lichens and others**.**

**Characteristics of pond ecosystem**

**1. Still waters:** These are lentic ecosystems-i.e., they involve stagnant or standing water.

**2. Surrounded by banks:** Pond ecosystems are surrounded by either artificial or natural banks.

**3. Wet:** These ecosystems are wet and humid ones.

**4. Different levels:** Distinct communities of creatures will live at different levels of a pond. Crustaceans and deep water fish may live at the lower level, whilst birds and blooming plants may live towards the surface.

**5. Variable in size:** Some pond ecosystems can be very small (such as a rock pool) while

others can be almost as large as a lake.

**Importance of pond ecosystem**

Pond ecosystems are very important, for better survival of different animals and needs to be protected.

**1. Biodiversity:** Pond ecosystems are very important habitats for so many different types of fish, birds, plants and crustaceans as well as insects such as dragonflies, damsel flies and pond skaters.

**2. Ubiquity:** Pond ecosystems can be found on every continent on the planet. That makes them very important for the life of organisms all over the world.

**3. Abundance:** Pond ecosystems are abundant all over the globe.

**4. Source of hydration:** Even they do not actualty live in the pond ecosystem, many species of animals will come to pond ecosystems drinking Humans can also use these ecosystems as a source of water.

**5. Beauty:** Pond ecosystems are very beautiful as well. As we watch the sunlight reflecting off the surface of a pond we can feel inspired, calm and in touch with nature

**PROCEDURE**

Biotic components of a pond can be studied exactly according to the classification of a pond ecosystem given above. Hydrophytes can be picked by hand and collected in polythene bags. Other submerged plants may also be taken out by iron hooks.

Phytoplankton and zooplanktons along with some water can be collected in glass plastic bottles. With the help of plankton nets, microorganisms can be collected in tubes

Macro-producers and macro-consumers can be estimated in gm. cubic metre by the quadrant method used in the exercise of biomass

Micro-producers and micro-consumers can be estimated in gm./litre of water collected as sample from an undisturbed part of the pond. They can be separated by centrifuging a little amount of pond water (containing micro-producers and micro-consumers) in test tube.

**OBSERVATION**

On the basis of their trophic position in the ecosystem observe different organisms and arrange them in the groups mentioned below.

