MAN-002
Archaeological Anthropology

Indira Gandhi
National Open University
School of Social Sciences

Block

3

GEOLOGICAL FRAME WORK

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BLOCK 3 GEOLOGICAL FRAME WORK

Introduction

Understanding geological history of our planet enables us to understand the backdrop as well as the stage within which the entire drama of organic evolution was played out. It will also be not just an over simplification to state that life itself is a product of the geological phenomenon. Another very important use of geological phenomena is to enable us the access to a geo-zoological sequence to help our understanding of the birth and progression of man in our planet. The sequencings of geological events provide convenient categories of time. In the absence of any form of calendar for such a distant past experts find it a convenient aid to form a time table or a chronometer. This chronometer is named 'Geo chronological time scale'. It is important to emphasis here that the various geo-zoological events are not necessarily of equal duration yet these are arranged as 'periods' of the past in a successive pattern. Invention of a plethora radiometric dating system has now been able to make the geo-zoological scale understood in a much better way.

Geology has enough evidence to prove that the planet has undergone very acute climatic fluctuations in the past. These climatic fluctuations resulted in thick sheet of polar ice descending as far south as almost 40^{o} N in the temperate belt. In the tropical belt the effect of the same change of increased precipitation caused heavy rain fall for long duration. This phenomenon is termed pluviation. Through, glaciation and pluviation cycles provided convenient stages within a time sequence.

Man evolved from within this climatic back drop. Around 14-17 million years ago trees started becoming less in E.Africa and hence a large number of primates were bushed to the ground. Ground living progressively changed their anatomy in such a manner that they could grind their food with specially evolved cusped teeth and also attempt an erect posture. This chain of changes took a long period of adaptive struggle for them. May be by 7 million years they already started showing 300 to 400 c.c. brain capacity. By the time this process reached 40,000 years from today man has already developed a brain capacity of 1200c.c to 1400 c.c. In addition to this his hands have been freed from locomotion. Nearly 50 different maneuverability of the wrist and fingers were also developed in this process. This enabled him as an accomplished tool maker. Power of cognition and co-ordinating movement enabled him to hunt animals and gather wild seed, roots and tubers.

Man's biological development in each of the stages in the path of his progression during all these million years clearly demonstrates that cultural development goes hand-in-glove in human evolution. Since erect posture brought about a narrowing of the birth canal, human babies had to be delivered with only 30 percent of its potential brain capacity. Consequently human babies are helpless for a much longer period of time than in other primates. This elongation of mother child dependency brought about a distinct change in their foraging technique. They started developing a 'home base' where weaning mothers or pregnant women are stationed, possibly maintaining a fire. The other members of the band return to this home base every night. This change brought about enormous number of changes in interpersonal communication and sharing of experience within the band. Progression of culture is studied by archaeologists, and human paleontologists study the biological process.

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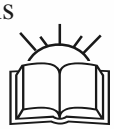
UNIT 1 TIME AND SPACE

Contents

Learning Objectives



Once you have studied this unit, you should be able to:

- understand the meaning of ice age and the climate that prevailed in the ice age;
- know about pluvial and inter-pluvial epochs that were present in the tropical region at the same time as the ice age in the temperate region; and
- learn the importance of environment for the evolution of Human being and his culture.

1.1 INTRODUCTION

It was Charles Lyell who brought forth the idea of geological time in his book, *Principles of Geology* in 1833. He was the first person to explain the relevance of geological strata for reconstruction of time. Geological strata means the layers of soil, clay, rocks and gravels which are usually found in linear order both on the surface and under surface of the earth. In fact the crust of the earth is made of such layers. Lyell's work is based on the law of superimposition of geological layers known as stratum. In an undisturbed sequence it is found that lower the stratum earlier the date of the stratum in respect to the layers lying on it. Natural history is divided into ages and eras based on this principle. Charles Darwin provided the evolutionist view and Lyell gave the background for the understanding of change and development.

Geology is a branch of science which deals with earth in historical order. Geology and geography are closely related to each other. Geography mainly studies the present day surface of the earth, which is exposed and can be seen, whereas the surface which was once exposed but now is under the present surface is mostly the subject of study of geology. Surface geology is equally important because a comparison of the undersurface condition with that of the present surface gives an idea about the conditions under which the undersurface layers were formed. In connection with surface geology major data which can be gathered are on the erosion and depositional activities. The present surface geology study, also known as, geomorphology, provides information about the land surface and the climatic

condition under which they were formed. This information helps us to reconstruct climatic condition of the earlier period. In the study of man the framework is made up of the geomorphology and environment of the area, that is the understanding of the space. It must be kept in mind that environment was not uniform throughout the time for human evolution.

Erosion and deposition are major activities in the formation of earth's surface. These are caused by elements like temperature, rainfall, wind and humidity. Surface materials are loosened by thermal activities, water and wind. The loosened materials are carried away by wind, water and by gravitation, if the surface is located on a slope. This process is called erosion. The eroded materials are carried by the elements, such as wind, water and gravitational pull and are deposited somewhere else. These two activities are going on on the surface of the earth under the influence of elements like wind, rainfall, temperature and humidity. These elements make up climates and are components of the environment.

Environment is made up of abiotic and biotic factors. Climate, soil and topography belong to the abiotic aspect of the environment. Flora and fauna belong to the biotic aspect of the environment. Man is a part of the biotic environment. Together with geology and geography comes another word, that is, ecology, which expresses the idea of interrelationships. Man evolved through Quaternary period. Therefore quaternary geography/ geology connote both environment and time. Various estimations put the date of Quaternary and about 4-2.8 millon years.

There are many approaches to the study of Quaternary geography. Following are the three basic approaches out of these (Butzer, 1964):

1) Individual Pleistocene researches by the natural sciences. These are carried out independently either in the fields or in the laboratory by geologists, geographers, soil scientists, botanists, zoologists and meteorologists. Most of the palaeoenvironmental data is obtained in this way.

2) Ecological and environmental information is gathered by collaborating with the anthropologist as also the archaeologist, especially in the field. Most common background for the study is provided by Pleistocene geology, geomorphology, palaeontology and pollen analysis.

3) Archaeological anthropologists work for a fuller understanding of human ecology of prehistoric man especially in the realm of cultural geography and economy.

1.2 GEOLOGICAL TIME-SCALE AND QUATERNARY FRAMEWORK

Of the 4,500 million and more years of the earth's existence only the last 600 million years can be traced with accuracy. Primitive forms of life must have been evolving for many millions of years before their first fossilized record is found in deposits dating from around 600million years. The earliest vertebrates did not appear for another 100 million years. Mammals date back to a little less than 250 million years. Man who is the most advanced of the mammals has only emerged within the last 2-3 million years.

Perspective of time is important for both culture historian and for the geologist. The Quaternary period is the last phase of geological history. It covers a time span of two million years and covers the total period of human history. Excepting for the last 5,000 years of recorded history, most of Quaternary represents prehistory.

> The history of the Earth is chronologically determined by the time scale which provides a base for the earth scientists, geologists, paleontologists, and other scientists to determine the age of the earth.

Geological time scale is divided into eras. The era in which we live is called Cenozoic. It is divided into two periods, the Tertiary and the Quaternary. Quaternary period is divided into two epochs, Pleistocene and the Holocene. Holocene is the recent time. It is a distinctive name for the last 10,000 years, for the sake of convenience. Pleistocene is a very unusual period in the history of the earth. It coincides with the history of man and also is a time when drastic climatic changes took place on earth. The environmental changes affected the mammalian life as well as human evolution. Throughout the greater part of earth's history world's climate was warmer and much less differentiated than it is today.

Towards the end of the Tertiary period, around 56 million years back there was a gradual cooling of temperature mainly in the higher altitude and latitudes. In the present day temperate regions there was a southward movement of the snowline compared to what it is at present. Similar change was observed towards north in the southern hemisphere. On the higher altitudes, on the mountain tops a similar lowering of snowline was recorded. As a result glaciers were found in areas where at present none exist. The present temperate zone was displaced towards equator by some 15 degree to 20 degree of latitude. The tropical regions of the world experienced change in average annual rainfall and subsequent decrease in the same. The climatic change brought in change in the environment and in the level of flora and flora. Pleistocene and Holocene environment changes are recorded in the strata of the earth's undersurface. Geological study produces a time scale for understanding of the evolution of man and change and development of his culture. Quaternary is considered as a framework, a backdrop against which anthropological study of man may be made. The framework is of environment, space and time. Human ecology gives rise to change and development in culture.

Pleistocene is divided into three parts; lower, middle and upper. This is based on time scale, which is available through geology, palaeontology, palinology and through radiometric dating. The beginning of Pleistocene is dated at c. 1.65 million years B. P. on the basis of date found at Olduvai Gorge. In the year 2009 International Union for Geological Science (IGUS) fixed the date for the beginning of Quaternary at 2.58 million years B. P. E (Before Present Era) at the base of Matuyama, palaeomagnetic event. Middle Pleistocene starts at 0.73 million years B.P. This is based on dates found at the sea core no. V28-238 (Shackleton and Opdyke, 1973), near the Solomon plateau in the Pacific Ocean. Upper Pleistocene begins approximately at 128 thousand year B. P.

Two developments have fixed time scale for Pleistocene. These are: (i) The advent of absolute dates for the entire 2.58 Myr and (ii) the stratigraphic record obtained from cores drilled into the ocean floors. These developments have revolutionised quaternary geology. The deep sea sediments provide a continuous stratigraphic

record of Pleistocene events that can be fixed at key points by absolute dates. The uppermost section falls within the range of C14 while sediments from the core can be tested for magnetic polarity. Palaeomagnetic studies have shown that at 0.73 Myr the earth's magnetic field changed from reversed to normal polarity. The Bruhn- Matuyuma boundary is a stratigraphic marker of worldwide significance since it can be identified in ocean cores and terrestrial volcanic rocks where it has been dated by Potassium/ Argon isotope decay methods. The boundary now marks the division between the lower and middle Pleistocene (Butzer and Isaac (ed), 1975). The last interglacial/ glacial cycle correspond to the upper Pleistocene at 128 Kyr. These are estimated dates. The climatic changes are gradual processes, and they happen over a range of time (Gamble, 1986).

1.3 PLIO-PLEISTOCENE BOUNDARY AND PLEISTOCENE PERIOD

Towards the end of the Tertiary period a gradual change in climate had been observed. The last epoch of Tertiary period which precedes the Pleistocene is known as Pliocene. The boundary between Pliocene and Pleistocene is important. This period is marked not only by absolute date but also by the presence of a group of animals who are the index to Pleistocene, meaning that they are found only in Pleistocene. Thus they are called index fossils for Pleistocene. These are known as villafranchian fauna after the name of a place called Villafranca d'Asti in Itally. At this place those fossils were first identified. Villafranchian fauna are *Equus* (horse), *bos* (cattle), *elephas* (elephant) and *camelus* (camel). The first three are more common in Eurasia. Any geological layer yielding any one of these fossils may be identified as Pleistocene. The beginning of Pleistocene is also marked by the appearance of deep water foraminifera *Globorotalia truncatulinoides.*

In India work has been done by various scholars both in the sub Himalayan regions and in the peninsular regions. New techniques and extensive works point to the Plio-Pleistocene boundary in the Siwalik deposits, in Kashmir valley in the Karewas deposit and in alluvial deposits in the peninsular region. The date for this boundary goes back to 1.9 Myrs (Dennel and Rendell, 1991).

1.4 CLIMATIC EPISODES OF PLEISTOCENE PERIOD

Glacial and Interglacial Periods

The pioneer in working on the climatic episodes of Pleistocene period was Agssiz in1840. This work was taken up by Penck and Bruckner in 1909. They made a synthesis of the fragmentary evidence found in the periglacial zone in the form of moraines, glacial tills, river terraces, loess profiles, pollen sequences, molluscan faunas, beetle assemblages and animal bones, particularly of rodent species. The result led to a classic Alpine chronology of four major glaciations separated by three interglacials. The terms for the four glaciers are Günz, Mindel, Riss and Würm, named after four little streams in the Alps. These four glacial and three interglacial stages formed the framework for the Pleistocene and Palaeolithic studies.

