Darwin's Theory of Evolution; Part II-B

Human Evolution

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In the previous two essays we had shown that Darwin's theory of natural selection as the chief *modus operandi* of organic evolution survived through the piercing scrutiny of advancing knowledge in the biological sciences. Now we shall see how he successfully applied this theory in a concrete case, namely, evolution of man, and thereby exemplified its utility. In the process we shall also study in detail how the understanding about human evolution has been perfected over time.

Logic of Analogy: Once the mechanism of evolution for the organic world in general was accepted and understood, it was but a corollary to conclude the emergence of man from some non-human forms through long term evolutionary sequence. In fact, Huxley[1] in England and Häckel[2] in Germany, who had accepted and championed the theory more loudly than Darwin himself, already speculated in public about the human evolution. By the same time, Lyell published his opinions on the antiquity of man on the basis of available geological data.[3] Next year, Wallace, who was already back home from the Far East, wrote an interesting article on the subject in the typical Darwinian way.[4]

Darwin himself, however, was a bit cautious man. He knew of the possible reaction of the believing masses first hand from that of his wife at home. He also knew that being the man of science did not automatically insulate one from the continuously corrupting impact of the millennia-long prejudices. Thirdly, he felt to be the chief target of the clerical orthodoxy. They had already started caricaturing evolution of man depicting a chimpanzee with the face of Darwin. For him, therefore, there were two preliminary tasks. One, to prepare the minds of the academic community as well as the lay public to accept the logic of evolution and its further consequence for man; two, to elicit the possibility of human evolution as a result of modification of some groups of pre-human forms by descent.

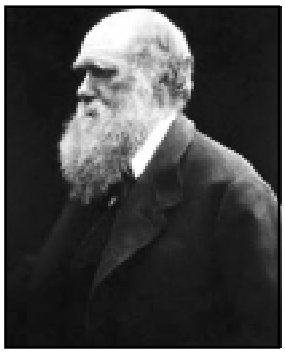

Fig.1: Charles Darwin

As regards the first point, Darwin started from the well-known fact of anatomical similarity of man with the large class of mammals, territorial (dog), aquatic (whale) as well as avian (bat). Despite the differences in their overall forms, there is a striking similarity in the skeletal structure of the homologous organs in mammals in general, for example, in the fore limbs. This was

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viewed as being the result of descent with modification from species to species up to the pre-human forms, like the apes. It was therefore only logical, Darwin argued, to consider the similarities in the skeletal design of man with other mammals, in spite of very many differences in their general morphology, to be the result of the same continuing process of descent with modification.

