EVOLUTION

EVOLUTION OF LIFE FORMS - A THEORY

EVIDENCE FOR EVOLUTION PALEONTALOGICAL EVIDENCE

Palaeontological Evidences –

The study of fossils is known as : **Palaeontology**.

Fossils word : **Taken from Fossilis / Fossolium**

Father of Palaeontology : **Leonard da vinci**

Founder of modern palaeontlogy : **George cuvier**

Birbal Sahni is famous for Indian palaeonotology

TWO BRANCHES OF PALAEONTOLOGY –

1. **Palaeobotany :** Study of plant fossils
2. **Palaeozoology :** Study of Animal fossils

Definition of Fossils was given by **Charls Lyell** "Impression of past organism found in rocks called fossils."

Fossils provide one of the most acceptable evidence in support of organic evolution.

TYPES OF ROCKS :

(1) Sedimentary Rocks –

These are formed at the bottom of ancient oceans by deposition of sediments of sand, lime, coal and minerals which slowly change into hard layers.

Sedimentry rocks are also called as **stratified rocks**. Eg. Lime Stone, Sand Stone.

Fossils are mostly found in sedimentary rocks.

(2) Igneous rocks –

Such rocks are formed by ancient volcanic deposits which slowly cooled down and hardened as rocks e.g. **Granite rocks.**

They generally do not have fossils.

(3) Metamorphic rocks –

These are formed by metamorphosis of sedimentary and igneous rocks. Such metamorphosis may be caused by pressure heat and physical movements. e.g. Marble and Slate rocks.

TYPE OF FOSSILS :

1. **Unaltered Fossils :**

   In this type whole bodies of extinct organisms are found frozen in ice at the polar regions eg. Wooly mammoths (25000 yrs before extinct fossils were found from siberian region)

2. **Petrified fossils –** Most common type of fossil.

   Replacement of organic part by mineral deposites is called petrification. These fossils consists of only the hard parts e.g. bones, teeth, shells, wood etc. of extinct organisms.

   In human body first fossilization occur of teeth.

3. **Mould fossils –**

   Here no any part of the original organism is present. Only an impression of the external structure of body is preserved in wet soil.

4. **Cast fossils –**

   Some times minerals fills in the mould, resulting in cast fossils.

5. **Print Fossils –**

   Foot print or prints of wings, skin, leaves, stems etc made in soft mud which subsequently become fossilized are a common type of fossils.

6. **Coprolites:** Preserved faeces or excreta of organisms.

How the ages of the fossils are calculated?

Answer: To find out the correct age of fossils, we determine the age of rocks from which fossils are found. Rocks contain some radioactive elements that decay and convert into their more stable forms. This radioactive decay takes place at a constant rate for each radioactive element irrespective of the environmental conditions.

It is already calculated that how long it will take for half the quantity of the element to change into its stable form, and this time is known as its half-life. After another half-life has passed, the element will have decayed to a quarter of its original amount and so on.

For example: half life of carbon-14 is 5730 years; it means in 5730 years, half of the C-14 converts into its stable form N-14.

Thus we can calculate the age of rocks by relative proportions of radioactive element and non radioactive element in a sample of rock. This method is called radioactive dating.

There are several methods used to determine the age of fossils-

(1) Uranium Lead method
(2) Radio carbon method
(3) Potassium argon method
(4) Electron spin resonance (ESR) method- this is the modern and most accurate technique.

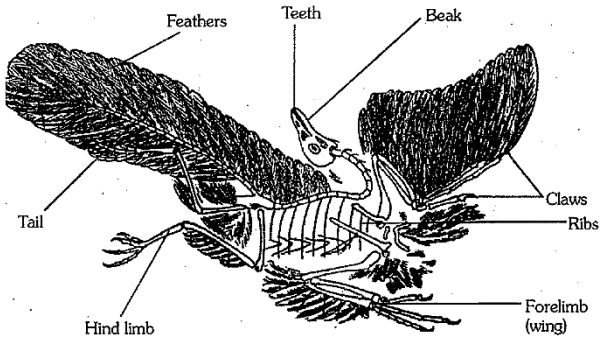
ARCHAEOPTERYX-

- It is a missing link between reptiles and birds.
- The connecting links which are not found in present times are called as Missing links.
- Its fossil was discovered by Andreas Wagner from Bavaria in Germany.
- It was found in the rocks of Jurassic period.