The deep sea core has revolutionised the idea of Pleistocene. It provides continuous stratigraphic record for the Pleistocene events. The stratigraphic record is constructed from hundreds of cores drilled into the ocean floor of the world. The coring of the ocean floor produces sediment columns, which are made up of small marine foraminifera. The foraminifera skeletons are made up of calcium carbonate and when the foraminifera were alive they had absorbed oxygen as well as its isotopes. Two types of oxygen are there, ^{16}O and ^{18}O of these ^{16}O is normal and ^{18}O is its isotope. The ratio of these two isotopes may vary because of evaporation. In case of high evaporation more of the lighter molecule of ^{16}O is taken up in the air and the heavier isotope ^{18}O is left in the oceans. At the time of ice formation, during the glacial part of the cycle the sea level falls as moisture is taken up and used to build continental ice caps. The oceans of the world then become smaller and are charged with ^{18}O. The sea cores inform us about the size of the ocean during Pleistocene and also about contemporary events that took place on the land surface (Gamble, 1986).The isotope sediments had been correlated by scholars for vegetation cycle on the basis of pollen analysis; by loess and loam cycles and by cave sediments. It became clear that oxygen isotope curve gives an indication of the changes of ice volume on land and of the oceans having consequently been slightly over 1% richer in ^{18}O at the last ice age maximum than today. Hundred thousand years scale dominates, then 40,000 years and subsequently 20,000 year of length of each fluctuation. Interglacial stages are identified by the pollen analysis. Through this time warmth loving fauna replaced the cold loving ones and deciduous mixed oak forests grew in place of coniferous ones.

Causes of Ice age

Several theories were put forth for finding out the reason for ice age. The most accepted one is the astronomical theory. It was developed by Crole and elaborated by Milankovitch. Earth's temperature would vary with periodic changes in earth's orbit and axis. Over approximately 96,000 years the shape of the earth's orbit is known to have changed from circular to elliptical and back. Axis tilts from about 21.5^0 to 24.5^0 and back over 42,000yrs. Variations in equinoxes resulted in variation in the time of the year when earth is nearest to the sun. This variation gave rise to the difference in reception of solar radiation on earth. Subsequently climatic fluctuation took place during Pleistocene.

Pluvials and inter pluvials climate

There is undoubtedly some evidence that there have been major climatic changes in the tropical region, in the lower latitude and lower altitude. There are traces of lakes in the region which are now dry; fossil soils are found which only could have been formed at a wetter and at subsequent drier periods than those prevailing today; and accumulation of windblown sand (dune) occurs under protective cover of vegetation. The relatively wet climate is known as pluvial and the relatively dry condition is known as interpluvial. There is no doubt that these climatic changes were directly or indirectly the effects of the same general cause which affected glaciation. The view that the pluvial in the low latitudes and glaciers of the high latitude were contemporaneous is still not firmly established (Oakley, 1968). Researches in East Africa have shown that there were four major pluvials with intervening interpluvials experienced in this zone. Their sequence is as follows:

4. Gamblian pluvial
   Third inter pluvial
3. Kanjeran Pluvial
   Second Interlpuvial
2. Kamasian Pluvial
   First Interpluvial
1. Kageran Pluvial

There have been two more wet phases recorded in the Post Pleistocene phase. These are:

ii) Nakuran

i) Makalian

The names for pluvial and interpluvial of east Africa are widely used in other parts of the country also to indicate similar climate and its sequences.

1.5 STRATIGRAPHIC EVIDENCES FOR CLIMATIC FLUCTUATION ON EARTH DURING PLEISTOCENE

Evidence for cold climate

Glaciers: It is a moving mass of ice. Snowline is the critical limit above which more snow falls than can melt. It is formed at a place where mean annual temperature is somewhere below freezing point (0^0c). Glaciers give important information about wind direction and moisture sources. Ice is an altered form of snow. Ice is formed due to repeated melting and over freezing of snow. Ice is capable of plastic movement. Movement of ice causes internal deformation and basal sliding over bedrock. The movement of ice leaves mark by carrying the loosened materials and also curving a deeply recessed basin known as *cirque* also termed as U shaped valley.

It is mainly stratigraphy which provides useful evidence of the Pleistocene climatic oscillation. Some of them are moraine, loess, frost soil, or solifluction, travertine, gravel deposits and certain types of flora and fauna.

Moraine: The debris material that is carried with the ice is known as moraines. Ancient moraines help in reconstruction of the past glaciers. There are various kinds of moraines, namely, lateral, end and bottom moraines. The classification is based on location of the moraine in relation to the path of the glacier. The bottom moraines are also known as till or boulder clay.

Loess: Windblown dust, which is finer than sand but coarser than clay. This is formed of rock waste of glacier climate, composed of dust which can be easily carried by wind. Loess is usually found in periglacial zone. It is pale yellowish in colour. Kukla (1975) distinguished alternating sequence of loess and loam. Loam represents warm climate. Stages of glacial and interglacial sequence on the basis of loess and loam are made in the areas where glacial ice did not reach.

Frost soil and solifluction: The area where temperature is such that subsoil remains permanently frozen is known as permafrost zone. During warm condition thawing of the soil takes place for only about a few cm to about a few mm. The zone has got certain geomorphic activities, such as solifluction, that is, soil creep of the thawed layer. In areas of annual freezing and thawing structures like ring or net work, known as stone ring and polygon soil are produced. Ice wedge is another formation. It is produced under -10 degree centigrade. Wedge shaped cracks are found due to presence of water and ice. Frost soil helps to recognise climatic feature. It is found in areas where the warmest month record below 10 degree centigrade. Such areas were too cold to allow any forest to grow.

Evidence for mild climate

Various kinds of soil are produced, namely, brown soil, black soil, due to growth of vegetation in a warmer condition.

Travertine: It is found in the lime rich region. It is a deposit of calcium carbonate. Formation takes under a humid climate.

Glacio-fluvial terraces: Streams of melt water formed near end of the glacier join to form rivers. The debris carried by the glacier is deposited as gravel along the course of the river when water supply to the river becomes less due to dry cold condition. At a subsequent time down cutting of the deposit takes place and a step like structure is formed. These terraces are important for understanding the glacial and interglacial sequence in a periglacial zone.

The area where actual presence of glacier is found is known as glaciated area. The area where direct presence of glacier is not found but the climate is influenced by the nearby glacier is known as the periglacial region. The area where no influence of glacier is found is known as a-glaciated zone. Man did not live on top of a glacier. He preferred periglacial and a-glaciated regions to live in.

1.6 PLEISTOCENE EPOCH IN INDIA

India is basically under tropical monsoonal climatic regime. Palaeoclimate varies in the subcontinent. There are three major geomorphological zones in India. They are the Himalayan region, the Indo-gangetic plain and the Deccan land mass. Wide glaciated tract is found in the Himalayas. The sub Himalayan region, mainly the Punjab plain and Potwar plateau were under periglacial condition and the rest of India was within a-glaciated or non glaciated tract having alternating pluvial and interpluvial climates.

Siwalik formation in North West India and Kashmir valley has yielded evidences of Pleistocene glaciations. Siwalik deposit occurs as low outermost hills of the Himalayas all along from the Indus to the Brahmaputra. The Siwaliks have yielded beds belonging to both Tertiary and Quaternary periods. The beds are named as Kamlial, Chinji, Nagri, Dhok Pathan, Tatrot and Pinjor. The Neogene-Quaternary boundary is found below the Pinjor beds. Fission track dating is made of a bentonic tuff, underlying a rich Pinjor fauna near Haro river (a tributary of the Indus), in Attock district, Pakistan and is placed at 1.61 plus minus 0.10 Myr B. P. (Agrawal, 1992).

Kashmir valley was formed around 4 Myrs ago. At the beginning the climate was warm subtropical with a South Western monsoon. But it changed to cool temperate (Mediterranean type of climate with winter rain) about 2Myrs ago with the rise of the Pir Panjal range. Between 0.6 and 0.3 Myrs three long cold periods have been detected on the basis of faunal, isotopic and pollen data, with corresponding warm periods observed in the loess-palaeosol sequence in late Pleistocene. The loess-palaeosol deposit of Kashmir valley is known as karewas.

De Terra and Paterson (1939) recognised main series of four glacial and three interglacial epochs, of which the first two glaciations were more intensive than the later two, with still later oscillations or stages of retreat. Each glacial period saw intraglacial pulsations of the ice front, more evident in the late stages than in the early, because of erosion and weathering. There had been two oscillations in the second glacial phase, four advances and a retreat in the third period and four advances in the fourth period, with several retreat stages.

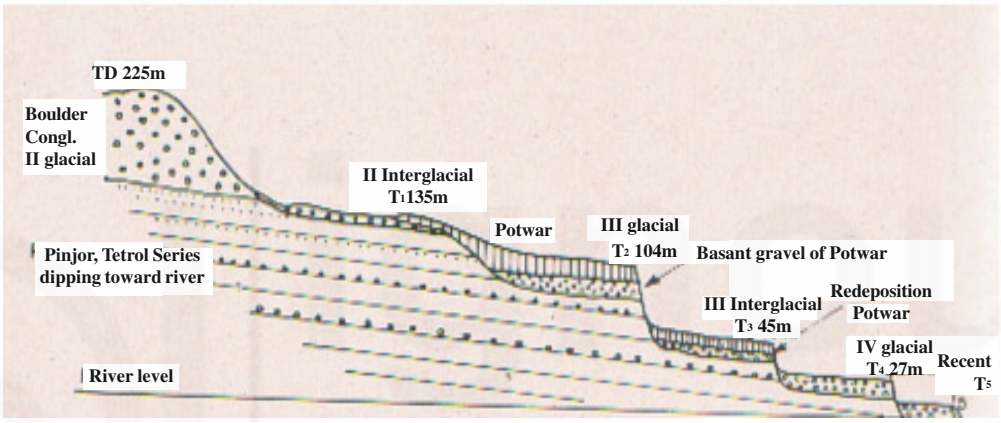


Fig. 1.1: Glacio-fluvial terraces in the sub-Himalayan region (Agrawal, 1992)

Pleistocene stratigraphy from second glacial period onward is found in the rivers of the region, such as, Jhelum, Indus, Sutlej and their tributaries. Fig. 1.1 above presents a composite picture of the stratigraphic sequence of the river terraces in relation to Siwalik formations. Owing to tectonic movement the boulder conglomerate which was deposited by second glacial period was tilted. The first rivers, Indus, Sohan etc were formed in the Potwar plateau. This started to curve away from them cutting into the boulder conglomerate giving rise to the first terrace (T1) at the second interglacial time. Second glacial terrace (TII) was formed by spreading of the gravel at first then covering it with loam. Third interglacial terrace (T III) is formed due to erosion carried out by the release of greater volume of water in the streams and rivers because of warming up of the condition and melting of glaciers at the source of the rivers. Terrace (IV) is of depositional nature belonging to fourth glacial period. The last terrace T (V) belongs to Holocene in the recent years. Large scale correction has been done for this sequencing. One of these refers to the entire glacio-fluvial succession of Potwar as belonging to late Pleistocene.

Pleistocene formation of peninsular India has yielded evidence for alternating wet and dry conditions, similar to that of Africa's pluvial and interpluvial conditions, though the nature and types of the climatic events are quite different in India from those of Africa.

A sequence of environmental changes in the Thar Desert for the last two million years has been analysed through laboratory and field studies. There are a number of formations which have yielded evidences and a correlation of them has given a complete sequence. The sediments studied are in the form of river sections, tanks, wells etc. The formations are named after local place names. There are some important formations. *Jayal* formation is made up of cobbly gravel and is dated to late Neogene to early Pleistocene. Though unconfirmed, lying on it is the *Amarpura* formation. It is made of loam, marl and kankar. *Amarpura* formation is dated from Middle Pleistocene to Upper Pleistocene period. *Didwana* formation is constituted of Aeolian and lacustral formation. This section had been dated by several techniques. The *Didwana* profile ranges in age from Middle Pleistocene to Holocene.

Quaternary deposits in Peninsular India

Quaternary geological formations can be classified into six distinct units depending on the mode of occurrence: (1) Fluviatile deposits of river valleys, (2) Aeolian deposits, (3) Shallow marine deposits, (4) Cave deposits, (5) Laterite and (6) Thick deltaic deposits (Prasad, 1999).

1) **Fluviatile deposits of river valleys:** The Pleistocene sequence in Narmada valley is important because it has yielded the fossil partial skull of Narmada man. It is one example of fluviatile deposit mainly of sand, silt and gravel. Along Pranhita-Godavari basin rich mammalian fauna consisting of *Elephas namadicus, Equus namadicus* and *Bos sp*. are found indicating Pleistocene date for the sediment.