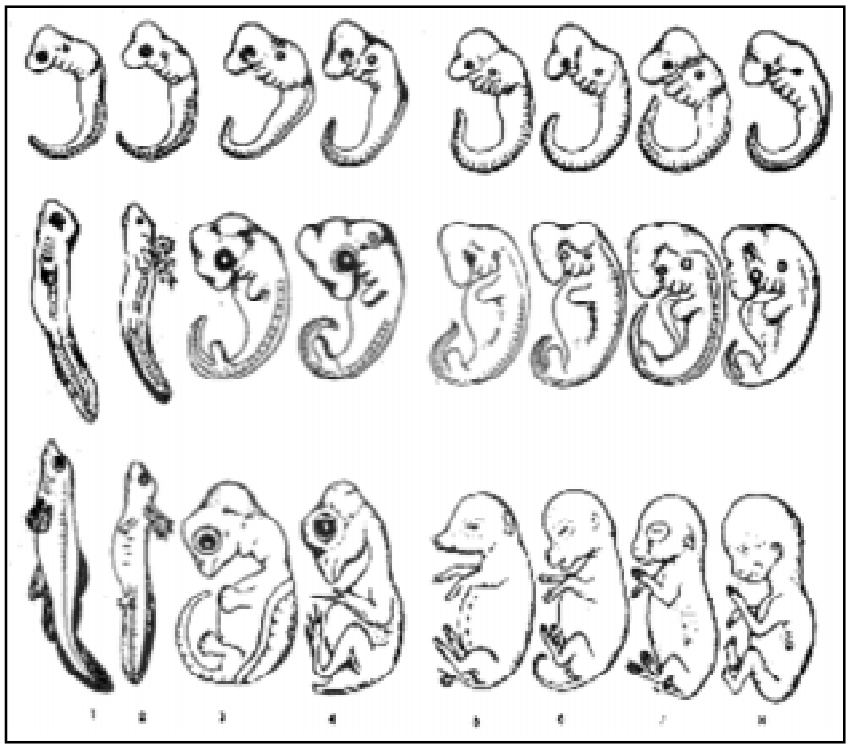

Fig. 2: Embryos of different vertebrates at three comparable stages of development; Note similarity at earlier stages up to man. [1-fish, 2-salamander, 3-turtle, 4-chick, 5-pig, 6-calf, 7-calf, 8-rabbit, 9-man

Secondly, Darwin pointed out that some of the man-like postures, like the absence of tail, erect gait, bipedal movement, use of fore limbs in tasks other than locomotion, etc., were as if in preparation among the anthropoid apes. This indicated the gradual modification of primate anatomy and behaviour towards making of man. Embryological comparison and neonatal similarities of the apes and man also seemed to strengthen the same inference. Comparison of brains and skulls of the higher primates like monkeys, apes and man, arranged side by side, similarly, pointed to an evolutionary sequence.

Thirdly, much embryological data were collected for various specimens of animals starting from fish to man by the time Darwin embarked on the subject of human evolution. The sequences of the embryological anatomy of these specimens arranged side by side for comparable levels of development clearly indicate a similarity at the common levels and departure at the subsequent levels for the successively higher animals (*see* Fig. 1). These data in a way put on record the facts of the later kind of species descending from the former types, in some cases directly, and in most of the cases indirectly.

Fourthly, he sailed from another indirect premise, then well documented by the travellers and missionaries from all corners of the globe, that various groups of men inhabiting distant parts belonged to different layers of cultural development. In this regard two allied works by McLennan[5] and Tylor[6] coming out in the same year, 1865, provided him with an interesting array of data. This signified a continuing involvement of mankind in an evolutionary course from a very poorly developed, almost animal like stage through various stages of backwardness to the present civilized state.