Reptilian characters:

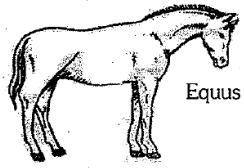
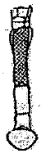
- Long lizard like tail with free caudal vertebrae
- Non pneumatic bones
- Weak sternum
- Teeth present in jaw

AVIAN CHARACTERS:



- Feathers on body
- Jaws modified into beak
- Forelimbs modified into wings (reduced)
- Hind limbs built in avian plan

EVOLUTION (PEDIGREE) OF HORSE-

Epochs	Height (in cms)	Appearance	Horse	Bones of limbs	No. of toes
Pleistocene	160	Modern Horse	 Equus		1 - toed (2 Splint bones)
Pliocene	120	Pony like	 Pliohippus		1 - toed (2 Splint bones)
Miocene	100	Donkey like	 Merychippus		3 - toed (No Splint bones)
Oligocene	60	Sheep like	 Mesohippus		3- toed (1 Splint bones)
Eocene	40	Fox like	 Eohippus		4- toed (1 Splint bones)

- Evolution of horse was described by C. Marsh.
- Many evolutionary changes were observed in house-

(i) Increment in body height, length of neck & legs.
(ii) Reduction in number of toes or fingers and development of running habit.
(iii) Development of high crown on teeth and formation of cement.
(iv) Enlargement in size of brain

GEOLOGICAL TIME SCALE -

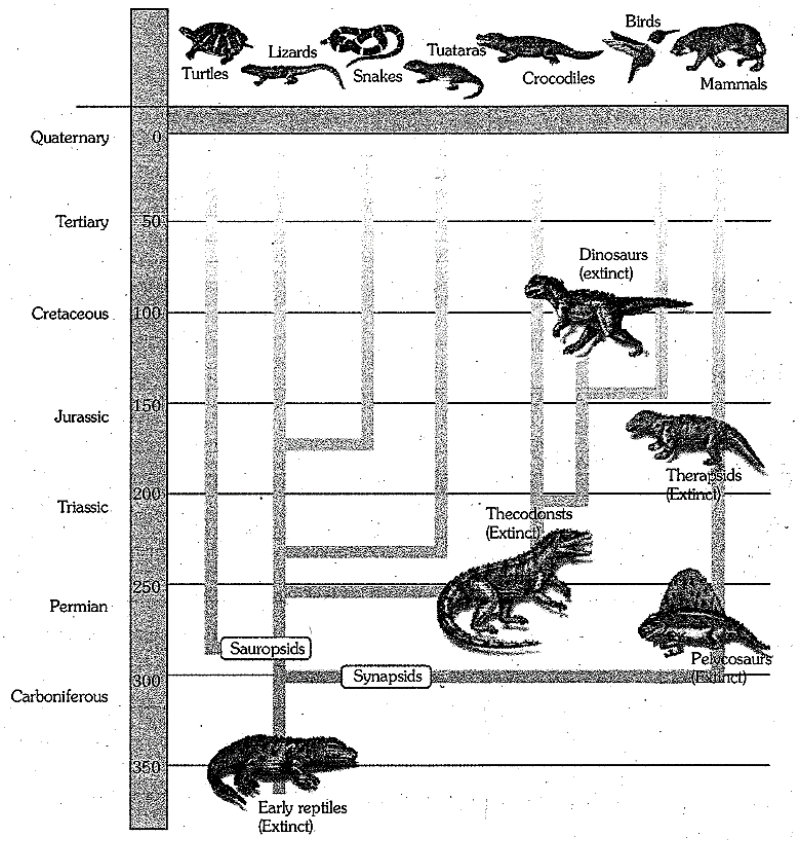
- It is the chronological order of the history of organic evolution on earth.
- The time after formation of the earth (4.5 billion years) is divided into 6 Eras, some Eras further divided into Periods and periods of recent era are divided into smaller time spans called Epochs.