   In Narmada valley, in Chennai region and in the eastern part of India the Pleistocene sediment is mainly represented by fluviatile deposit in the form of alternating deposits of gravel and silt bed. The gravel beds represented wet phase. River had more water and due to greater volume and velocity of the river gravel was formed and deposited. At the time of a relatively dry phase volume and velocity of the river water was less and finer materials were deposited. On the whole two distinct cycles of wet and dry phases are noticed in most of the areas. In eastern India three cycles are identified (Ray, 1999).

2) **Aeolian deposits:** Aeolian deposits are represented by loess and windblown sand dunes. These are confined to arid and semi-arid regions. The coastal tract contains various terraces of sand dunes indicating successive positions of the shore lines.

3) **Shallow marine deposits:** Near Tuticorin a number of beds have yielded invertebrate shells belonging to late neogene/quaternary boundary. These also included *Elephas hysudricus* and *Bos sp.* The Milolite limestone known as Porbandar stone of Saurasthra, the littoral concrete of Bombay and Kathiawar coast and the shell limestone deposits along the coast lines of Kerala and Tamilnadu represent Pleistocene deposits of coastal region.

4) **Cave deposits:** The cave deposits in Kurnool, Andhra Pradesh contain numerous fossils in the stalagmite floors. These belong to Pleistocene- early Holocene date.

5) **Laterite:** Laterite is a product of weathering in a humid climate. Low lying plains of east and west coasts are covered by laterite. They also cover terraces and are associated with palaeolithic implements. In Madras and Singhbhum area secondary laterites were also deposited in the tributary river valleys in place of gravel and silt deposits.

6) **Thick deltaic deposits:** The Rivers flowing into the Arabian Sea showed comparatively slow rate of deposition along its mouth. Kutch and Cambay region is uplifted to the present height in the Quaternary time.

Human habitat and culture: As mentioned earlier the Quaternary gives a framework for the study of human adaptation, change and development of culture. A complete geographical-ecological understanding of a prehistoric community – the palaeoenvironment, its resource potential and external limitations, and man and environment relationship which is manifested in the economics are considered an important aspect in the study of Archaeological Anthropology.

The glacial periods did not have a high biomass. Man adapted to this environment by cultural innovation. Interglacial period had produced higher biomass and human adaptation with culture was more prolific in nature.

In the tropical region the oscillation between wet and dry phase was not drastic. Change and development of culture was more gradual in nature, without much drastic change. Culture that flourished during Pleistocene is known as Palaeolithic. It is subdivided into lower, middle and upper Paleolithic stages.

1.7 SUMMARY

Quaternary geo-morphology has been the backbone of prehistoric chronology for a long time. Of course this was also aided with palaeontology and palynology. However, in the recent years deep sea core oxygen isotopic analysis with palaeomagnetic reversal phases have provided a stronger and more solid support to this prehistoric calendar. Geo-morphology, and geology, as such, have been used as an aid for reconstructing past climatic features during various periods within Pleistocene. The world experienced two types of climatic events. One in the temperate regions and the other was in the tropical areas. In the former there were advance and retreat of glaciers, corresponding with cold and mild climatic phases. In the tropical areas there were alternating wet and dry conditions, corresponding with more rainfall and less amount of rainfall. Cause of ice age is predicted as a result of astronomical change in the axis and orbit of the earth around the sun and subsequent variation in the reception of solar radiation on earth. Quaternary gives a background for the study of man and his culture in the fluctuating climatic situation. India experienced glacial condition in the Himalayan and sub-Himalayan regions. Rest of India experienced pluvial and interpluvial conditions. Evidences of Quaternary climate are found in various stratigraphic evidences. In fact regional variation of climate and biosphere, within specific geological stages, was responsible for giving rise to different types of ecological condition. Paleolithic culture in India and other parts of the world was formed in response to the fluctuating climatic condition, which varied through space and time within quaternary epoch.

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Sample Questions

1) Discuss why Quaternary is considered as a framework in the study of man.
2) What are the stratigraphic evidences for cold climate in Europe.
3) What are the evidences for mild climate in temperate region.
4) What was the climatic background of Europe during Pleistocene period.
5) What kind of climatic fluctuation took place in tropical region during Pleistocene period.
6) What are the evidences of Pleistocene climate in Rajasthan
7) Write short notes on the following
    i) Moraine,
    ii) Loess,
    iii) Interglacial,
    iv) Periglacial,
    v) Karewas,
    vi) Didwana

UNIT 2 RECENT PERIOD

Contents

Learning Objectives

Once you have studied this unit, you should be able to:

- learn about Holocene, the present epoch in which we are living;
- understand the climatic change from fluctuating Pleistocene to stable Holocene or recent period;
- understand the present climatic event through various stratigraphic evidences; and
- get a brief outline of nature of adjustment made by man in the changing condition.

2.1 INTRODUCTION

Holocene is the last phase of the Quaternary. It is synonymous to the terms Recent and Post-glacial. It is convenient to maintain a distinctive name for the last 12,000 years (B.P.E.) because the climatic set up in this period was much different from its preceding period. The onset of the Holocene in Europe brought in climatic and ecological conditions similar to those of the present day. During the last 12,000 years (B.P.E.) there were numerous short term fluctuations, as well as, long term trends towards cooler or warmer, moister or drier climate. These were not significant compared to the climatic events which took place by the end of the Pleistocene. In Europe and other temperate regions the climate gradually became warmer. Previously, climate was quite cold. With the rise in the temperature snowline receded pole ward and to a higher altitude on mountain tops. As a result land form changed, patterns of vegetation changed and cold loving animals moved north wards giving way to warmth loving species.

Similar changeover of climate from the Pleistocene fluctuating condition to that of the present day stable climate has also taken place in the tropical countries like Africa and India. It is believed that the Holocene is nothing but a prelude to another glacial or pluvial time. Probably the peak of the recent interglacial/ inter pluvial epoch was reached at c. 12,000 yrs (B.P.E) and we are heading for a changed sequence in another c. 10,000 yrs. The marks of climatic change and the change in the environment are left on the surface of the earth. Geological study of different areas has confirmed that smaller climatic oscillations marked

the post Pleistocene climatic regime. It means that at the early part of Holocene there were shorter cold and warm fluctuations until the present climatic stability was reached. Man reacted to the change by adjusting to the environment with his culture. Culture of early Holocene or Post Pleistocene time period is called the Mesolithic culture. Subsequent stabilisation of climate and development of the modern man gave rise to agricultural economy, which culminated in great civilizations of the world. In fact considering the time span of human history it is the last c. 10,000 yrs that have seen very fast progress in the cultural and economic history of man.

2.2 HOLOCENE GEOMORPHOLOGY

Europe

Europe was under the influence of glaciations during Pleistocene period. Snowline marking the arctic tundra was extended up to the present temperate zone. At the end of Pleistocene period, due to change in solar radiation, Europe was gradually warming up. This led to mass scale change in geography, biology and human culture of Europe.

Deglaciation

By the end of the Pleistocene there was evidence of the retreat of glaciers towards the polar regions of the earth. First warm phase after the last glaciation, that is, würm, is known as Bölling. Then around 12,000 B. P. another interval came, which is known as Alleröd. Tundra vegetation was replaced by coniferous forests. Climate was warmer during Alleröd times than the main Würm glaciation. Overall climate became continental and on the dry side in Europe. However, there was a short cold phase after the warm phase. Glaciers readvanced in Europe and north America and world sea level dropped by another 5-10 m.

Change in the sea level

In Europe the changes in the sea level is understood in detail in the Baltic region. The evolution of Baltic region to that of the present geographical condition is summarized below:

Baltic Sea	Began c. 2000 B. C.
Littorina Sea	Began c. 5000 B. C.
Ancylus Lake	Began c. 7800 B. C.
Yoldia Sea	Began c. 8300 B. C.
Baltic Ice Lake	Began c. 9000 B. C.

Movements of the sea level, also known as eustatic movement and the land surface movement known as isostatic, took place with the end of the ice age. Sea level rose because large quantity of water was released in the sea due to melting of the ice. With the melting of the ice great mass of weight was lifted from the surface of the earth and land surface was raised upwards. This has been studied in detail in the Baltic Sea region of the Scandinavian Peninsula. Baltic was an Ice Lake by the end of the glacial period. During Pre-Boreal period with the melting of the ice, it became a sea and was known by the name Yoldia Sea. It was named after the molluscan fauna *yoldia artica*. Land surface rose during Boreal

phase and Baltic became a fresh water lake and is known as Ancylus Lake, with the characteristic presence of mollusc, *Ancylus fluviatilis.* During the subsequent Atlantis period the sea level rose again and Baltic became a sea known as Littorina Sea. This phase is identified with the presence of common periwinkle shells known as *Littorina littoria.* Several transgressions and regressions of sea took place in Atlantic period. Transgression means advance of sea and regression means retreat of the sea. Some of the transgressions are dated.

Change in vegetation pattern

The first phase of Holocene is known as Pre-Boreal (8300-7500 B. C.). Boreal means forest and pre-boreal is the period which preceded the full development of forest. At this time environment changed much more. The glaciers were reduced to their present dimensions. The retreat of glaciers was rapid. Climatic changeover from glacial to post glacial went through a gradual process producing an over-all warm condition, gradual retreat of the continental glacier and a climate ultimately warmer than that of the present day. Standard pollen zones were established. From the perspective stages of vegetation, the environmental changes of the early Holocene proceeded gradually.

K. Jessen in 1934 divided Holocene climate of Europe into nine basic zones based on pollen analysis. Pollen analysis provided a picture of forest development in north and northwest Europe. Forest in Scandinavian language is referred to as boreal. Europe was under Park Tundra condition (pollen Zone I-III) by the end of Pleistocene. With warming up of climate park tundra vegetation made way for Birch-pine pollen zone (IV) of the pre-boreal period that is a period through which forest development was taking place. The first phase of forest development is known as early boreal (pollen zone V). This phase was dominated by pine trees, but hazel and birch were also found. This is followed by late boreal (pollen zone VI). Pine and hazel trees dominated the forest, together with some elm and oak in its first phase and lime and alder at its later phase. Pollen VII (a) is known as Atlantic period because the land bridge connecting Great Britain to Europe was submerged and the climate of the area was exposed to the influence of Atlantic Ocean. The forest of this period is characterized by the presence of alder-oak-elm-lime trees. This phase continues into a period known as sub Boreal (pollen zone VII b). In it elm declines slowly and hazel increases (Table.2.1). The climate becomes such as is found today in Europe.

Table 2.1: Pollen profile of Holocene period in northwestern Europe (after Butzer, 1964. P. 407)

Zone	Date (B.C.)	Name	Dominant Vegetation	Inferred Climate
VIII	After 800	Subatlantic	Beech	Maritime
VII	3000-800	Sub-boreal	Oak-beeck	More continental
VI	5600-3000	Atlantic	Oak-elm	Warmer and maritime
V	(7500) - 5800	Boreal	Hazel-pinc oak	Warmer and continental
IV	8300 - (7500)	Preborcal	Birch pine	Warm-continental

Change in the animal world

Forest did not abruptly replace tundra at the close of the Pleistocene. Rather, forest-tundra and parklands, succeeded by open and woodlands, dotted by numerous drained tundra lowlands. The woodlands forest tundra was preferred by reindeer and bison in winter. The Pleistocene tundra fauna gradually became extinct. Large species like mammoth, wooly rhinoceros, giant elk and musk-ox gradually disappeared. The reindeer which provided most of the livelihood in Pleistocene became restricted mostly to Northeastern part of Europe. New animal spectra appeared.

Change in human adaptation

The onset of the Holocene period had a sudden and serious effect on man. The great herds of herbivorous were replaced by more solitary games, such as, deer, wild cattle, boar and similar other animals. The Mesolithic culture was considered a consequence of environmental changes. Human populations adapted themselves with the changed condition. In the Boreal period growth of forest gave rise to forest based culture represented by heavy equipments like axe and adzes, suitable for woodwork. Some of the areas in the central Europe was free from forest because of infertile loess deposits of last glacial epoch. In this area and along the Mediterranean coast microlithic culture flourished.

> The Holocene is the name specified to the ~10,000 years of the Earth's history –the moment since the end of the last major glacial epoch, or ice age.