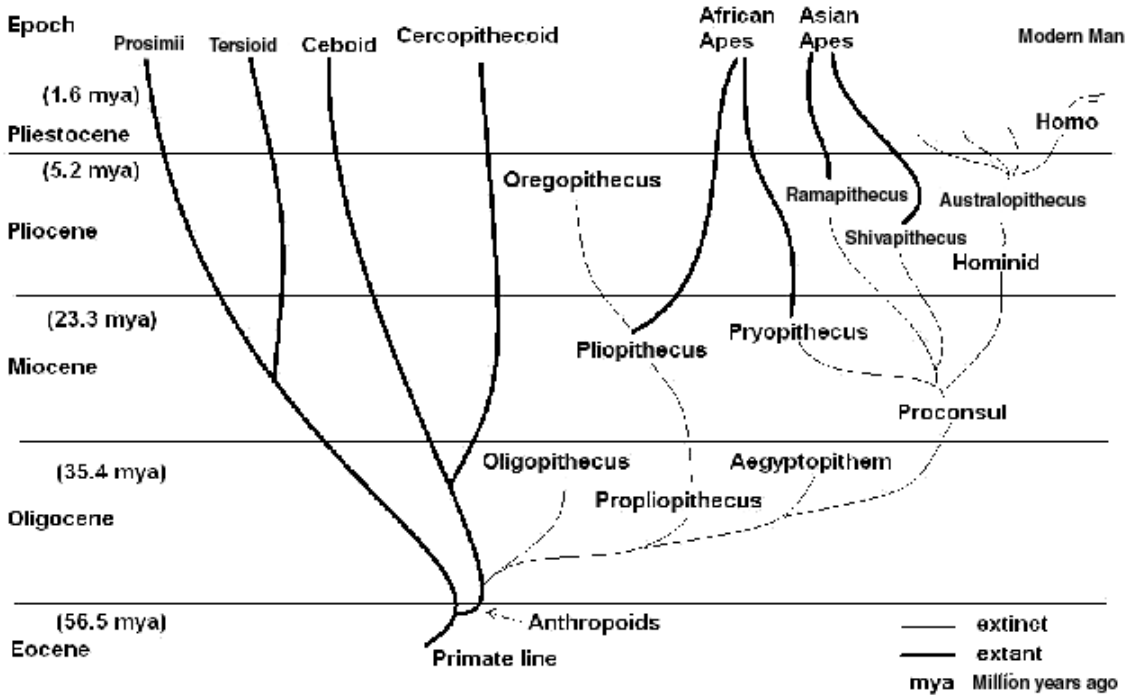

Chart 1: Modern view of man's descent in primate line

When you have data about evolution at the left end for the animals up to the higher primates and at the right end for man after his appearance on the earth, you are entitled by sheer logic to fill in the gap in between by drawing an evolutionary curve, even if imaginary, from the primate line to man. He gathered a large body of information from people travelling abroad through a questionnaire addressed to them seeking detailed report on the culture and ethos of the backward communities they met.

When all these tasks were fulfilled in the main, he felt it proper to publish his second major work on the evolutionary history of mankind[7] in 1871.

Hardcopy of Evidence:

Much water has flown though the Thames since then, in the interlude between Darwin and us. Human evolution has been much better understood, with the help of many new facts and finds, with most of the gaps in between the great apes and modern man filled up by fossil discoveries. Although geologists and anthropologists are yet to arrive at a consensus on all major points, there is a fair amount of agreement on the essentials. Now we can trace the intermediate species which milestone the evolutionary pathway from the suspected ancestor of the primate branch leading gradually to man. Let us take a snapshot of that winding pathway in the light of the present level of relevant knowledge (still subject to improvement and correction).

The first human fossil was found in 1856 in the Neander valley of the Alps in Germany. But that it was a specimen of our very near relatives took a century to grasp. Still older fossils were obtained from all over the globe which stood in between the apes and man till now. Only recently, was it possible to

trace the lineage still backward.

[1] **From Ape to Man (?):** Previously Darwin's theory was grossly misunderstood in popular journalism as meaning that man had evolved from monkeys or apes. This gave birth to the continuing search for "missing links", that is, fossils that would represent intermediate forms in between monkeys, apes and man. The Christian opponents in the late nineteenth century Europe who used to attack Darwin on this point in debates and cartoons asked with a serious mien the question, which now appears so silly: Had Darwin's theory been true, why didn't the present monkeys and apes change into man?

The proper theory was, however, much simpler than that, namely, that man, apes, and the other extant monkeys have in all probability descended from a common and distant, now extinct, primate ancestor. "Clearly, no living ape can be man's ancestor, but, if man's own evolutionary history is being considered, the history of other living primates must also be examined. There cannot be any 'missing link' in *modern* ape-like form. From a common early primate stem, evolutionary advance had progressed towards greater complexity, culminating in the higher primates and man."[8]

The lineage seems to begin from a supposedly tree-living small gorilla-type tailless primate, called Proconsul (or, alternatively, *Ægyptopithecus*) in Africa, some 30-20 million years ago, in the early Miocene era. This may have been the common ancestor of the various genera of the *Pongidae* (African great apes) and the *Hominidae*. Through the *Dryopithecus* and *Dendropithecus* in Europe and *Kenyapithecus* in Africa in the middle Miocene15-10 million years ago, they diverged into two distinct routes: one leading to the African apes (gorilla and chimpanzee) and the Hominid group including man; and the other to *Ramapithecus* and *Shivapithecus* during 14-9 million years ago. The fossils of the latter two groups have been found in many parts of Asia, Africa and Europe, like in India, Pakistan, China, Turkey, Hungary, etc. They seem to have radiated into the routes of the Asian apes like Gibbon in South Asia, and Orang-utan in the Southeast and then disappeared into the kingdom of the dead (*see* Chart 1).