- Intense geological disturbances have occurred on earth time to time, in which most of the pre existing organisms perished out and the few remaining ones evolved into new and varied organisms. These disturbances are called as revolution or cataclysm.
- The time before palaeozoic era is also called as Precambrian era because the first period of palaeozoic is Cambrian.

GEOLOGICAL TIME SCALE			
Era	**Period**	**Epochs**	**Life forms**
COENOZOIC (Age of Birds, Mammals and Angiosperms)	**QUATERNARY**	Holocene (Age of Man)	Mental age, supremacy of man
		Pleistocene (ICE AGE)	Human appeared, social life of human started
	TERTIARY	Pliocene	Apelike ancestors of human appeared
		Miocene	
		Oligocene	Anthropoid apes evolved from monkeys
			Rise of monocots
		Eocene	Eohippus appeared
		Palaeocene	Origin of primates
ROCKY MOUNTAIN REVOLUTION			
MESOZOIC (Age of Reptiles)	**CRETACEOUS**		Extinction of Dinosaurs & archaeopteryx
			Origin of primitive placental mammals and
			Modern birds
			Angiosperms also appeared
	JURASSIC (Golden age of Dinosaurs)		Dominance of dinosaurs and origin of first toothed birds and marsupial mammals
			Gymnosperms and ferns also dominated
	TRIASSIC		Origin of dinosaurs and oviparous mammals
APPALACHIAN REVOLUTION			
PALAEOZOIC	**PERMIAN**		Origin of mammal like reptiles, first Gymnosperm appeared
	CARBONIFEROUS (Golden age of amphibians)		Amphibians were dominant and origin of reptiles (seymauria)
			First seed plant originated
	DEVONIAN (Golden age of fishes)		Fishes were dominant and origin of amphibians
	SILURIAN		Jawless fishes were dominant and Origin of true fishes
	ORDOVICIAN		Giant mollusks were dominant
			Origin of jawless fishes (1st vertebrates), origin of chordata
	CAMBRIAN		Trilobites (Extinct arthropods) were dominant
SECOND GREAT GEOLOGICAL REVOLUTION			
PROTEROZOIC			Origin of protozoa, sponges, coelenterate, annelida & mollusca
FIRST GREAT GEOLOGICAL REVOLUTION			
ARCHAEOZOIC			Prokaryotes originated and dominated
			(Era of invisible life)
			Eukaryotes also evolved
AZOIC			No life, Only **chemical evolution** took place