Africa

Leakey found two wet phases intervened by a dry phase during the post pluvial condition in Africa. They are Makalian and Nakuran respectively. The Makalian is the first post pluvial wet phase. Evidence of this phase was found in the lake Nakuru and is represented by a strand line 375 ft above present day Lake Nakuru. Cultures contemporary to this climatic stage are Elmentieta, Wilton and upper Capsian, better known together as Late Stone Age culture in Africa. The Nakuran is the second of two distinct post pluvial wet phases recognised in Kenya. It is represented by a strandline 145 ft above the present Lake Nakuru. The *contemporary* cultures were Late Stone Age cultures of Africa. This phase was preceded by a very dry phase correlated with climatic optimum. That means that in between the wet phases Makalian and Nakuru represented a dry phase.

Holocene in India

Similar to Pleistocene, Holocene geological formations can also be classified into six distinct units depending on the mode of occurrence: (1) Fluviatile deposits of river valleys, (2) Aeolian deposits, (3) Shallow marine deposits, (4) Cave deposits, (5) Laterite and (6) Thick deltaic deposits (Prasad, 1999).

1) Fluviatile deposits of river valleys

In the Kashmir valley the palaeosol developed at 18Kyrs is considered to be the first phase of deglaciation of the valley. Climatic amelioration was suggested by Agrawal (1992) around 18Kyrs, 6-5 Kyrs and 1 Kyrs B. P. This is also correlated with increase in human settlement in Kashmir valley.

In the Potwar region of the Siwaliks last terrace in the rivers of the area, the terrace T (V) belongs to the Holocene period. Even in the peninsular region, wherever identifiable, the last terrace near the river bed belongs to the Holocene.

2.2.1 Sea level Changes

3) **Shallow marine deposits**

Work in the ocean floor sediments of Arabian Sea and Bay of Bengal suggested a weak monsoon around 20,000 B. P. during the last Pleistocene epoch. Evidence from the Arabian Sea core has shown that there were three cold and arid phases approximately at 18kyrs, 7 kyrs and 2 Kyrs. At Tuticorin bay Zeuner had identified fossil dunes and present day dune along the coast. His study has shown that sea level changed from higher to lower level by early Holocene time. The fossilized dunes were formed at the time of higher sea level. Sea was higher by 20-30 ft at the end of the Pleistocene. Worldwide dry climatic phase led to the formation of dunes and also to lagoons along the coast. These are locally known as *teris*. The Mesolithic people lived on the ancient dunes and exploited the marine resources.

Afterwards the climate changed and weathering occurred. This made the dunes get fixed. They became reddish and cemented. In the next phase wind activity restarted and fresh *teris* and lagoons began to be formed.

2.2.2 Deltas

6) **Thick deltaic deposits**

The delta regions have shown mainly the sea level changes and also the changes that had taken place due to tectonic movement by the early Holocene period. This is mainly observed in Kutch, the deltas of Arabian Sea.

2.2.3 Deserts

2) **Aeolian deposits**

In the deserts of Thar the lacustrine formation of Didwana sediment yielded interesting results. The alternating evaporate and non evaporate suggest fluctuating hydrology in response to the slight amelioration of the arid climate of the terminal Pleistocene and the early Holocene (13,000-6000 B. P.). Organic rich clays and domination of *Artemisia* pollens suggest sub-humid climate between c. 6000 and 4000 B. P.

Dunes were formed during late to early Holocene period in the arid areas of Gujarat, especially at the Mesolithic sites of Langhnaj. The dunes were formed after a short wet phase. The low areas around the dunes were inundated and formed lakes. Mesolithic people lived along the lake shores. Their habitation also coincided with gradual desiccation and formation of the dunes.

5) **Laterite**

In Deccan plateau and other areas the Holocene deposit consisted of red colluviums soil made of pelletic laterite. There are loose kankary deposits found over the gravel of last wet phase.

Special mention may be made of a calcareous deposit known as *ghutin* lying on top of the silt bed or alluvium deposit of late Pleistocene. Geologists found that the *ghutin*layer always suggested Post Pleistocene deposition.

2.3 SUMMARY

Worldwide Holocene heralded the beginning of recent climatic condition. Recent or Holocene is considered as a period of climatic stabilisation. It could very well be another interglacial age. However, this period had experienced a gradual changeover from fluctuating climate of Pleistocene to stable climate of Holocene. Evidences from geography, geology, palinology and palaeontology have clearly shown the dynamicity of climatic change over and subsequent cultural adaptation of man to the changed climatic condition in Europe.

Holocene deposit in India had shown that there were smaller climatic oscillations before the present day condition was reached. In the glaciated and periglaciated regions small advances of cold phases gradually led to the present day condition. This is noticed in the Karewa deposits and in the terrace sequence of Kashmir valley and Siwaliks, respectively. In the Desert area the pollen study had shown alternating short spells of semi-arid condition until the present day arid condition set in. This is also recorded in pollen analysis from lakes in Rajasthan and measuring of the alternation of salinity and fresh condition of the water of the lakes. In the coastal region fossil dunes were formed. In the plateau area kankary lateritic pellets and calcareous ghutin were formed because of the onset of dry condition after a short wet phase.

India is a land of diverse geomorphological features. Similar diversity was maintained in the Holocene period. Man settled in diverse environmental zones and adjusted with his culture in the varied condition and formed ecological niche. In India the culture of early Holocene is known as Mesolithic or Microlithic. In later part of Holocene agriculture developed in river valleys. Hunting-gathering way of life continued in hills and jungles.

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Sample Questions

1) Define the geological period known as Holocene.
2) What are the stratigraphic evidences for the onset of Holocene in Northwest Europe?
3) What kind of climatic changes took place in Europe during Holocene.
4) Write short notes on:
   i) Teris in Coastal region in South India
   ii) Ghutin in the plateau area
   iii) History of Baltic Sea
   iv) Pollen sequence of Post Pleistocene in Europe
   v) Holocene sequence in Didwana formation

UNIT 3 HUMAN PALAEONTOLOGY

Contents

Learning Objectives

Once you have studied this unit, you will be able to understand:

- what Palaeoanthropology aims at;
- what is a Primate;
- which Primates were closer to humans;
- which biological and behavioural characters made us different from other Primates; and
- whether humans are still evolving or the end product of evolution.

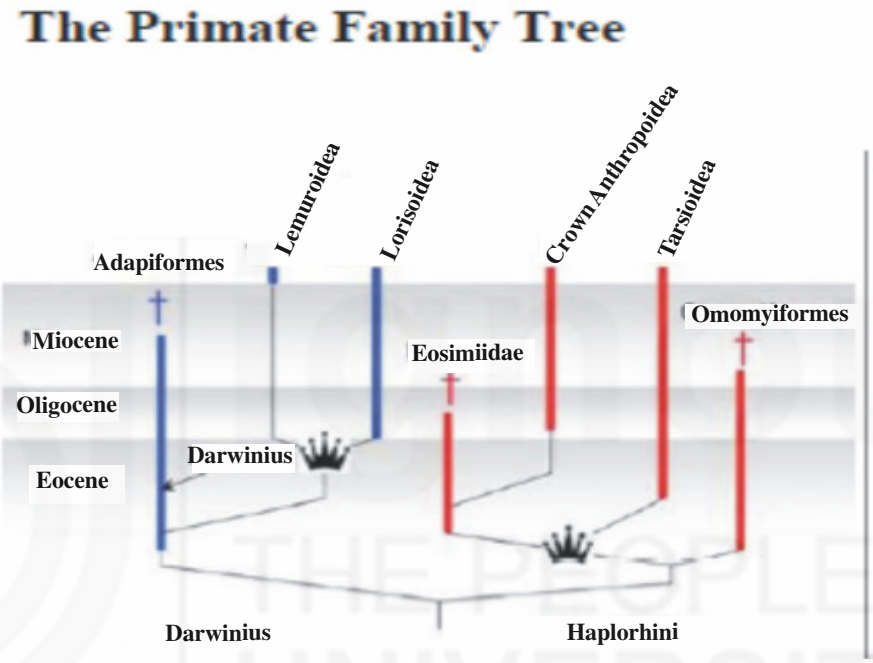
3.1 ORIGIN OF PRIMATES

3.1.1 Introduction

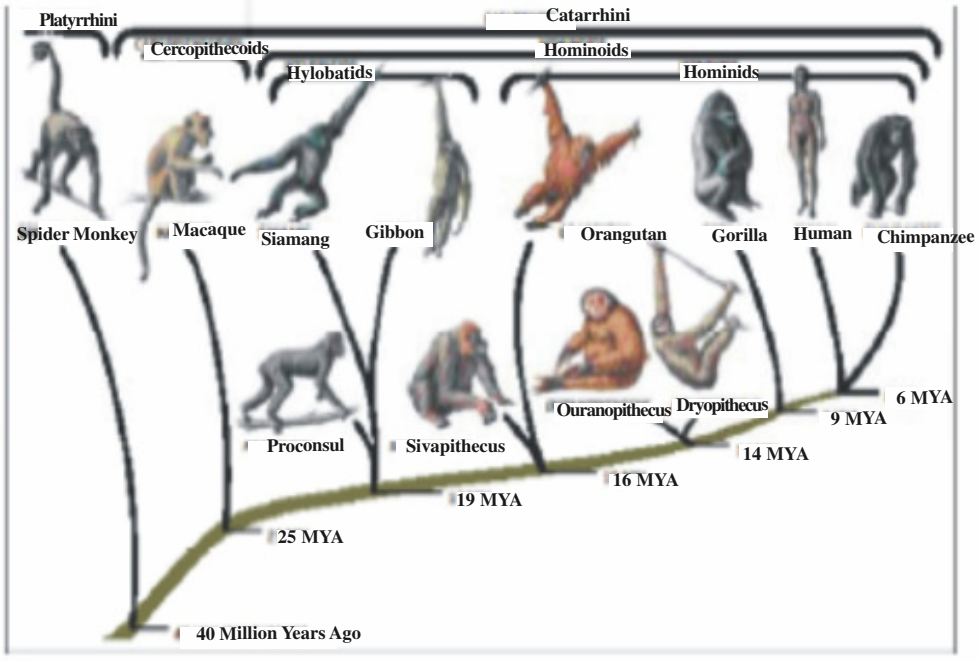
Human Palaeontology or Palaeoanthropology is a very fascinating and challenging subject. Also known as evolutionary anthropology, it aims at the scientific study of human origins in time and space. Palaeoanthropologists seek to illuminate the evolutionary history of the human lineage: when, where, and how our species, *Homo sapiens* evolved. For long palaeoanthropologists confront the creationists or philosophical critics of Darwinian doctrine of evolution as they interpret human "uniqueness" a result of "special creation" without any links with the apes. Their fundamental arguments were that the great apes (chimpanzee, gorilla and orangutan) walk in an inclined quadrupedal fashion and have small brains in contrast to humans who walk in upright bipedal fashion and possess large brains and higher intellectual and ethical standards. But, great progress made in human palaeontology during the nineteenth and twentieth centurie led to amazing discoveries of ape and human fossils from the entire Old World. At large, the fossil record of early apes and humans is now complete enough to make one

visualize how humans evolved from some very peculiar kind of ape or more apelike precursor ('hominoid') which shared traits with early human ancestors ('hominids').

In this section we shall understand why anthropologists study the Primates, and we understand human evolution better or about the lives of our ancestors if we understand more about primate biology, behaviour and ecology since the first members of the human species were more similar to living nonhuman primates than to any other animals on earth. Which seemingly "human" traits are ours alone, and which are shared with various primate relatives? What the different branches of the Primates are and when they split, and which branch or lineage evolved to man.



A simplified early primate evolutionary tree (after Williams etal. (2010)



After David Begun Scientific American Inc. (2003)

It is now fairly established that the hominid and the great ape lineages split around 6 to 8 million years ago, but many of their common traits are much more ancient, and could be traced back to about 20 million years ago when the first "tail-less monkey", known as *Proconsul,* appeared in Africa. In fact, many more common traits of the hominids and hominoids are also shared by the monkeys and can further be traced back to over 40 million years ago when the 'anthropoid' primates (monkeys, apes and hominids together) had not differentiated. We can further visualize the unbroken thread of shared ancestry further back in time to the early primates over 55 million years ago when there was a divergence of the two great branches of the primate family tree. One branch was of the haplorrhines, represented today by tarsiers and the anthropoids, and the second was of the strepsirrhines, the group to which living lemurs, lorises, and 'bush babies' belong. Latest combination of genetic, zoological, and palaeontological data has supported the view that the tarsiers and their omomyid relatives were most closely related to the early anthropoids, whereas the *Darwinius* and its kin were more closely related to the lemurs.