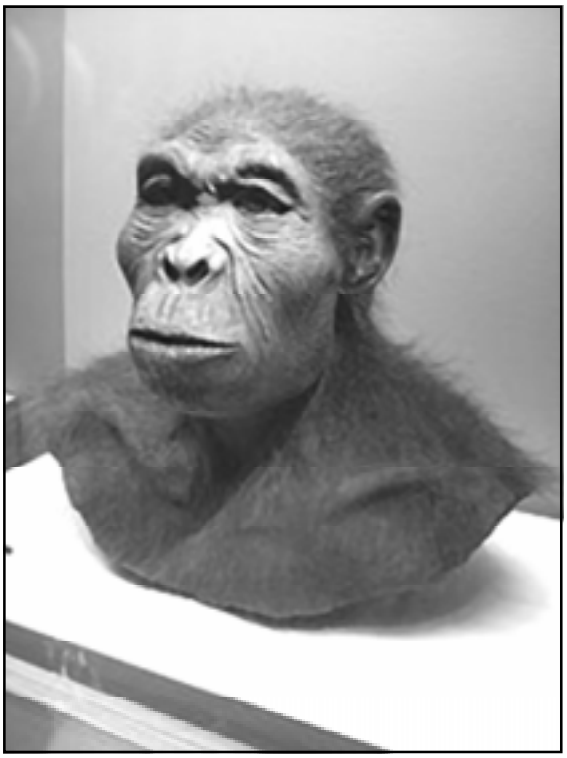

Fig.3: Reconstruction of Homo Habilis face

[2] **Australopithecus:** The evolution of the higher primates took a qualitatively different turn at the point when a new group of species forming a separate cluster of genera diverged and started terrestrial life. Fossil record places them some time in the interval of 10-5 million years back in the late Miocene or early Pliocene era. One of them has been called *Australopithecus* (meaning monkey of the southern hemisphere). The time period referred to in geology as tertiary points to a terrestrial condition in Africa with increasing

Fig.4: Homo Erectus skull, kept at the Natural History Museum, Ann Arbor, Michigan, USA

aridity, denudation of dense forests and big trees, spread of grasslands (savannah), etc., which made arboreal life difficult. Types of primates which could live on the surface and feed on the insects and leaves available there had a fairer chance of survival. They survived and branched out in a dozen lineages. They were still ape-like (hence honoured as *pithecine*) in that they could not walk on two hind legs for long; their forelimbs were longer than their hind legs and supported the body in locomotion; their lower jaw was much protruded forward.

On the other hand, they showed the first signs of the three man-like specifics, called the *hominid triad*, namely, erect gait, bipedal locomotion and prehensile use of forelimbs in grasping things. Unlike the apes, their skull is characterized by a smooth curved surface and is conspicuous by the absence of the sagittal crest; the foramen magnum, or the hole of the lower skull through which the spinal chord connects with the medulla of the brain, came to the centre. So they belonged to a supra-genus called Hominid (which included the genus Homo).

During the same time some other hominid groups appeared which are known as *Ardipithecus* and *Paranthropus*. They also radiated into several species, which were more or less similar to those belonging to the genus Australopithecus. Most of them ended in some blind alleys.

[3] **Homo Habilis:** However, fossil evidence indicates a productive radiation from the A. africanus into a newer group of species under the genus *Homo* (*see* Chart 2). One of them was the first direct ancestor of modern man and appeared on the earth during 3 to 2 millions years ago. They acquired more man-like characters: the fore limbs were equal to the hind limbs in length; the toes of the feet differentiated from the fingers of the hands; lower jaw was inwardly drawn; eye sockets became less deep; the spine acquired the lumber curve in the form of an elongated 'S'; so they could walk much longer on two legs; their head stood on the neck more erectly; the forehead was plain and straight; etc.