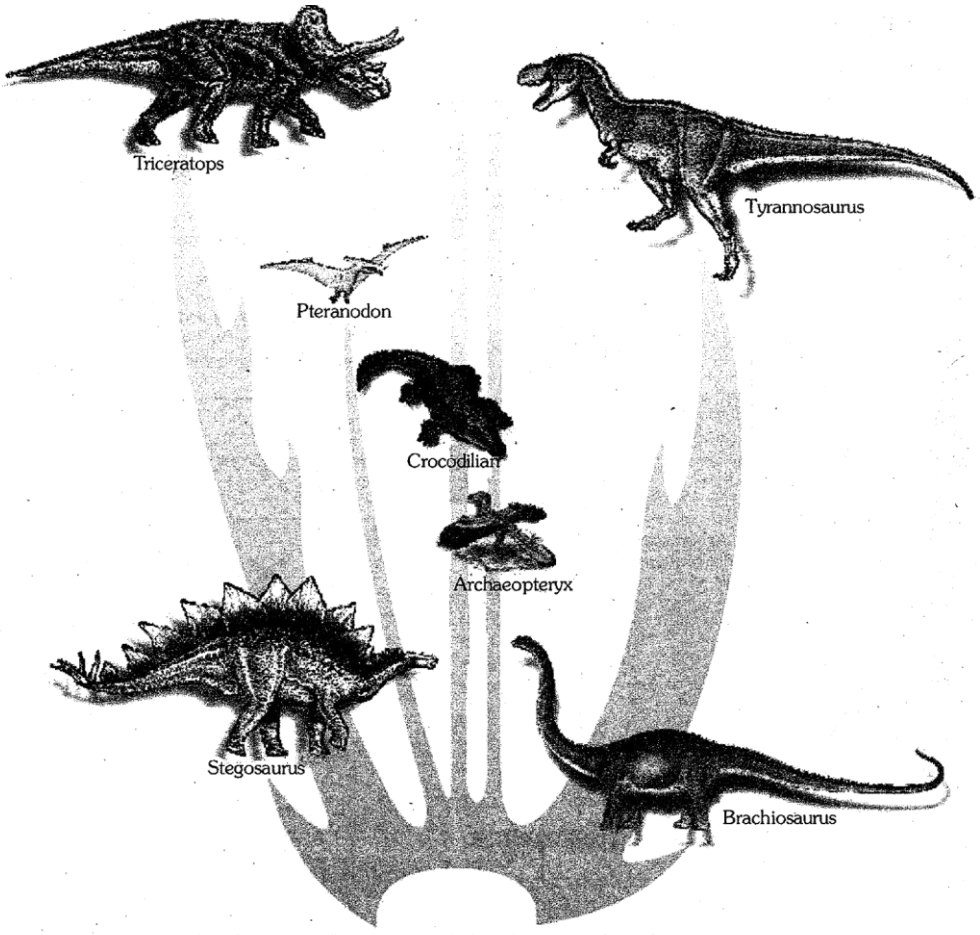
A brief account of evolution-

- About 2000 million years ago (mya) the first cellular forms of life appeared on earth.
- By the time of 500 mya, invertebrates were formed and became active.
- Jawless fishes probably evolved around 350 mya.
- Sea weeds and few plants existed probably around 320 mya.
- The first organisms that invaded land were plants. They were widespread on land when animals invaded land.