3.1.2 Major Features of Primate Behaviour

Besides physical resemblances between us and the Primates, it is important to understand what social behavioural traits we have inherited from the Primate ancestors. Some main traits are briefly described below.

i) *Gregarious*

Primates are social animals, living and travelling in groups that vary in size from species to species. In most species, females and their offspring constitute core of social system.

ii) *Aggression, Dominance/ Hierarchy & Territoriality*

Primates have clear territoriality, especially in forest species. Many primate societies are organised into dominance hierarchies that impose some degree of order with groups by establishing parameters of individual behaviours. Although aggression is frequently a means of increasing one's status, it serves to reduce the amount of actual physical violence; exerts control simply by making a threatening gesture**.**

iii) *Affiliative behaviours*

To minimize actual violence and to defuse potentially dangerous situations, there is an array of affiliative, or friendly, behaviours that serve to reinforce bonds between individuals and enhance group stability, e.g, physical contact (touching), and hand holding, hugging, and kissing in orangutan, gesture of friendliness, submission, appeasement or closeness; most notable primate activities is grooming, the ritual cleaning to remove parasites, shreds of grass or other matter. The mother-infant bond is the strongest and most long-lasting in the group.

iv) *Play*

Frequent play activity among primate infants and juveniles is a means of learning about the environment, testing strength, and generally learning how to behave as adults.

v) *Communication*

Primates have a great range of calls that are often used together with movements of the face or body to convey a message; warning calls, threat calls, defense calls, and gathering calls.

vi) *Tool use*

In the wild, gorillas do not make or use tools in any significant way, but chimpanzees use digging sticks to hunt termites. Bonobos and chimpanzees, provide essential clues in the reconstruction of adaptations and behaviour patterns of our earliest ancestors

3.1.3 Physical Charactersistics that Classify the Primates

Primates are classified broadly into two suborders: the prosimians and the anthropoids.

Suborder: Prosimia

They are the most distant and most varied primate relatives of man. Many are nocturnal (active in the night), hence have more developed sense of smell than other primates (wet, "naked" doglike nose), large eyes, independently mobile ears, sensory whiskers, many arboreal, hence the four non-thumb digits act together, not independently, many have a "grooming claw" on the second toe only; nails on other digits, many have a "dental comb" comprised of the four lower incisor teeth and the lower canines, which are long, narrow, and close together, for use in grooming fur and gathering food, less complex behaviour, less learning, relatively smaller, less developed brains than the anthropoids. Most have the full three premolars. All prosimians, except tarsiers, have the post-orbital bar but lack the post-orbital plate; tarsiers have both, like anthropoids do. Prosimians are further divided into *three infraorders: lemuriformes, lorisiformes & tarsiiformes*

Lemuriformes (lemurs)

They are found only on Madagascar Island and have evolved there in isolation into diverse forms and are therefore regarded as a case of adaptive radiation. Most of the lemurs are small sized, tree-dwelling, nocturnal, quadrupedal as well as vertical clinging and leaping.

Lorisiformes (lorises)

They occur both in Africa and Asia, Sri Lanka and are small, nocturnal, arboreal; mostly eat fruit, gum, and insects. Examples: *galagos* (fast hoppers) and runners ("bushbabies"), slender?*lorises*: slow climbers and creepers.

Tarsiiformes (tarsiers)

They inhabit rain forests of Southeast Asia and Indonesia. They are small, nocturnal, arboreal, vertical clinger and leapers; eat insects and some small vertebrates. They are recently classified in the anthropoid suborder, rather than prosimians.

Suborder: Anthropoidea

We along with the monkeys and apes belong to this Suborder of generally larger bodied, mostly diurnal (active in the day) primates; retina with a fovea (central

area of higher resolution vision)- absent in prosimians except the tarsiers; dry nose, reduced sense of smell, reduced sensory whiskers, independently controlled, dexterous digits, nails on all digits (no claws), generally larger brain relative to body size, generally more complex behaviour, post-orbital bar (like all primates) including the post-orbital plate (absent in prosimians except the tarsiers). Anthropoids are subdivided into *two infraorders: Platyrrhines* and *Catarrhines.*

Infraorder: Platyrrhines

Platy=flat, Rhine=nose; they are "flat nosed": round, forward-facing, widely separated nostrils only in the New World, hence often called "New World monkeys" (NWM), three premolars on top and bottom, almost all diurnal all mostly arboreal, living in forests mostly quadrupedal, some able to swing by arms or tail a few have prehensile tails, which are found only among the New World monkeys specifically, only among one family of NWMs, the Cebids, e.g., the capuchin monkey, which is notable for being one of just four primates that are known to regularly make and use tools- the sticks as weapons, modify twigs and leaves to probe for insect larvae.

Infraorder: Catarrhines

Cata= prominent /raised, rhine= nose. Humans, apes and Old World monkeys fall in this category. They have narrow, downward-facing nostrils, two premolars on top and bottom, rather than three, some have tails, but none are prehensile, more variable adaptations than New World monkeys. Catarrhines have *two superfamilies: Cercopithecoids* (Old World monkeys) and *Hominoids* (apes and humans)

Superfamily: Cercopithecoidea (Old World monkeys: OWMs)

It is a highly variable group, arboreal and/or terrestrial; has many kinds of social organisations and mating strategies, often groups of numerous females and one or several males. *Cercopithecoids* have *two subfamilies: Colobines* and *Cercopithecine.*

Subfamily: Colobinae

It is of arboreal leaf-eaters found in Africa and Asia. E.g., colobus monkeys: no thumbs (apparently an adaptation to moving through trees?); langurs: sometimes called "leaf monkeys", "Miss Waldron's Red Colobus", last seen in 1970's, declared extinct in September 2000.

Subfamily: Cercopithecinae

They are mostly semi-terrestrial, quite varied, found in Africa; macaques also live in Asia typically in large, multi-male, multi-female groups, e.g. baboons, macaques, vervet monkeys.

Subfamily: Hominoidea

It is the branch of the apes and humans; generally the largest primates, with no tails, have relatively larger brains, Y-5 molars, basically forest dwellers, more or less arboreal, wide chest with shoulder blades (scapulae) on the back, rather than on the side as in quadrupeds, so the forelimbs can stick out sideways, rather than just moving forward and back, greater mobility of shoulders, elbows, wrists, these are presumably adaptations for complex climbing in trees, rather than just

walking on top of branches. Traditional classification has *three families: hylobatids* (lesser apes), *pongids* (great apes), and *hominids* (us).

Family: Hylobatidae

It is of the "lesser apes", generally smaller than the pongids, e.g., gibbons and siamangs. They live in tropical forests of Asia; nearly full-time brachiators (overhand swingers through the trees) with very long arms, monogamous mating, little sexual dimorphism, males more involved in infant care than most other primates, especially the siamangs, highly territorial.

Family: Pongidae (great apes): orangutans, gorillas, and chimpanzee (it includes bonobos=pygmy chimpanzees)

Orangutans are only on southeast Asian islands of Sumatra and Borneo; extremely sexual dimorphism in size, face, etc., quadrumanual and arboreal when small, more terrestrial when grown to large size, (especially males), very solitary, fruit, leaf, and bark eater.

Gorillas live in central African forests in small groups of one or two adult males, a few females, some young; they eat leaves, stalks, bamboo; mostly terrestrial (although this may vary depending on their environment).

Chimpanzees and their close relatives bonobos called "pygmy chimps", even though they are not consistently much smaller mostly eat plants, especially fruit, but sometimes insects and other animals

Common chimps: *Pan troglodytes* large multi-male, multi-female groups centered on a stable group of related males who stay in their natal group

Bonobos: *Pan paniscus,* female-centered groups; regularly use tools and modify objects to serve as tools, strip twigs to "fish" for termites, wad up leaves to sponge water out of cavities in tree trunks; crack nuts using a stone in one hand and a larger stone or root as an anvil.

Family: Hominidae

The family of man and his Plio-Pleistocene ancestors, traditionally placed in their own family, probably more closely related to chimps (and / or to orangutan) than to gorillas, bipedal, have reduced canines, huge brains for body size. More discussion follows in other section.

3.1.4 Early Fossil Primates and their Evolution

Primates arose as part of a great adaptive radiation that began more than 100 million years after the appearance of the first mammals and the flowering plants about 65 million years ago.

Palaeocene Primates

By 65 million years ago, primates were diverging from other mammalian lineages (such as those which later led to rodents, bats and carnivores). For the period between 65-55 Mya, it is extremely difficult to identify the earliest members of the primate order since the available fossil material is scarce, and they were not easily distinguished from other early (generalised) mammals.

Eocene Primates

First fossil forms that are clearly identifiable as primates appeared during Eocene (55-34 Mya). From this period have been recovered a wide variety of primates, which can all be called prosimians. Lemur-like adapids were common in the Eocene, as were species of tarsier-like primates. They were insect eaters and adapted to tree-dwelling. They had larger, rounded braincases; nails instead of claws, eyes rotated forward, binocular vision, presence of opposable large toe.

This time period exhibited the widest geographical distribution and broadest adaptive radiation ever displayed by prosimians. In recent years, numerous finds of Late Eocene (36-34 Mya) suggest that members of the adapid family were the most likely candidates as ancestors of early anthropoids.

Oligocene primates

The center of action for primate evolution after Eocene is confined largely to Old World; only in Africa and Eurasia. We trace the evidences of apes and hominids during Oligocene (34-23 Mya) the vast majority of primate fossils coming from just the Fayum area of Egypt with 21 different species. The main genera are:

Apidium

The most abundant of all Oligocene forms, adapted to fruit and seed diet, they were a small arboreal quadruped, adept at leaping and springing, like a squirrel.

Propliopithecus

Morphologically quite primitive, small to medium in size, likely fruit eaters.

Aegyptopithecus

It was the largest of Fayum anthropoids, similar to modern howler (6-8 kg) with primitive skull, short-limbed, heavily muscled, slow-moving arboreal quadruped. It bridges the gap between the Eocene prosimians and the Miocene hominoids.

3.1.5 Advanced Hominoid Primates and Common Ancestors

Early Miocene

Large-bodied hominoids first evolved in Africa ~ 23 Mya. Then they migrated into Eurasia, dispersed rapidly and diversified into a variety of species. After 14 million years ago, we have evidence of widely distributed hominoids in many parts of Asia and Europe. The separation of the Asian large-bodied hominoid line from the African stock (leading ultimately to gorillas, chimps and humans) thus would have occurred at about that time.

They are presently classified into at least 23 species, lived in dense rain forests to more open woodlands, were partially terrestrial (ground living) and even occasionally bipedal, and most of them were fruit eaters, some included leaves as well. Currently recognised African Early Miocene (20- 17 Mya) fossil taxa are: *Proconsul (P. heseloni, P. majus,* and *P. nyanzae); Afropithecus, Turkanopithecus, Otavapithecus, Equatorius Nacholapithecus*

Middle to Late Miocene

The well-known Middle Miocene African hominoid is *Kenyapithecus* that falls on the threshold of the "advanced" hominoids, appeared by 14.5 Mya at Fort Ternan Kenya. Hominoids are rare in African Later Miocene; the known one is S*amburupithecus* around 8-9 Mya followed by *Sahelanthropus* ~7-8 Mya in Chad, regarded as the 'Chimpanzee-hominid' last common ancestor, but still debated.

Not all African apes evolved into hominines. Those that remained in the forests and woodlands continued to develop as arboreal apes, although ultimately some of them took up a more terrestrial life. These are the bonobos, chimpanzees and gorillas, who have changed far more from the ancestral condition than have the still arboreal orangutans.

European and Eurasian Hominoids

They appeared during Middle Miocene (14-11 Mya) and currently recognised fossil taxa are:

Dryopithecus (=Rudapithecus),

*Ankarapithecus (*earlier *Sivapithecus meteai)*

*Graecopithecus (*earlier *Ouranopithecus)*

Griphopithecus, Heliopithecus, Oreopithecus

Some scholars regarded *Dryopithecus* as the common ancestor to Chimpanzee-hominid clade, but others as ancestor to African apes only. *Ankarapithecus* is on the orangutan clade; *Heliopithecus* is closer to the gibbons, whereas the, *Oreopithecus* is debated either a monkey or a side-branch of the hominoids.