Interestingly, the Australopithecine did not possess a large brain; its brain was on the average of the chimpanzee size (400 cubic centimetres). Now the species *Homo habilis* showed, in fossil evidence, a brain as large as 600 cc. With its fore limbs, now turned into hands, it could 'work', other than grasping, like carrying and grinding blocks of rocks and stones; it could use the rocks as weapons to hunt animals. This signified a change in its dietary habits too. In addition to vegetables and insects, they started to feed on animals they could kill with their stone missiles. They also learnt to clear mountain caves and occupy these as their shelters. All this gave them a selective advantage.

[4] **Homo Erectus:** Naturally the genus Homo diversified in multiple directions, as shown in the chart above. Many fossils dated 2 million years back or after have come to light, which had advanced further in the

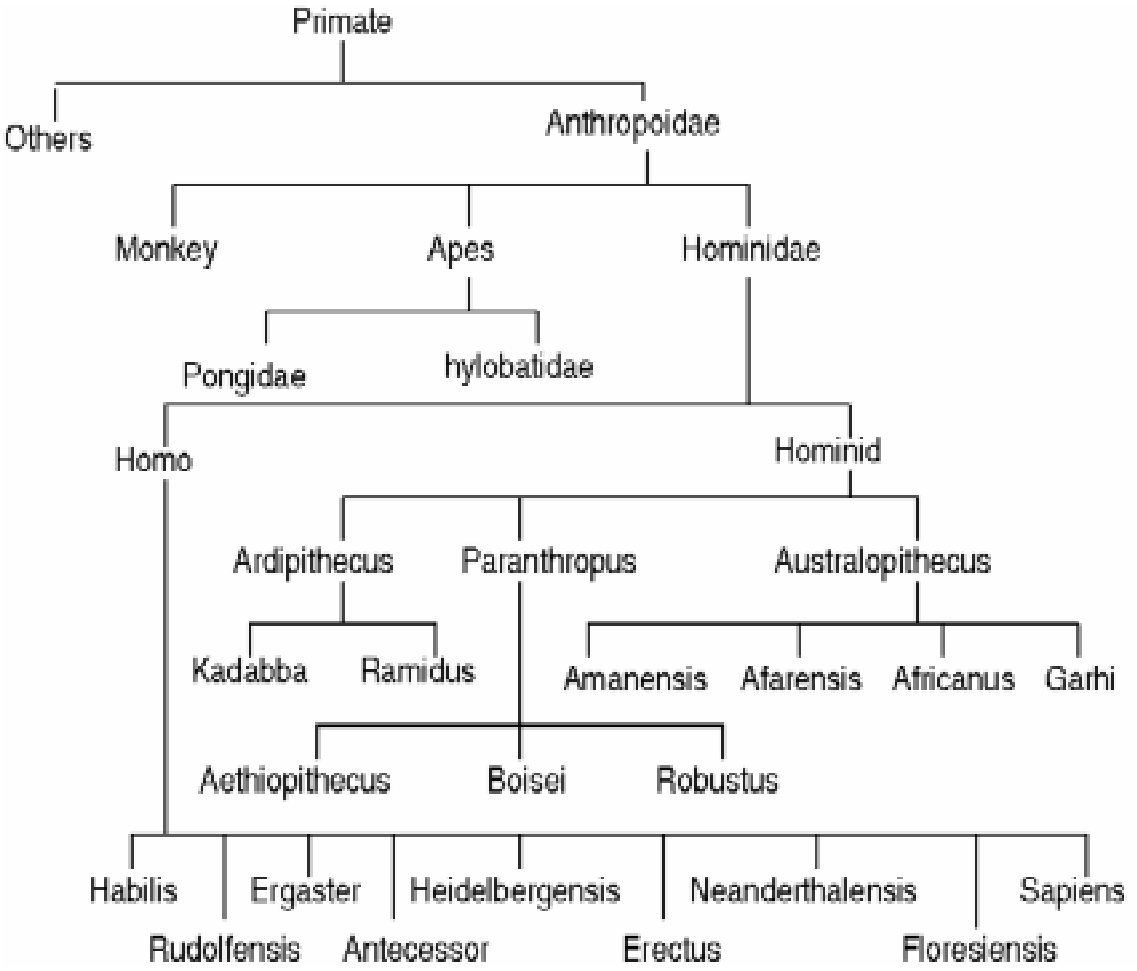

Chart 2: Man's Position in the Primate Family Tree[9]

evolutionary scale. They were more erect, had shorter forelimbs compared to the hind limbs, walked on two legs, used hands for manipulative purposes rather than walking, could produce articulate vocal sounds (speech), so on and so forth. They are called *Homo erectus*.