Representative evolutionary history of vertebrates through geological period

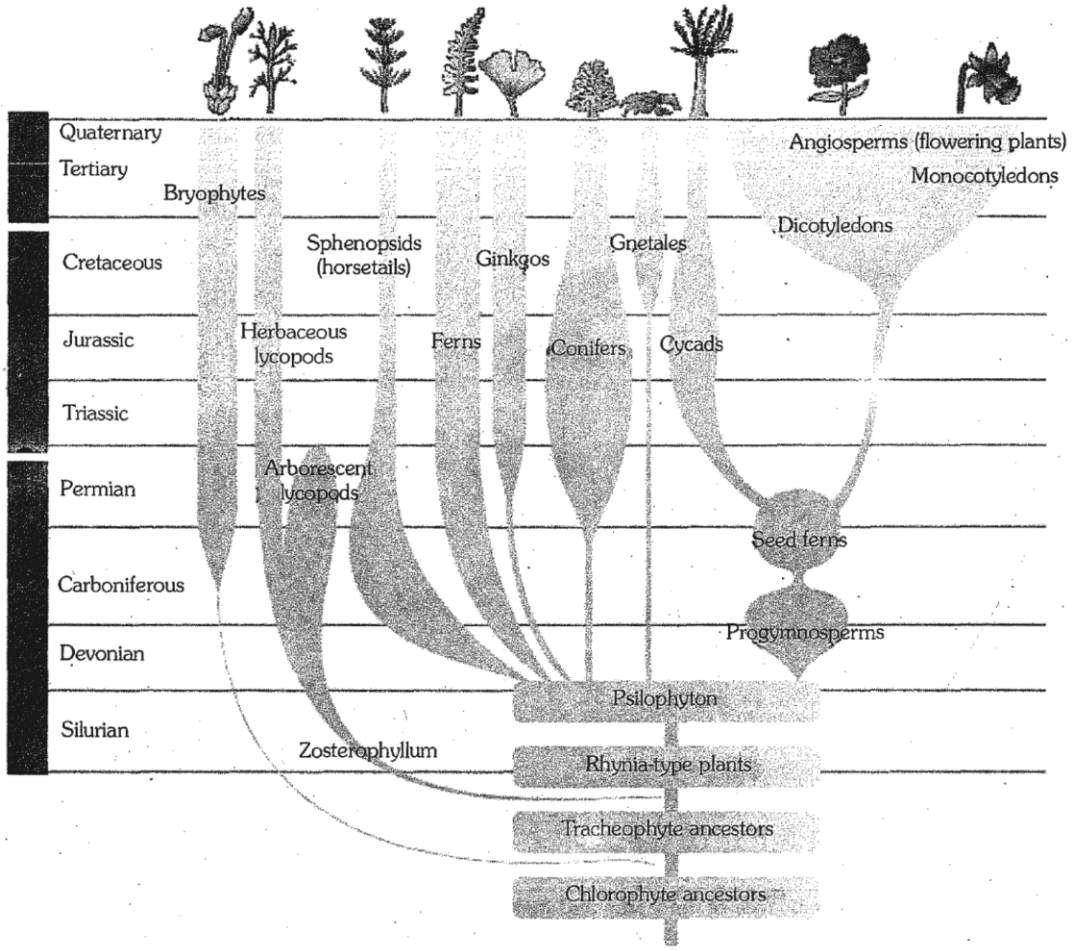
- Fish with stout and strong fins could move on land and go back to water. This was about 350 mya. In 1938, a fish caught in South Africa happened to be a Coelacanth which was thought to be extinct.
- These Coelacanth or lobefins evolved into the first amphibians that lived on both land and water. There are no specimens of these left with us. However, these were ancestors of modern day frogs and salamanders.
- The amphibians evolved into reptiles. They lay thick shelled eggs which do not dry up in sun unlike those of amphibians. Again we only see their modern day descendents, the turtles, tortoises and crocodiles.
- Synapsids were the mammal like early reptiles which gave rise to mammals.
- Sauropsids were the lizard like early reptiles which gave rise to different dinosaurs, modern reptiles and birds.



A family tree of dinosaurs and their living modern day counterpart organisms like crocodiles and birds

- In the next 200 million years or so. reptiles of different shapes and sizes dominated on earth.
- Giant ferns (pteridophytes) were present but they all fell to form coal deposits slowly.
- Some of the land reptiles went back into water to evolve into fish like reptiles probably 200 mya (e.g. Ichthyosaurs).
- The land reptiles were. of course. the dinosaurs. The biggest of them, was Tyrannosaurus rex about 20 feet in height and had huge fearsome dagger like teeth.
- About 65 mya, the dinosaurs suddenly disappeared from the earth. We do not know the true reason. This may happened due to (i) Climatic changes killed them or (ii) Meteorites collisions killed them. The truth is still unknown.
- Small sized reptiles of that era still exist today.
- The first mammals were like shrews. Their fossils are small sized.

- Mammals were viviparous and protected their unborn young inside the mother's body. Mammals were more intelligent in sensing and avoiding danger at least.
- When reptiles came down mammals took over this earth.



A sketch of the evolution of plant forms through geological periods

MORPHOLOGICAL AND ANATOMICAL EVIDENCES –

Different animals and plants show dissimilarities in their structure but in some characters they show similarities. These similarities are of two types.