**1. Producers:**

**i. Submerged:** Vallisneria, Ceratophyllum, Hydrilla, Potamogeton, Chara, etc.

**ii. Free-floating:** Azolla, Eichhornia, Lemna, Pistia, Spirodella, Salvinia, etc.

**iii. Rooted floating:** Trapa, Jussiaea, Nymphaea, Potamogeton, Nelumbium, etc**.**

**iv. Rooted Amphibious:** Marsilea, Typha, Ranunculus, Polygonum, Cyperus, etc.

**v. Phytoplankton:** Algal members of Chlorophyceae, Xanthophyceae, Bacillariophyceae, Myxophyceae, etc.

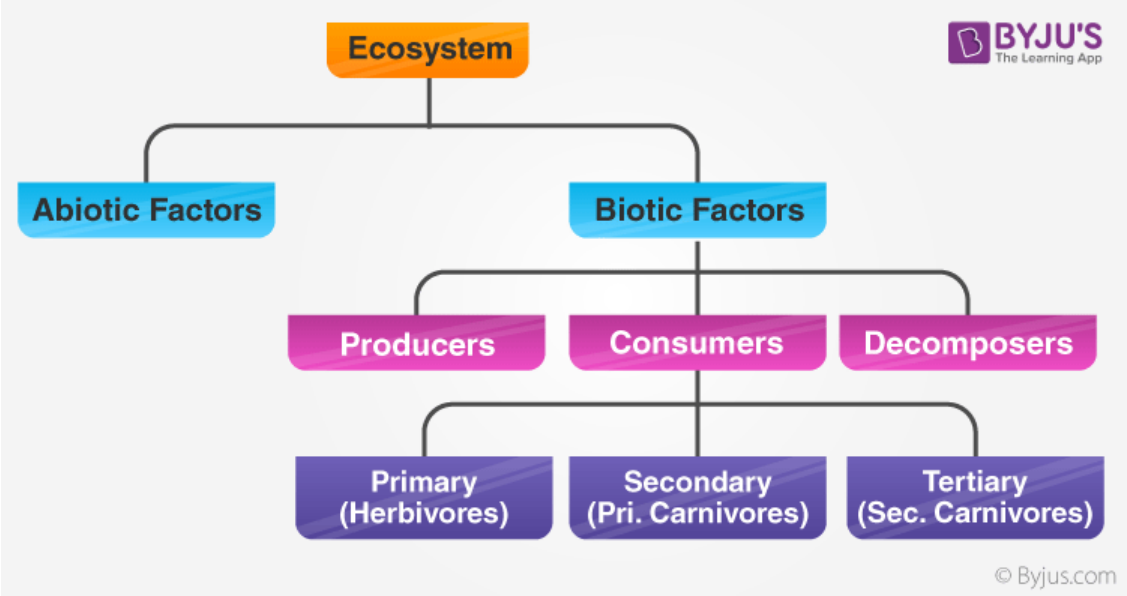
**2. Consumers:**

i. Consumers of the 1st order (Primary consumers): Zooplankton, some insects.

ii. Consumers of the 2nd order (Secondary consumers): Fishes, frogs and some insects.

iii. Consumers of the 3rd order (Tertiary consumers): Birds, big fishes, etc.

**3. Decomposers: Fungi and bacteria.**



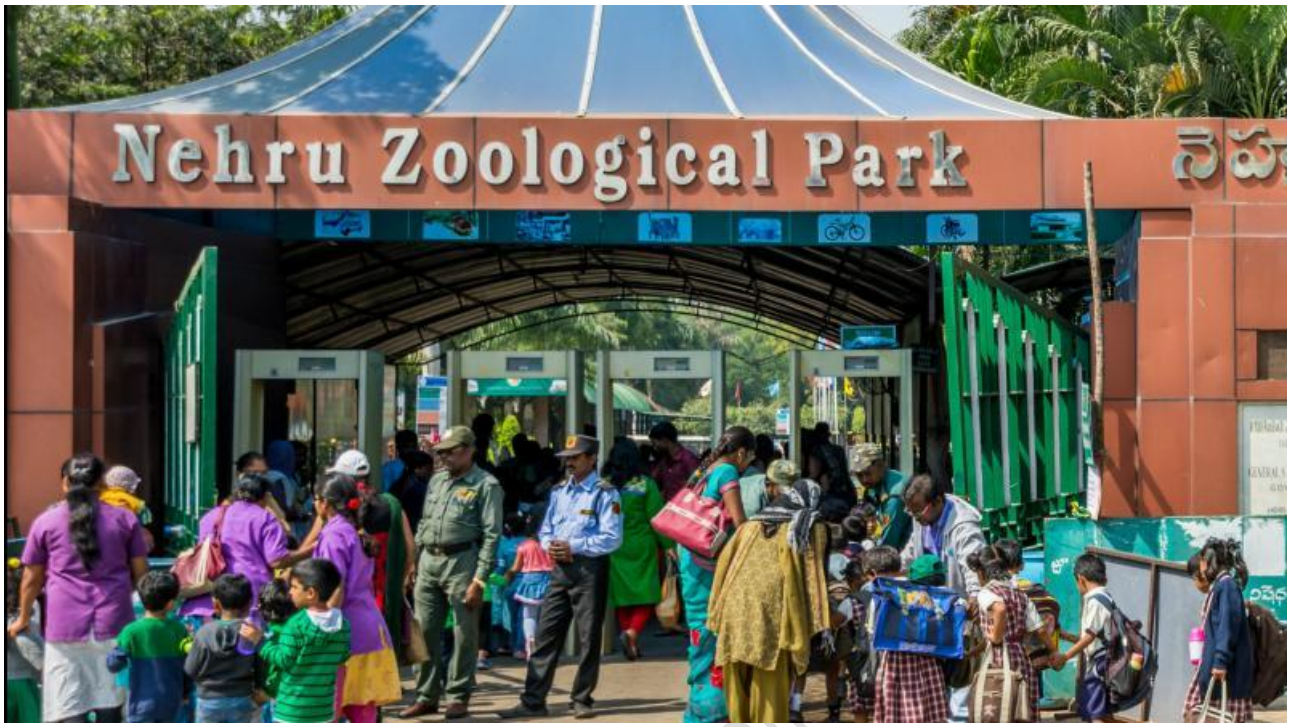

## II. Field visit to Zoo park to study the management, behavior and enumeration of animals

### INTRODUCTION

A Zoo (short for zoological garden or zoological park and also called an animal or park menagerie) is a facility in which all animals are housed within enclosures, displayed to the public, and in which they may also breed.

The term "zoological garden" refers to zoology, the study of animals, a term deriving from the Greek zoon ( 'animal') and logos (study). The abbreviation "zoo" was first used of the London Zoological Gardens, which was opened for scientific study in 1828 and to the public in 1857.