Notably, fossil records of the species belonging to the Australopithecus and Habilis were obtained only from the continent of Africa. From now onward, fossils of the new types were found scattered all over the Old World – in China, Malaysia, Germany, Russia, and so on. This showed that they had migrated from their original homeland to all parts of the globe in the literal sense of the term.

And with reference to the Ice Age we have to entertain another question: how did the erectus and the kindred species survive the sustained sub-zero climatic condition in the Northern Hemisphere without the natural fur coat grown on their skin? On the contrary, what happened to the habilis? Why did they, *par se* fossil record, lose the game on the earth?

The answer, as we know it today, is quite simple. The erectus species learnt to burn fire, or, once fire was naturally inflamed, to preserve it for a long time. However, they had also a larger brain (about 900 c. c.) that was able to cope with such a complex situation. And as soon as they acquired this art, they achieved still newer skills.

Production of fire yielded four advantages to those primitive men: (a) They could withstand the impact of pinching cold of the Ice Age in the North; (b) They could frighten wild and ferocious animals away from their cave-shelters and improve self- defence; (c) They could work and hunt in the night with burning torches in hands; and lastly, (d) They learnt to roast the acquired games, that is, cook food. As a result they soon defeated the habilis in the struggle for living, preponderated over an ever increasing area of the globe, and spread and diverged in several directions in the evolutionary course.

Moreover, they learnt to kill big games like bison, mammoth, etc. With erect walking and free hands it became easier for them to throw rocky missiles to the big animals. They fashioned stones into differential tools for separate uses. Even then they could hardly kill a bison or mammoth alone, single-handed. Instinctively they went in hunting in a horde, killed a game, brought it near their shelters, hung over a fire-work to roast and finally slice it up into pieces for feast; usually the stronger taking the larger shares and the weaker the smaller. In addition, they found out utility of the large skins of the big games, properly peeled off, as body covers, for sleeping as well as wearing. Man became as if ashamed of his nudity for the first time in the midst of the wide openness of nature.

Hunting big games required herd activity; herd activity necessitated reciprocal communication among the hunters. Probably it was gestures of the free hands and guttural sounds like those emitted by birds and higher mammals. But they were

Fig. 5 : Mounted Neanderthal skeleton, kept at the American Museum of Natural History

brainier species with a 900 c.c. cranial space; microscopic study of the imprints in the inner cranial surface indicates distinct contours of the Broca's area – the motor-control area of articulate speech. Oesophageal skeleton shows artenoid cartilages, the chief component of the vocal chord. These two anatomical features

support the guess that the erectus could speak in the human sense, using symbolic sounds for objects and phenomena.

Since then the biological history took a new turn; it turned into bio-cultural evolution of man. While still undergoing organic progression man entered into a dynamic process of socio-cultural evolution, where the acquisitions and achievements of a generation could be directly transferred to the next without through the physical mechanism of heredity. Every generation learnt faster than its predecessors and advanced a few steps ahead, however insignificant. In other words, for the first time in the history of the organic world, a new element entered into the evolutionary dynamics, where a species could choose its own course of development with a purpose.[10] Inheritance of acquired characters became possible for the first time in the organic world – although this inheritance was extrinsic to the physical machinery of heredity.