South Asian (Siwaliks) and East Asian (Chinese) Taxa

Hominoids appeared in South Asia (Siwaliks) and their fossils have been found in India and Pakistan at ~12.3 Mya and survived there until ~5.5 Mya; spread eastward to southern China ~ 8 Mya. Currently the following species are recognised:

Sivapithecus (*S. parvada, S. indicus, S. punjabicus (= Ramapithecus*)

Krishnapithecus (= *Pliopithecus*)

Gigantopithecus (="*Indopithecus*")

Lufengpithecus (L lufengensis), L. keiyuanensis & L. hudienensis

- They varied in size from moderately small (*Ramapithecus*) to large (*Sivapithecus indicus)* and very large (*Sivapithecus parvada*). Indian *Gigantopithecus* (*G. bilaspurensis*) and Chinese (*G. blacki*) were great giant "aberrant hominids" of gorilla-size, sometimes speculated as the ancestors of the illusive "Himalayan Snowman".

- *Ramapithecus,* earlier considered hominid, is now lumped in *Sivapithecus* genus, but recognised a separate species, *S. punjabicus* or *S. sivalensis*.

- *Sivapithecus indicus* face has a concave profile and projecting incisors bearing striking similarities with the orangutan. But, dentition and lower jaw are closer to early hominids.

- But, *Sivapithecus* forelimbs indicate a unique mixture of arboreal quadrupedalism and no suspensory component of the orangutan. *Sivapithecus* possessing a mosaic of hominid and 'pongid' (orangutan) characters are regarded some scholars their exclusive last common (or generalised) ancestor.

- *Lufengpithecus* in China is similar to *Sivapithecus*.

- *Krishnapithecus* (=*Pliopithecus)* was probable ancestor of the gibbons.

3.2 ORIGIN OF MAN

3.2.1 Plio-Pleistocene Hominids

Plio-Pleistocene hominids are presently known from Africa only. The following hominids genera and species are currently recognised indicating a great diversity:

Australopithecus: (i) A. africanus, (ii) A. aethiopicus

Kenyanthropus: i) K. rudelfensis (ii) K. platyops

Paranthropus: (i) P. walkeri (ii) P. bosei (iii) P. robustus

Praeanthropus: (i) P. anamensis (=A. anamensis), (ii) P. afarensis [=A. afarensis (Lucy)], (iii) P. garhi = (A. garhi), (iv) P. bahrelghazali (=A. bahrelghazali)

Ardipithecus: A. ramidus

Traditionally, three genera were recognised, viz., *Australopithecus*, *Paranthropus*, and *Ardipithecus,* the last one is currently regarded closer to *Homo.* They are collectively recognised as australopithecines.

The first member of australopithecines was discovered in 1924 in a limestone cave at Taungs in South Africa by Raymond Dart. It was named as *Australopithecus africanus* ("Southern ape of Africa" regarded as a "missing link" between apes and humans. They had hominid upright stance; the molar teeth were very large whereas the front teeth very small unlike apes. In 1959 a nearly complete skull, well-dated to 1.8 Mya was discovered at Olduvai Gorge, Tanzania by Mary Leakeys, named as "*Zinjanthropus boisei*" (now *Paranthropus boisei*). Major findings came from Kenya, Ethiopia, and other areas of the Great Rift Valley East Africa, dated to 4.2 Mya with the earliest evidence for bipedalism in *Australopithecus anamensis* (later *Praeanthropus anamensis*). The 3.5 Mya *Ardipithecus* ("Little Foot") is currently regarded closer to humans. Hominid footprints of 3.8 Mya were discovered at Laetoli in Tanzanian are the hallmarks of bipedalism.

In the mid-1970s, "Lucy" skeleton (*Australopithecus afarensis*) was discovered by Donald Johanson, dated to 3.2 Mya having long arms and short legs yielding 3½ feet stature. But her pelvis and knee was fully biped human like, but her toes and fingers were long and curved like an ape's, the brain too small like an ape. Her molar teeth were large and with thick enamel like humans, but the rib cage was conical, neither precisely like known apes nor humans. So, Lucy possessed a mosaic, partly ape, partly human, and partly intermediate.

The other australopithecines is "*Kenyanthropus platyops*" found near Lake Turkana in 1999 and dated to 3.5 Mya, was a small-brained biped with small front teeth and large rear teeth.

A new species dated at ~2.5 Mya, *Australopithecus garhi* (now *Praeanthropus garhi*), was "robust" australopithecines. Robust hominids evolved gradually as the climate of Africa underwent a prolonged period of cooling and grasslands expanded at the expense of forests. They developed large (megadont) molar teeth, and strong bones and muscles to enable them to crack and grind down energy rich hard nuts and seeds. *Paranthropus* represents such an extreme robust lineage discovered by Mary Leakey in 1959 and dubbed as "Nutcracker Man".

Did australopithecines make tools? *A. garhi* had associated evidence of butchered gazelle bones and supported tool use.

Three major stages may be recognised in Hominid Evolution. The stages in sequence, the stage of Australopithecus, the stage of Homo erects and the stage of Neanderthal man.

3.2.2 Pleistocene Hominins: Distribution and Bio-Cultural Characteristics

In this section you will learn the evolution of our genus, *Homo,* and its various species through time and their distribution in the Old World. Several species have evolved and preceded the modern *Homo sapiens* and these are listed in the box.

A Recent count of the various species of Man (*Homo*):

1) *H. habilis* (Africa)
2) *H. ergaster* (Africa)
3) *H. erectus* (Asia: Java, China, India)
4) *H. georgicus* (Europe)
5) *H. antecessor*(Europe)
6) *H. cepranensis* (= European*H. erectus*)
7) *H. heidlebergensis* (Old World)
8) *H. neanderthalensis* (Europe, West Asia)
9) *H. sapiens* (Old World)
10) *H. floresiensis* (Indonesia)

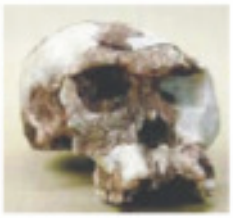
We shall understand the variation of morphological characters of various fossil species generally referred to as 'hominins' with special reference to the cranial traits that changed during the course of hominin evolution.

1) ***Homo habilis***

   The earliest indications of the genus *Homo* are recorded at about 2.4 to 1.8 Mya in East Africa at the same time and place as the earliest recognisable simple stone tools, known as Oldowan, made on small rounded pebbles. *Homo habilis* is the earliest known *Homo* showing anatomical evolutionary continuity from the preceding *Australopithecus* to the following *Homo ergaster*.

The most famous specimen of *Homo habilis* lineage is ER-1470 discovered in 1972 Richard Leakey's expedition in the Lake Turkana in Kenya. Its reconstructed skull showed brain volume of ~ 735 cc but a flat face. Another and better skull is ER-1813 but with a relatively smaller brain ~600 cc, also found in Olduvai Gorge and in South Africa, initially called "Telanthropus" .

The 1st Stone Tool-maker ~2mya: Homo habilis-though still small- brained but intelligent scavengers and tool- makers (slide by A.R. Sankhyan)



Oldowan Chopper made by Homo habilis

The most interesting feature of *Homo habilis* is its facial reduction and cranial increase (compared to australopithecines). But, its limb proportions – the long arms and short legs, are quite primitive fitting somewhere between the Great apes and the *Australopithecus* indicating imperfect bipedal locomotion.

2) **Home ergaster**

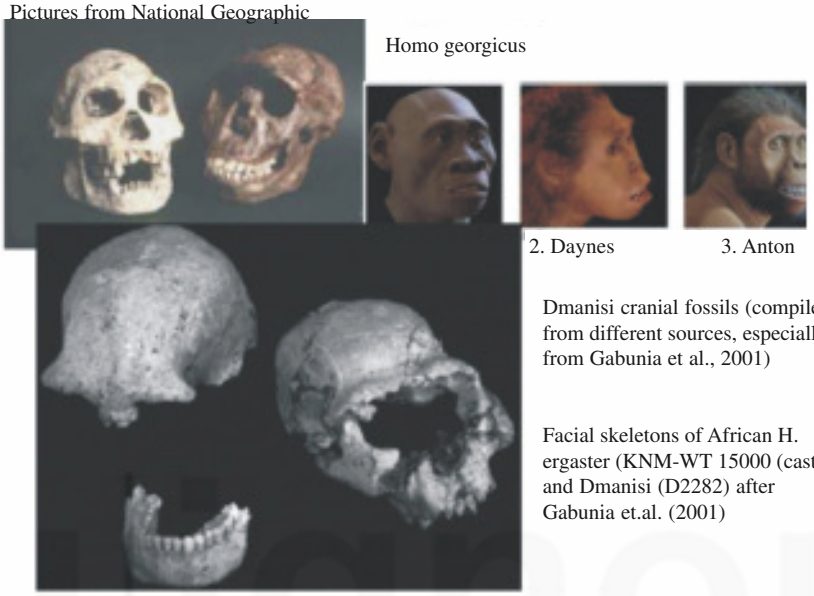
Compared to the very gracile *Homo habilis, Homo ergaster* (ER-3733) discovered in 1974 was taller and large brained (850 cc), and efficient tool-maker who hunted with choppers and crude handaxes. It firmly established that enlargement of brain occurred but with robust body about 1.8 Mya.

A nearly complete skeleton (WT-15000) of an adolescent male (ER-3883) was discovered in 1984 by Richard Leakey's team on the western side of Lake Turkana, famous as the 'Nariokotome Boy'- who lived and died about 1.6 Mya. He had heavily muscled arms, prognathous face, no forehead and strong supra-orbital torus. He stood about 5½ feet tall even at ~12 years age and if fully grown it could have become the first six-footer of Pleistocene. This indicates running over long distances, and therefore, *Homo ergaster* is considered the first hominin to venture out of Africa.

3) ***Homo georgicus***

Homo georgicus was similar to *Homo ergaster* in many ways and therefore regarded the descendant of the latter. Discovered in 1983 in the southeast Europe in Georgia at Dmanissi site at 1.8 Mya, *Homo georgicus* is the first earliest representatives of *Homo* outside Africa. Later on, stone tools and at least six individuals were found along with stone tools and cut marks on animal bones indicating the possibility of meat processing.

1. D 2700 (Dmanisi) and WT 15000 (Nariokotome)- Homo ergaster are two similar small and quite lightly- built adolescent skulls. Pictures from National Geographic



2. Daynes 3. Anton

Dmanisi cranial fossils (compiled from different sources, especially from Gabunia et al., 2001)

Facial skeletons of African H. ergaster (KNM-WT 15000 (cast)) and Dmanisi (D2282) after Gabunia et.al. (2001)

Morphology

The Dmanissi crania are similar but about 90% smaller than African *H. ergaster*. They were stout and short (stature ~150 cm) as they lived in the temperate zone, whereas African *H. ergaster* was lean and tall since it lived in a relatively dry and hot steppes environment. Other salient features are:

- Moderate supraorbital tori, relatively tall, thin-walled, narrow cranial vaults
- Small cranial capacities (600-800 cc) like *Homo habilis* and unlike the Asian *Homo erectus* (~1000).
- Mandible has primitive bucco-lingually narrow anterior teeth and P/3; The D2282 face similar to *H. ergaster*, but small and pyriform (nasal) aperture.
- Limb proportions similar to modern humans: legs (femurs) longer than arms; vertebral column S-shaped, the foot well arched- indicating long distance walking and running.
- *S*houlders and arms were unique; hands resting outwardly.
- They exhibit a unique mosaic of "primitive" (ancestral) and "derived" (novel, descendant) features, while almost modern in their body proportions.
- They were associated with core-and-flake industry indicating that the Oldowan Industry associated with foraging strategy was also as efficient in facilitating dispersal as the Acheulian technology.