Zoo animals live in enclosures that often attempt to replicate their natural habitats or behavioral patterns, for the benefit of both the animals and visitors. Nocturnal animals are often housed in buildings with a reversed light-dark cycle, i.e. only dim white or red lights are on during the day so the animals are active during visitor hours, and brighter lights on at night when the animals sleep. Special climate conditions may be created for animals living in extreme environments, such as penguins. Special enclosures for birds, mammals, insects, reptiles, fish, and other aquatic life forms have also been developed. Some zoos have walk-through exhibits where visitors enter enclosures of non-aggressive species, such as lemurs, marmosets, birds, lizards, and turtles. Visitors are asked to keep to paths and avoid showing or eating foods that the animals might snatch




**AIM**

To study the management, behavior and enumeration of wild animals of a zoo

**OBJECTIVES**

After this experiment you will be able to

- Know the advantage of zoo for study of various animals in enclosures as well as in open areas.
- Understand the management systems of a 200.
- Understand the behavior of animals,
- Understand and identify the method for counting of animals. Know the benefits of a field visit.
- Apply the knowledge for preparing a detailed field visit report.

**STUDY OF MANAGEMENT OF ZOO**

The activities of Zoological Parks (National/Regional/Dist level) are managed by ten groups of administers of the zoo. Each group is headed by an officer or supervisor. They are Administrative Section, Animal Section, Veterinary Section, Sanitary Section, Stores Section, Education Section, Research Section, Garden Section, Security Section and Maintenance Section.

The Administrative work is headed by Administrative Officer and responsible for establishment and finances. AO is assisted by one Superintendent and 3-5 ministerial staff.

**The Animal Section** is the lifeline of the zoo park and looks after to take care of the feed and health of animals. This section is headed by Range Officer who is under DFO, And chief at district level is Conservator of Forests. The DFO is overall responsible person for all matters related to the animals present/enclosed in a particular zoo park. Forest Bet Officers. attendees working under the Range Officer to take care of all the needs of the animals.

**The Veterinary Section** is other most crucial section of the zoo park. It is headed by Govt.Veterinary Officer. Assistants/helpers of Veterinary Officer are also required to help and support. All are responsible for proper medical care of the animals during sickness. They are also responsible to decide the feed of the animals and to take preventive measures including routine checkup of animals. The zoo should have a modern well equipped Veterinary Hospital in the campus with all diagnostic facilities along with trained technical employees to carryout hospital activities.

**The Sanitary Section** is headed by a Sanitary Inspector. He is responsible for maintenance of clean and hygienic environment in zoo park and animal cages.

**The Stores Section** is responsible for procurement and supply of all essential items required for the operation and maintenance of the zoo park. The daily food of all animals is received by the store section and then it is distributed to different animal houses as per requirement of each animal every day. Further every day food distribution is to be recorded in register by section in charge

**The Education Section** is looks after awareness among the visitors Publication of zoo literature and organize special conservation related programmes for the masses, target groups, and students on special important days. The Curator (Education) is the officer assisted by Education Assistants. It also conducts educational programmes to school children on national and international important days. And develops educational films on animals, wild life and zoological parks.

**The Research Section** takes care of in-house data collection and basic research on various aspects of animals in captivity in the zoo. This group encourages students to take up activities related to zoo activities. This Section is under Curator (Education) Assistants.

**The safety and security** of zoo including related to animals, visitors and infrastructure is taken care by Security Section. They are responsible to maintain round the clock vigilance in the zoo. It is under a Security Supervisor with a group of 4-5 assistants.

**The Garden Superintendent** is responsible for maintenance of the greenery including lawns and gardens. This section should also maintain vermi compost unit to meet the manure requirement of the zoo park. All the natural waste is collected and kept a side for composting.

The responsibility of day to day maintenance of the animal enclosure and all infrastructure of the zoo is with the Maintenance Section. This section is under a Work Supervisor who is supported by 10-15 labor.

## STUDY OF BEHAVIOR OF ANIMALS IN A ZOO

Ethology is the scientific and objective study of animal behaviour. Behaviourism is a term which details the scientific and objective study of animal behaviour, Understanding animal behaviour is important in animal training.

Behaviour can be measured through visual observations either by standing and watching the animal or through the use of camera equipment to take photographs or video footage.

1. Wild animals are shy creatures. They learn from their parents to be very mistrustful of humans, because they have no way of knowing whether or not we mean them harm. When faced with a threat, wild animals believe they will survive only by fleeing, fighting, flirting.