[5] Homo Neanderthalensis: In course of further evolution, while the erectus probably led to a new species called *flouresiensis*, some contemporary species (or a variety thereof) belonging to the genus Homo evolved into the *neanderthalensis* (the Neanderthal man), The Neanderthals which stood in between the erectus and sapiens in terms of evolutionary development had advanced in many respects; they further improved upon stone implements and enlarged their dietary provision. They used to bury the dead with some food and stone tools kept beside the decedent. They were quite robust in body structure, with a brain capacity of 1500 c. c. in average, a barrel chest and beefy hands. As a result for long they were considered an earlier variety (or a sub-species) of the sapiens and even termed as Homo sapiens neanderth-alensis. However, it is now reasonably believed that they had evolved much earlier and existed prior to and side by side the sapiens for some time in parallel (during 65000 to 25000 years ago), before they completely disappeared. This fact has led to their nomination as a separate species. They were creatures of mainly the Northern Hemisphere. Recent researches on the frequent fluctuations of the last interglacial climate of the northern temperate region on the basis of the improved method of study of palaeoclimatic data (the so-called Oxygen Isotope Stage 3, or, OIS-3 method) resulting in rapid changes in the existing flora and fauna or the available food base vis-à-vis the study of available fossils showed how or why their population might have rapidly dwindled. So, with the rise of the sapiens from the tropical woods of Africa with greater versatility in many respects including multiclimatic adaptability, they gradually outwitted the neanderthals to perish.[11]

[6] **Homo Sapiens:** Some other kindred species produced a more successful mutation – the modern man or the Homo sapiens, the species we belong to. This transition may have taken place between 200 000 to 50 000 years back. This species appeared on the earth with a 1400 c. c. brain capacity on the average, denuded of almost all body hairs. The sapiens soon spread all over the globe and diversified into a large number of varieties. They adapted in all climatic conditions, starting from the extremely hot sub-Saharan tropics to the extremely cold Arctic environment of Greenland; from the Siberian Tundra forest to the Fertile Crescent of Mesopotamia. Of various skin colours, height, body builds, facial designs, ocular shapes, hair textures, lip muscles, nasal structures, etc., specifying some distinct racial characteristics of the Caucasoid, Negroid, Mongoloid, Semitic and Australoid (although today there is no member of such a pure race), the species sapiens showed a tremendous elasticity in

adaptation, food habit, life style, and so on.

This sketch shows that there was no unilinear development from the ancestral primate to the modern man; at every step there were several groups of species radiating in parallel from a common stock; some of which successfully survived and some others perished. However, if we try to trace the ancestral lineage of the sapiens from its original primate ancestor, it is possible to draw a single line backward through the fossil records at various stages as its line of descent. Moreover, starting from the africanus to the sapiens, we note an interesting trend of secular ascent in the brain size, height and the fore-limb:hind-limb ratio (Intermembral Index) in the successive species over time (*see* Table 1).

Table – 1
Parameters of Progress in Higher Primates (Averages)

Species	Height (cm)	Intermembral Index hand:leg	Brain Capacity (c. c.)
Asian Apes	160	131	350
Chimpanzee	170	145	400
Gorilla	180	116	500
Australopithecus	130	110	500
Homo habilis	150	100	600
Homo erectus	170	80	900
Man	180	70	1350

Functional Evolution: An important aspect of human evolution is his increasing non-genetic adaptability expressed through tool use and making, language and social organization, which took shape through functional diversification of the bodily organs rather than as manifestation of the genetic endowments. It is not that these adaptations could arise without through the mediation of the genetic resources. The genetic resources had surely contributed their share in providing the potentiality of such acquisitions. But the results themselves were no more pre-programmed in the gene-pool of man at that time than now, as is known today. On the one hand, those gene-pools which had such potentialities encoded within, were successful through the selection pressure than those which had none; on the other, among them those groups of Homo sapiens which could translate these potentialities into realities, had a greater selective advantage over those which could not.