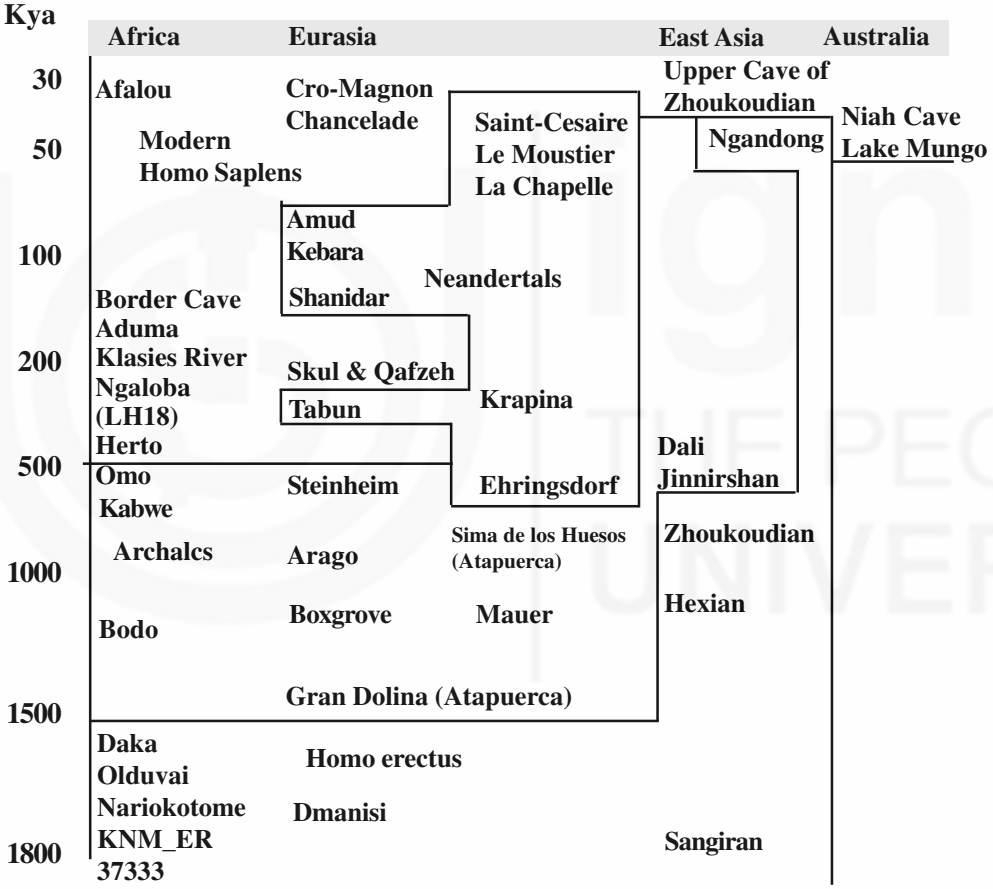
4) ***Homo erectus***

Homo erectus evolved from *Homo georgicus* and was higher-brained and versatile tool-maker, skilled organised hunter and therefore the widest spread species having colonized most of the Old World one million year ago. Typical *Homo erectus* first appeared in China and Java at ~1.6 Mya and survived as late as 200 – 300 Kya (K= kilo=thousand, ya=years ago), even later at Ngandong (Java) at ~100 Kya. Earlier presence of *Homo erectus* was debated in Western Europe, but the skull from the Tautavel Arago Cave besides Palaeolithic evidences from Lazaret cave and Terra Amata at Nice in southern France attest their presence.

Distribution

The box below displays the main *Homo erectus* and other hominins.

Temporal and Special Distribution of H. erectus, Archaic & Modern H. sapiens and H. neanderthalensis (adapted from Conroy, 2005)



Box 1: Distribution sites of Homo erectus

an early African fossil (KNM-ER 3733 from Kenya, which is dated to 1.78 mya)
an early Indonesian fossil (Sangiran 17 from Java and dated to between 1.7-1.0 mya)
a late Chinese fossil (Zhoukoudian reconstruction that is dated to between 600-300 kya)
a late Indonesian fossil (Ngandong from Java dated to 53-27 Kya)
and even an immature individual (the 8-11 year old Nariokotome boy from Kenya that dates to 1.6 mya).

Box 2: Distinguishing Cranial Characteristics of Homo erectus

1.	Cranial capacity > Australopithecus but <Homo sapiens 750 - 1225cc. mean = 900cc. EQ 3.3-4.0 (Mchenry, 1994)
2.	Long, low cranial vault with thick cranial walls (nearly twice as thick as modern humans)
3.	Face is short but massive, nasal aperture projecting forward relative to the lateral facial regions (not a dished or concave face) the lower part of the face protrudes (prognathism)
4.	Large supraorbital torus (usually in the form of a bar) and supraorbital sulcus
5.	Frontal bone low and receding
6.	Postorbital constriction greater than Homo sapiens but less than Australopithecus
7.	Variable development of a sagittal keel along midline
8.	Angular occipital with occipital (nuchal) torus
9.	Broad base cranium - maximum breadth of skull low on temporal bone (about the level of the external auditory meatus - ear) = pentagonal-shaped skull (when viewed from behind) - Not Bell Shaped
10.	Basicranium moderately flexed
11.	Tooth size is smaller than Australopithecus (reduced megadonty) but greater than Homo sapiens
12.	No chin

5) The Archaic *Homo sapiens*

The later ("evolved") *Homo erectus* and early ("archaic") *Homo sapiens* are indistinguishable. The terms "evolved" and "archaic" are not taxonomically accepted, but often applied to a Old World widely occurring Middle Pleistocene hominins living during 600 -150 Kya. So, many scholars consider these a single species, *Homo heidlebergensis,* which is transitional between *Homo erectus* and *Homo sapiens*.

Box 3: Dates and distribution sites of late Homo erectus/early Archaic Homo sapiens or Homo heidlebergensis

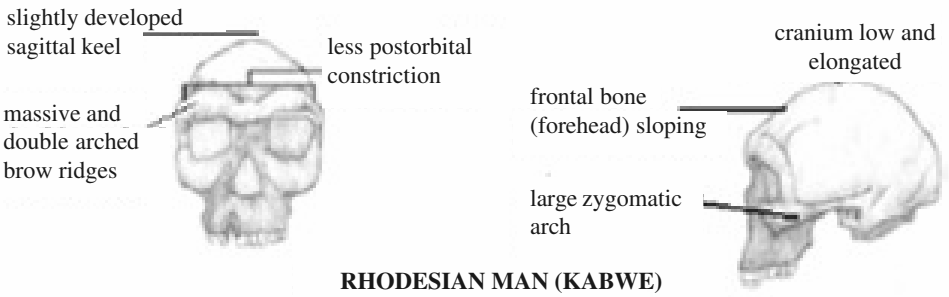
African specimens	European specimens	Asian specimens
Kabwe cranium (Zambia), 125 kya? or 500 kya - 200 kya Bodo cranium (Ethiopia), 600 kya	Steinheim cranium (Germany), 200-250 kya Sima de los Huesos - Ata-puerca numerous specimens (Spain), 300-400 kya Arago face and partial cranium (southern France), 320-470 kya Mauer mandible (Germany) 500 kya	Dali cranium (China), 180-230 kya Jinniushan (China) (200-280 kya

In their overall morphology, *Homo heidlebergensis* are similar to *Homo erectus* in thick cranial vault, low sloping forehead, long low skull and a large robust face with heavy brow ridges. But, they have two important differences, a larger braincase (1210 cc) and lesser development of three *Homo erectus* bony ridges:

(a) the double arched supraorbital torus, (b) the reduced occipital torus, and (c) the sagittal keel. So, they would seem to be more advanced towards modem *Homo sapiens*.

Important fossils of the *Homo heidlebergensis* or "archaic" *Homo sapiens* are: Kabwe (Zambia), Petralona in Greece, Steinheim in Germany, Dali in China, and Narmada in India.

The Homo heidlebergensis have some Neanderthal-like specialized listed in the box.



RHODESIAN MAN (KABWE)

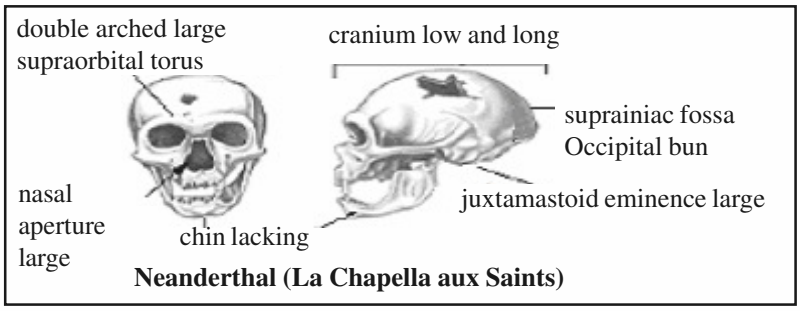
1.	Larger average brain size, 1212 cm3 (Campbell, Loy, & Cruz-Uribe, 2005)
2.	Rounded parietal bones, giving the cranium a barrel shape from posterior view
3.	Development of an occipital bun, a rounded bony protrusion on the occipital bone in the region of the occipital torus
4.	Development of midfacial prognathism produced by inflation of the maxillary bones
5.	The presence of large noses
6.	Development of a retromolar gap (a space between the lower third molar and the ascending ramus of the mandible)

6) **Neanderthals – *Homo neanderthalensis***

'Neanderthal' is an informal term, referred to a unique population with a distinctive morphology found in Europe and the Middle East ~150- 27 Kya. They are currently classified as *Homo neanderthalensis* but earlier as *Homo sapiens neanderthalensis.*

Postcranially Neanderthals were very well built with many unique features, namely, shortened distal segments (radius and ulna in forelimb, tibia and fibula in hind limb), large joint surfaces, and pronounced anterior posterior curvature of the femur and radius, likely representing adaptations to the colder climates. The salient cranial and postcranial characters of the Neanderthals are shown in the figure and listed in the boxes.

Salient Features of Neanderthal Cranium



Neanderthal (La Chapella aux Saints)

Neanderthal Features: Cranial &

1.	Large cranial capacity, mean = 1498 cc (Ruff et.al. 1997), male range = 1524-1640cc and female range = 1270-1425 cc (McKee, 2005), EQ = 4.78 (Ruff et.al., 1997).
2.	Long, low and wide cranial vault
3.	Cranial base is often relatively flat (often not highly flexed)
4.	Large face characterized by midfacial prognathism, inflated maxilla, big nose and no canine fossa
5.	large supraorbital rorus often forming a double arch
6.	occipital bun (chignon with a suprainiac fossa
7.	Maximum breadth at midparietal
8.	Small mastoid but a large juxtamastoid eminence
9.	Chin usually absent
10.	Teeth size smaller than Homo erectus but larger than ours, molars with enlarged pulp chamber (taurodont) and a retromolar gap (gap between M3 and the anterior margin of the ascending ramus of the mandible).

Postcranial

1.	Overall short and robust people, Body mass mean = 75 kg, F mean = 67.2 kg (Rosenberg et al., 2006). Stature estimates = 1.5-1.7 meters (4'1111-5'7") (Conroy, 2005), M=169 cm (5'6.5"). F = 160 cm (5'3") (Stringer & Gamble 1993).
2.	Barrel-like chest cavity with broad scapula and large shoulder joint.
3.	Pelvis wide with by a long narrow pubic ramus
4.	hand with wide fingertips and strongly griping
5.	Femur and tibia have large spiphyses (end joints) with robust, cortically thick shafts (although not as thick as Homo eroctus). The radius and femur are curved antero-posteriorly. patella (kneecap) large and thick.
6.	Shorten distal limb segments (fore-arm and tibia)

lineage leading to Neanderthals

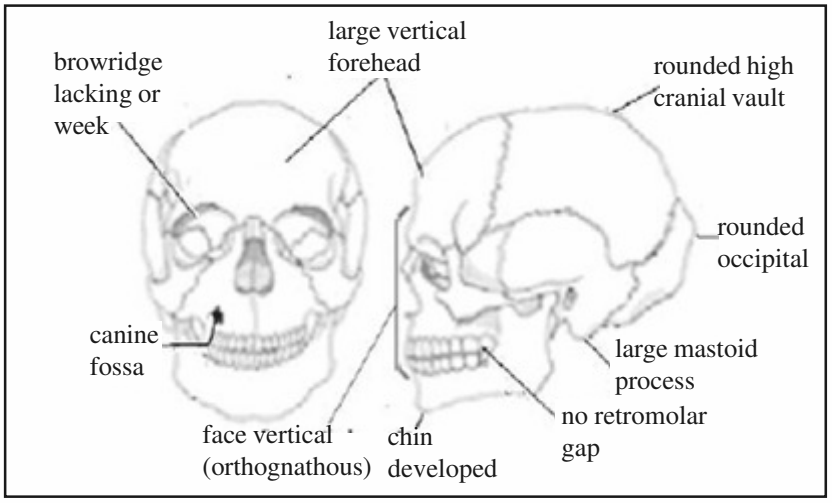
There are two specimens that date from 800 kya to 650 kya (Gran Dolina of Atapuerca Spain and Ceprano of Italy), somewhat from *Homo heidlebergensis* and placed into a separate species, *Homo antecessor*, but treated on the lineage leading to Neanderthals.

7) Anatomically Modern *Homo sapiens* (AMHS)

Modern *Homo sapiens* or earlier *Homo sapiens sapiens* (we) evolved with many changes over the archaic type that include the enlargement and rounding of the cranial vault by the expanding brain, at the same time reduction in the size of the face. Earlier view was that modern humans had not appeared until 35 – 40 Kya, but several fossils were discovered with modern features between 195 and 100 Kya in Africa and subsequently at 90 Kya in the Middle East.