1. Homology 2.Analogy

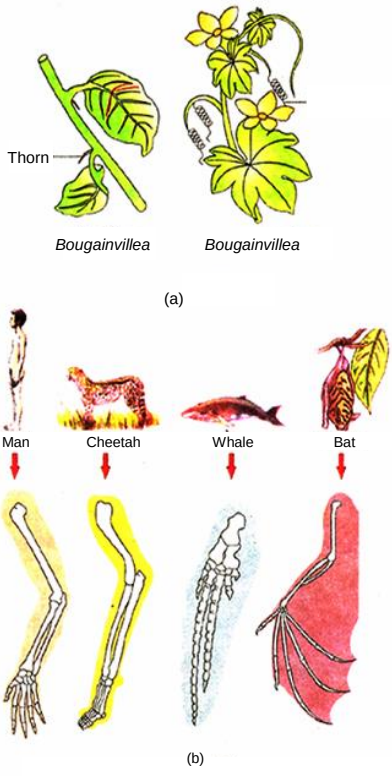
1. HOMOLOGY –

The similarity based on common origin, similar basic plan of organization and embryonic development is called **homology.**

Similarity in appearance and function is not necessary.

The organs which have common origin, embryonic development and same basic structure but perform different functions are called **Homolgous organ. Homologous term given by Richard Owen.**

EXAMPLES OF HOMOLOGOUS ORGANS –



Example of homolgous organs in (a) Plants and (b) Animals

(i) Forelimbs of mammals –

Horse	**Bat**	**Whale**	**Seal**	**Man**
Appearence Hard	Foot	wings	Paddle	Flipper
Function Holding	Running	Flying	Swimming	Swimming

In their fore limbs similar bones are present like – **humerus, radius, ulna, carplas, metacarpals and phalanges.**

(ii) Legs of invertebrates –

Cockroach	**Honey bee**
Walking	Collecting of pollens

But in both segmented legs are present are segments are same like **coxa, Trochanter, Femur, tibia, 1-5 jointed tarsus.**

(iii) Mouth parts of insects

Cockroach	**Honey Bee**	**Mosquito**
Biting and chewing	Chewing and lapping	Piercing and sucking

In each of these insects the mouth parts comprise **labrum, mandibles and maxillae.**

(iv) Homology is also seen in the skeleton, heart, blood vessels and excretory system of different vertebrates.

(v) **Thorn of Bougainvillea and tendril of cucurbita (Modification of axillary bud).**

(vi) Wings of sparrow and pectoral fins of fish.

(vii) Hind limb of mammals.

(viii) Potato & ginger.

(ix) Radish & Carrot

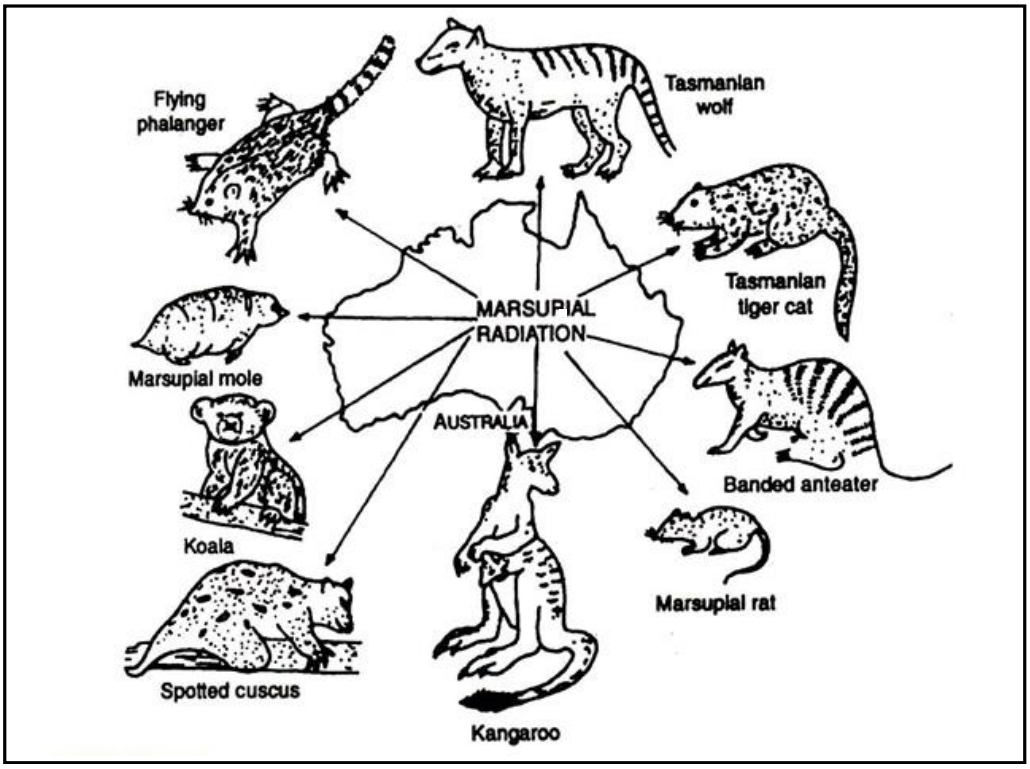
(x) Homology is also seen amongst the molecule. This is called **molecular homology.** For example the proteins found in the blood of man and apes are similar.