Among the non-genetic adaptations the most important is the acquisition of speech as a complex and dynamic system of artificial sound symbols with their arbitrary semantics for things and phenomena immediately surrounding the different species belonging to the genus Homo. It is evident that the speech organs are all organs of other, more fundamental, physiological functions (for example, the mouth for eating, teeth for chewing, tongue for tasting etc.). These organs had to adopt speech as an extra function together with the additional neuronal mechanism and connections. Speech as a sensory input is significant only in relation to its reception by hearing. With production of speech as a specific function, has to arise the ability to hear the specialized speech symbols and grasp the meaning attached to them in the given (social, cultural, psychological and linguistic) contexts. Hence the same organs which were previously sensitive only to (physical) sounds *in general* had to become adapted further to hearing and differentiating the (articulated) sounds *as words*. The human brain had to create the newer specialized areas within the mosaic of the cerebral cortex for these newly emerging tasks, which also needed increasing neuronal connections, additional cranial space and increased mass and volume of the cortical tissues. This explains the relatively selective success of the brainier species among the Homo and the rapid

increase of the brain from 400 c. c. in the Australopithecus, 600 c. c. among the habilis, 900 c. c. among the erectus to the 1400 c. c. in the modern man.

This had another dimension. The erectus learnt to kill bigger games and got increasingly used to consuming larger quantity of protein diet, which seemed to have greatly solved the problem of food procurement in the Ice Age and its aftermath. This ability too is supposed to have a greater impact on the growth of the brain – although in an indirect way. All mammalian *brains* – of both herbivores and the carnivores – feed mainly on sugars. And both groups show a comparable rate of consumption of sugars as well as a comparable ratio of brain to body in terms of masses. Since neurons do not undergo cell division they do not need continuous replenishment to replace the dead cells, the chief function of the proteins. Animal babies are born with virtually fully grown brain masses. For example, the non-human primates have the ratio of the brain-mass of the neonates to that of the adults as 2:3. With man the ratio is 1:4. Not only this. One must keep in mind the rate of growth of human brain after birth: the human neonate born with merely 25 per cent of the adult brain mass acquires 50 per cent at six months; at five years of age the brain grows to about 90 per cent; and to 95 per cent at about the age of ten. By the age of 25 years the remaining 5 per cent maturity of the adult brain is complete.

This implies, the brain of the human child matures long before the body matures to adulthood. The rate of growth of the brain tissue (mainly through the growth of the glial cells) sharply falls with the growth from childhood to adolescence. In other words, the growth rate of the human brain is, as it were, inversely proportional to the rate of intake of protein by the human body growing to adulthood. Thus protein consumption has evidently no significant contribution in the direct building of the brain tissue of animals as well as man. Stomach may differ in the entertainment of the types of food it receives from nature; but brain (animal or human) is notoriously vegetarian. The "blood-brain barrier" developing in the maturing brain in the early childhood obstructs entry of not only any protein-type bigger molecules but even the simple molecules of amino acids, the building blocks of proteins, from the blood stream to the brain tissue. In fact, it is one of the interesting ways the brain secures itself from random intrusion of any alien body injurious to its existence. Moreover, it has also ensured the survival of man irrespective of the type of food chains he belongs to.

Indirectly, however, adoption of protein diet had a tremendous impact on the rapid growth of human brain. Hunting and killing big games required collective and concerted actions by the primitive men, which required in its turn socially co-ordinated and language mediated communications. Skinning the games and roasting the beef demanded great skill both in fashioning the peeling tools or cutleries and in using the hands. Those brainier species which had acquired the potentiality of all these complex functions had a selective advantage over the others. As a result, when the species sapiens appeared on the scenario of the earth, about fifty thousand years ago, its genetic evolution had, in the main, come to an end and was almost entirely replaced by the cultural evolution that both followed and fostered the increasingly functional improvement of the human brain and hands.

Knowledge about the development of human culture is scanty, but there is a tendency to conclude what suits a particular point of view (as we shall see later) from the early man's history and to show that as a human nature, etc. Hence it is better to listen to the caution voiced by an expert: "Many

characteristics of early human behaviour are, however, difficult to reconstruct, as no appropriate material evidence is available. .. Inference often blends into guesswork .. Our ideas about the way of life of human ancestors will no doubt change in response to new fossil evidence, and with improvements in the way we interpret it.'' [12] We have to keep these points in mind in our next study of Darwinism in its sociological and philosophical contexts.

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