Distribution

The specimens to represent modern humans or nearly modern humans include: at Omo, Herto, Klasies River Mouth Cave (Laetoli Hominid 18), and Ngaloba Border Cave in Africa, at Middle East (Israel), namely Qafzeh, and Skhul Caves, Chancelade and Cro-Magnon (France), Upper Cave of Zhoukoudian (China) or Lake Mungo (Australia).



Salient Features of Early Modern Humans

Morphology

Early AMHS were essentially like modern humans *albeit* somewhat more robust in some specimens. The salient features of these early modern humans are listed in the boxes below.

Cranial

1.	tall rounded cranial vault with a large brain, mean = 1349cc and EQ = 5.28, (Ruff, 1997)
2.	small, vertical face with canine fossa
3.	relatively vertical frontal bone (forehead)
4.	brow ridge development is absent or relatively small
5.	large mastoid process
6.	highly flex cranial base
7.	gently rounded occiput (no torus or bun)
8.	when viewed from behind the skull in widest near the top of the parietal region
9.	chin
10.	small teeth
11.	no retromolar gap

Postcranial

1.	generally less robust postcranial skeleton, mean body weight - F = 58kg (127.6 lbs), M = 49kg (107.8 lbs) (McHenry & Coffin, 2000) mean stature - F = 175cm (≈5'9"), M = 161 cm (≈5'3") (McHenry & Coffin, 2000)
2.	limb bones can vary from small and delicate to very large and robust however, they are still significantly less robust than earlier people
3.	scapula is characterized by a bisulcate or ventral sulcus on the lateral margin
4.	thumb distal phalange 2/3 the length of the proximal phalanx
5.	distal limb segments usually longer relative to entire limb
6.	cortical bone of the femur and tibia thinner than in earlier people
7.	pubic bone is shorter and thicker than that of the neanderthals

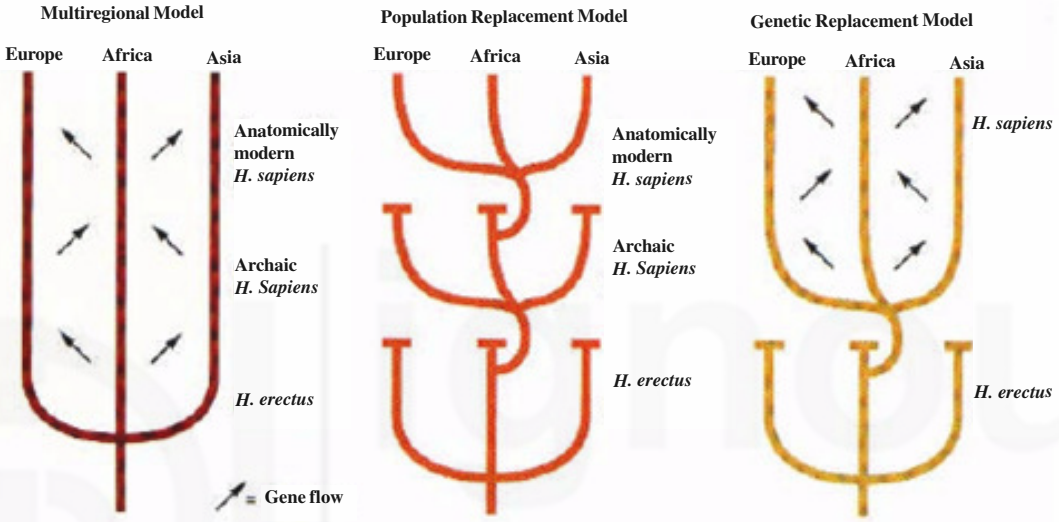
The fundamental question still debated in palaeoanthropology are where, when and how did modern humans arise. There are basically two models that address these questions:

1) **Multiregional Model:** It suggests that there was an early migration of *Homo erectus* to Asia, eventually into Europe, and during this period of geographic expansion, the hominin populations maintained enough gene flow between populations in the various regions of the world to preserve species integrity. This widely dispersed hominin population evolved from early *Homo erectus* to archaic and eventually into modern *Homo sapiens*. So, there is continuity of characteristics in each region shared by the entire humanity.

2) **Single Origin or Replacement or Out of Africa Model**

It postulates that hominins exited Africa early in the Pleistocene and occupied Asia and eventually Europe, and that gene flow was occurring within each region of the world but not extensively between the different regions. But, modern humans arose in Africa around 150 Kya, and later colonized Asia and Europe replacing the resident archaic populations of those regions. This model postulates that modern humans first evolved and there is no continuity of *Homo erectus* traits to archaic hominins to modern humans in each region of the world. One would also expect to see some overlap in resident archaic populations and the immigrant modern human populations.

Partial Replacement/Assimilation Model



It is basically the Out of Africa Model, but postulates some gene exchange between migrant modern humans and local archaic humans. This model still argues that most of our ancestry is African but it allows for some contribution of the more ancient local populations.

3.3 NARMADA MAN

Narmada Man, rather men, is known by the cranial and postcranial fossil remains representing two types of archaic hominins or human populations.

3.3.1 Cranial Remains

A partial right portion of the skullcap (calvaria) Narmada Man was discovered from Hathnora in Central Narmada valley during 1982 by Arun Sonakia of the Geological Survey of India, who reported the finding in 1984 in the *Records of the* Geological Survey of India. Detailed studies on it were conducted by M.A. de Lumley in France during 1985, and in USA during 1991 by Kenneth A.R. Kennedy. The calvaria show a mosaic of *H. erectus* and "archaic" H. *sapiens* characters. The main *Homo erectus* characters include:

1) Small mastoid process
2) Narrow post-orbital constriction
3) Maximum breadth across the mastoid
4) Prominent *torus angularis*

The important *Homo sapiens* characters traits include

1) A relatively high elevation of the cranial vault
2) The landmarks *bregma* and *vertex* are not coincident
3) The most posterior point in the instrumental calibration of maximum cranial length falls superior to the landmark *inion (*where it lies in *erectus* skulls)
4) The estimated cranial capacity is between 1155 and 1421 cubic centimetres. This on the contrary averages at about 1000 cubic centimeters in erectus.

Important "unique features" in Narmada Cavaria infrequent/absent in er*ectus* and modern *sapiens* are:

1) The furrowing of the sagittal ridge along the top of the Cranial Vault.
2) A large external auditory meatus (ear hole)
3) An unusually long temporal bone.

But, scholars remained divided on the status of Narmada calvaria as either "evolved" *H. erectus* or "archaic" *H. sapiens,* but, recently many favour it as H. heidlebergensis (for details see reference).

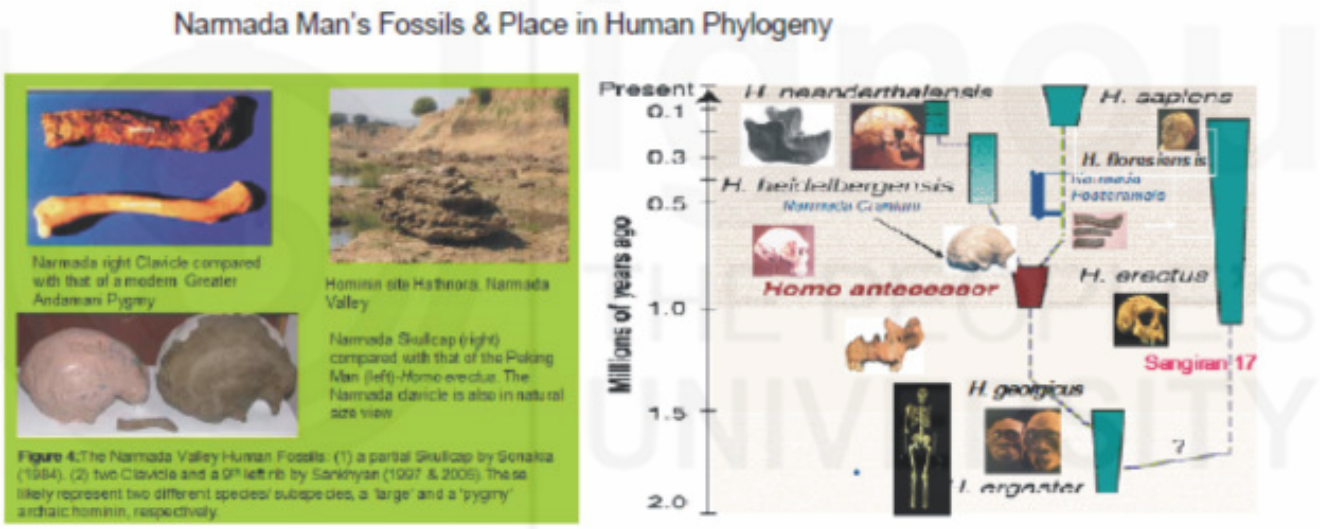


Figure 4:The Narmada Valley Human Fossils: (1) a partial Skullcap by Sonakia (1984). (2) two Clavicle and a 9th left rib by Sankhyan (1997 & 2005). These likely represent two different species/ subspecies, a 'large' and a 'pygmy' archaic hominin, respectively.

3.3.2 Postcranial Remains

Another discovery of Narmada Man was made by A. R. Sankhyan of the Anthropological Survey of India, reported in January 1997 in Journal of Human Evolution from the vicinity of the Calvaria site of Hathnora but slightly younger bed to it. It was of three postcranial fossils, namely right and left clavicles and a partial 9th left rib. These fossils revealed very short, robust and stocky archaic hominin, with a stature (134 cm) and shoulder width (30 cm) found in the shortest female Andaman Pygmy.

Thus, the cranial and postcranial bones from Narmada valley come from two types of Middle to Late Pleistocene archaic hominins. They were found associated with Late Acheulian handaxes, cleavers and choppers, and Middle Pleistocene mammalian fauna indicating about 250-200 Kya (for details see references).

3.4 SUMMARY

There is no science other than human palaeontology or palaeoanthropology which through the hard fossil evidences studies man as a species in time and space. It seeks to understand the natural origins of mankind and how humans are biologically and behaviourally related to other animals, e.g. the primates. After two centuries' struggle with orthodoxy, thanks to palaeoanthropology that we have now understood that we are the product of a long evolutionary past, and that the entire present humanity belongs to a single highly adaptive species, *Homo sapiens*, which could succeed over several species which went extinct during the course evolution. For over 10 million years we remained undifferentiated from the apes, and got splitted about eight million years ago. We were small-brained hominids until two million years ago, and acquired modern brain and physique just over 150,000 years back. Like the physique, human mind, myths, superstitions and other behaviours are also the products of evolution. Our evolutionary wisdom- a gift of palaeoanthropology-can potentially serve the humankind in a befitting way since it cuts across the continental, regional, racial, ethnic, cultural and socio-religious biases.

Suggested Reading

Kennedy, K. A.R. (2000). *God-Apes and Fossil men: the Paleoanthropology of South Asia.* Michigan: The University of Michigan Press.

Sankhyan, A.R. and Rao, V.R. (2007). *Human Origins, Genome & People of India: Genomic, Palaeontological & Archaeological Perspectives.* New Delhi: Allied Publishers.

Sankhyan, A R. (2009). *Asian Perspectives on Human Evolution*. New Delhi: Serials Publications.

Williams, B., Kay, R., & Kirk, E. (2010). *New Perspectives on Anthropoid Origins. Proceedings of National Academy of Sciences.*

Sample Questions

1) How would you define a Primate?
2) Which Primates were closer to humans?
3) Name the currently recognised last common Ape-Hominid ancestor in the fossil record?
4) Discuss the status of the Siwalik, European and African hominoids in understanding the last common ancestor.
5) Do fossil evidences support the Chimpanzee as the closest ape to man?
6) Discuss the Evolutionary hypotheses-'Out of Africa' 'African Eve' or 'Out of Asia' in brief.
7) Distinguish between the Multiregional and the Single Origin hypotheses.
8) Was *Homo erectus* a dead evolutionary end in Asia?
9) Who were the probable ancestors of Hobbits- *Homo floresiensis?*
10) What is the status of Narmada man/men in the broad Old World perspective of early human evolution?

11) Do the Cranial and Postcranial fossils of Narmada Man belong to a single species or archaic population?

Write short note on the following

i) Missing Link

ii) Heidelbergenesis