2. Fleeing is the most popular way wild animals respond to danger. Because most wild animals will try to get away from humans. It is stranger to think that the animal running away is even more frightened than you

3. Animals in a nest or den feel cornered and will defend or fight themselves if approached, especially if they have young to protect.

4. Animals may try to fight by threatening, especially when they can get away quickly Wild animals use the same sorts of defense measures as their domestic cousins, they bite, peck, scratch, kick and flap their wings.

5. Snakes are a good example of animals that fight, perhaps because they are not as good at running away as those animals with legs or wings. If they are unable to escape, snakes will try to bite whatever is threatening them

6. Flirting is a way wild animals trick the person or creature thretening them or their babies, If a bird, such as a plover that nests on the ground, sees a predator coming towards its nest, it will behave in a way that leads the predator away. It flaps one of its wings while moving away from its nest. This behavior makes the predator think the parent bird is injured. The predator begins to hunt the parent who ties away as soon as it is wise to do so. Lured by the promise of an easy meal, the predator is tricked into moving away from the plover's nest

7. Freezing, like fluting, is used by an animal only if there is no escape and if there is no way to defend itself. They sometimes look as though dead. Birds caught in a trap or net will sometimes

freeze and appear very calm as we approach, even though they are extremely scared By playing dead, they are able to fool predators especially hunters.

8. Habituation is a simple form of learning and occurs in many animal taxa is the process where by an animal ceases responding to a stimulus. Often, the response is an innate behaviour. Essentially, the animal learns not to respond to irrelevant stimuli. For example, prairie dogs (Cynomys ludovicianas) give alarm calls when predators approach, causing all individuals in the group to quickly scramble down burrows. It is learned behaviour.

9. Kelp gull chicks peck at red spot on mother's beak to stimulate regurgitating reflex is Instinct behaviour.

Although it is wonderful to watch animals in the wild, it is safest to avoid wild animals in forest. Injured wild animals are especially fearful because they know that they have less chance of escaping, and so are more likely to hurt, if we get to close. Remember wild animals don't know that you want to help. If you find an injured wild animal it is better to inform specialized persons for help.

A group of researchers started giving potatoes to Macaques on the beach Later they started moving onto the beach, picking the potatoes from the sand, and cleaning and eating them. This is social transmission of behavior. About one year later, an individual was observed bringing a potato to the sea, putting it into the water with one hand, and cleaning it with the other. This behavior was soon expressed by the Macaques; when they gave birth, this behavior was also expressed by their young - a form of social transmission.

## ENUMERATION OF ANIMALS IN A ZOO

It is very hectic job, requires dedicated persons. The process of enumeration of wild life is nor same for all animals ie. land animals, fliers, nocturnal, diurnal, aquatic, burrowing, cave animals etc.

Birds are counted using photographs taken at a particular place. Images are helpful when photos are taken after disturbing a large group of birds. Each bird is identified and counted by marking 'x' on the bird image. Species are marked differently. It may not be perfect in counting the number of birds but for different species identification can be done positively.

Animal enumeration will be of very laborious as most of the animals move from one place to the other generally in search of food in a given territory. It is advisable to keep video cameras at water bodies and counting can be done to get a figure. It is can also be done manually by 4-6 persons depending on the area of animal counting. First the area is demarked into 4-6 parts and all enumerators should move in early hours of a day. As most of the nocturnal animals move into nest and diurnal comes out early hours of a day. Manual counting is time consuming.

This is detailed in simple manner but latest techniques such as satellite imaging can identify all animals but it is expensive.

**Question bank:**

1. **Ecology experiment----------6 Marks**
    a. **Determination water/Soil pH**
    b. **Estimation of chlorides in given water sample**
    c. **Estimation carbonates in given water sample**
    d. **Estimation of bicarbonates in given water sample**
    e. **Estimation of dissolved oxygen in given water sample**
2. **Problems on Hardy-weinberg law of equilibrium----- 5mar.**
3. **Spotters 2x2=4**
    a. **Endangered species**
    b. **Study of fossil animals**
    c. **Study of homology and analogy**
4. **Project question 5 marks**
    a. **Identification of zooplanktons**
    b. **Identification of zoogeographical realms with the help of map**
    c. **Macro evolution using pictures of Darwin finches**
5. **Record and Field visit report and Viva 5 marks**
    a. **Record book includes all the above material for 1,2,3,4 questions**
    b. **Field visit report submission includes (i) study of pond ecosystem**

**(ii) Visit to Zoo Park**

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