(xi) Testes in male and Ovaries in female develop from same embryonic tissue.

(xii) Pectoral fin of fish and flipper of seal.

(xiii) Flipper of penguin (bird) and dolphin (mammal)

Divergent evolution (adaptive divergence/adaption radiation)



Homology found in different animals indicate their evolution from common ancestors.

Species which have diverged after origin from common ancestor giving rise to new species adapted to new habitats and ways of life is called **adaptive radiation,** exhibit large number of homologous organs.

Homology shows **Divergent evolution.**

For Example Adaptive radiation gave rise to a varity of marsupials in Australia.

2. ANALOGY –

It is similarity in organs based on similar function.

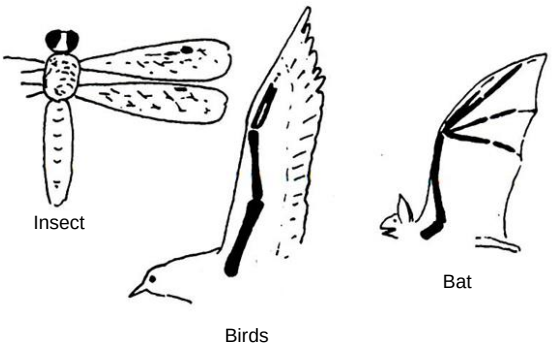


Fig.: Analogous organs

Organs which have different origin and dissimilar fundamental structure but have similar function are called **Analogous organs.**

Examples of Analogous organs –

(i) Wings of bat & birds are analogous to wings of insects.

(ii) Pelvic fins of fish, flipper of seal

(iii) Sting of bee and scorpion.

(iv) Phylloclade of Ruscus and leaf

(v) Chloragogen cell of pheretima and liver of vertebrate

(vi) Hands of man and trunk of elephant

(vii) Potato and sweet potato.

(viii) Eyes of Octopus and eyes of mammals (different in their retinal position).

(ix) Dog fish and whale.

Convergent evolution (adaptive convergence/parallel evolution)

Development of similar adaptive functional structures in unrelated groups of organisms is called **convergent evolution.**

For Example : Some of the marsupials of Australia resemble equivalent placental mammals that live in similar habitats of other continents.

When adaptive convergence is found in closely related species, it is called **parallel evolution.**

Analogous organs do not show common ancestory but they show evolution.

Evidences from biochemistry -

- Similarities in proteins and genes performing a given function among diverse organisms give clues to common ancestry.
- Composition and structure of protoplasm; enzymes, hormones, DNA, blood in chordates is also almost same. It shows that organisms shared ancestors in recent or distant past.