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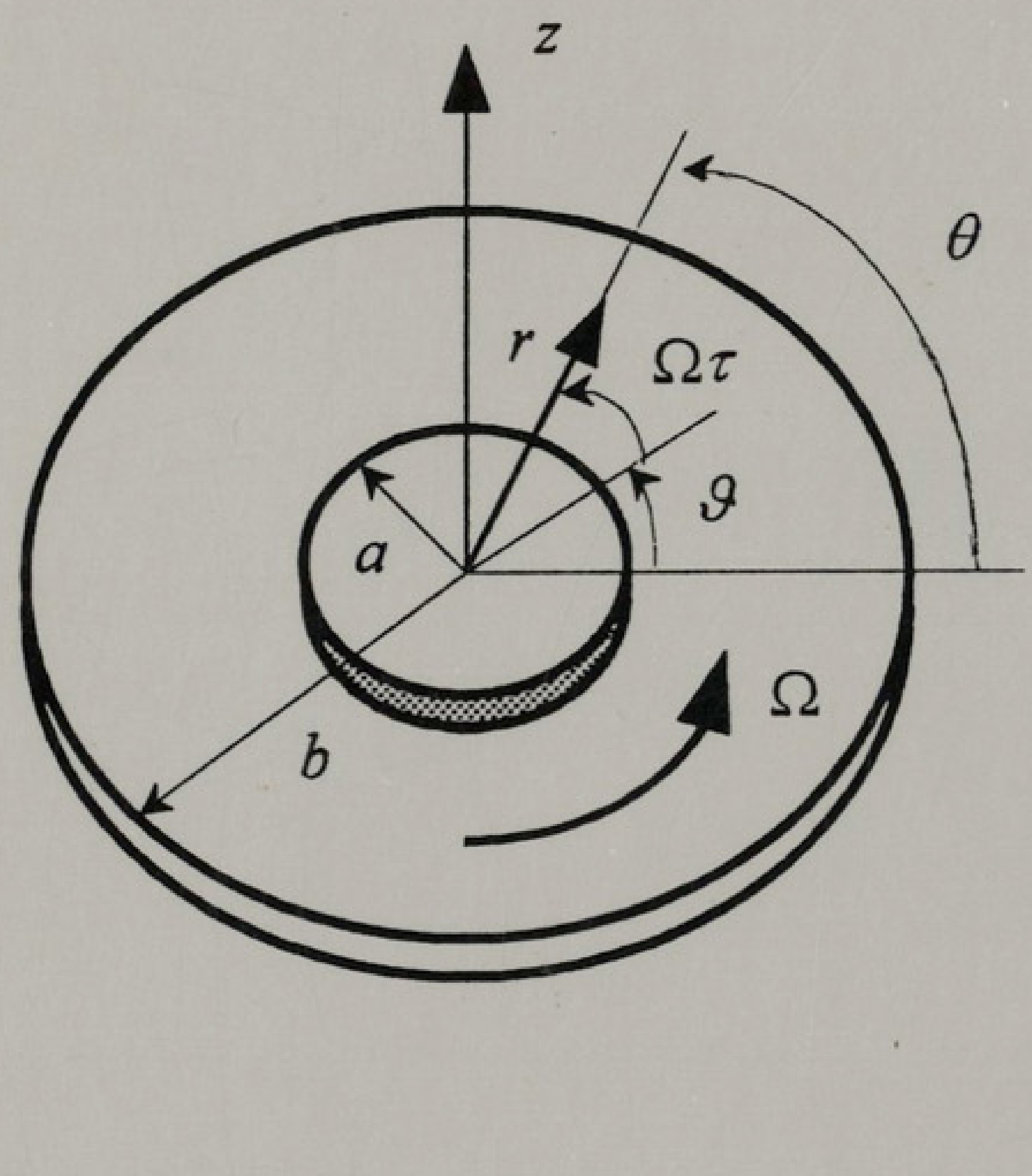

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The Notion of Time from Big-Bang up to Date (From Nature to Man : A Temporal Perspective)

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Abstract

From the Big Bang to the emergence of human beings, and then through a series of culturally evolutionary events, we have traveled into a world containing elements that have developed on several scales.

In this paper we examine the length of time, from one critical transition in the evolutionary journey to the next, from the beginning of the universe to the latest cultural developments. This is in an attempt to reflect on the tempo of change and its implications both for understanding the reasons for the rate of evolution and its change through time, as well as its implications for the co-existence of human beings with other physical and biological elements of the world.

In general, the emergence of life on earth marks a shift to a biological time scale that is superimposed on the cosmic scale. The emergence of culture, marking a key transition in how life forms interact, signals a shift to yet another time scale. The observed changes in cosmic, biological, and cultural phenomena lead to a perception of directional time and an evolutionary trajectory. Current estimates of the timing of key events indicate that evolutionary change is logarithmic, marked by a progressive acceleration in the speed of change.

Keywords: Universe, Evolution, Notion of time, Human development, Time measurement, Logarithmic scale.

Introduction

Our perceptions of time are crucial to the way we deal with nature, and reflect on our destiny and ethics. In other words, when dealing with history in its widest sense, i.e. when looking at the history of the cosmos; the history of geological formations; the history of biological evolution; the history of human evolution; and the history of civilization, we use different measurements or units of time. For example, when dealing with cosmic evolution, we talk in *billions* of years. When we talk about geological evolution, we use a scale of *millions* of years. In referring to human evolution, we use a scale of *hundreds of thousands* of years. For the evolution of civilization we use a scale of *thousands* of years. When discussing modern civilization, we talk in *hundreds* of years. And finally, when talking about the evolution of information technology, we speak of *tens* of years.

The problems appear when we try to compare these aspects of history with each other. When we try to show on one chart an aspect of history, such as geology, and another aspect, such as civilization, we find that the two time scales are incompatible.

There have been several attempts to show the various aspects of history on a single chart. But there is always the problem of different scales for different aspects. The solution we are proposing is a convenient one, since the scale changes with the depth of time. The proposed chart assumes a *logarithmic* scale rather than the standard *linear* scale of time.

The proposed timeline would explain some sociological aspects of history. It shows clearly that the pace of human development is changing with time, which would explain the notion of the different frequency between different generations.

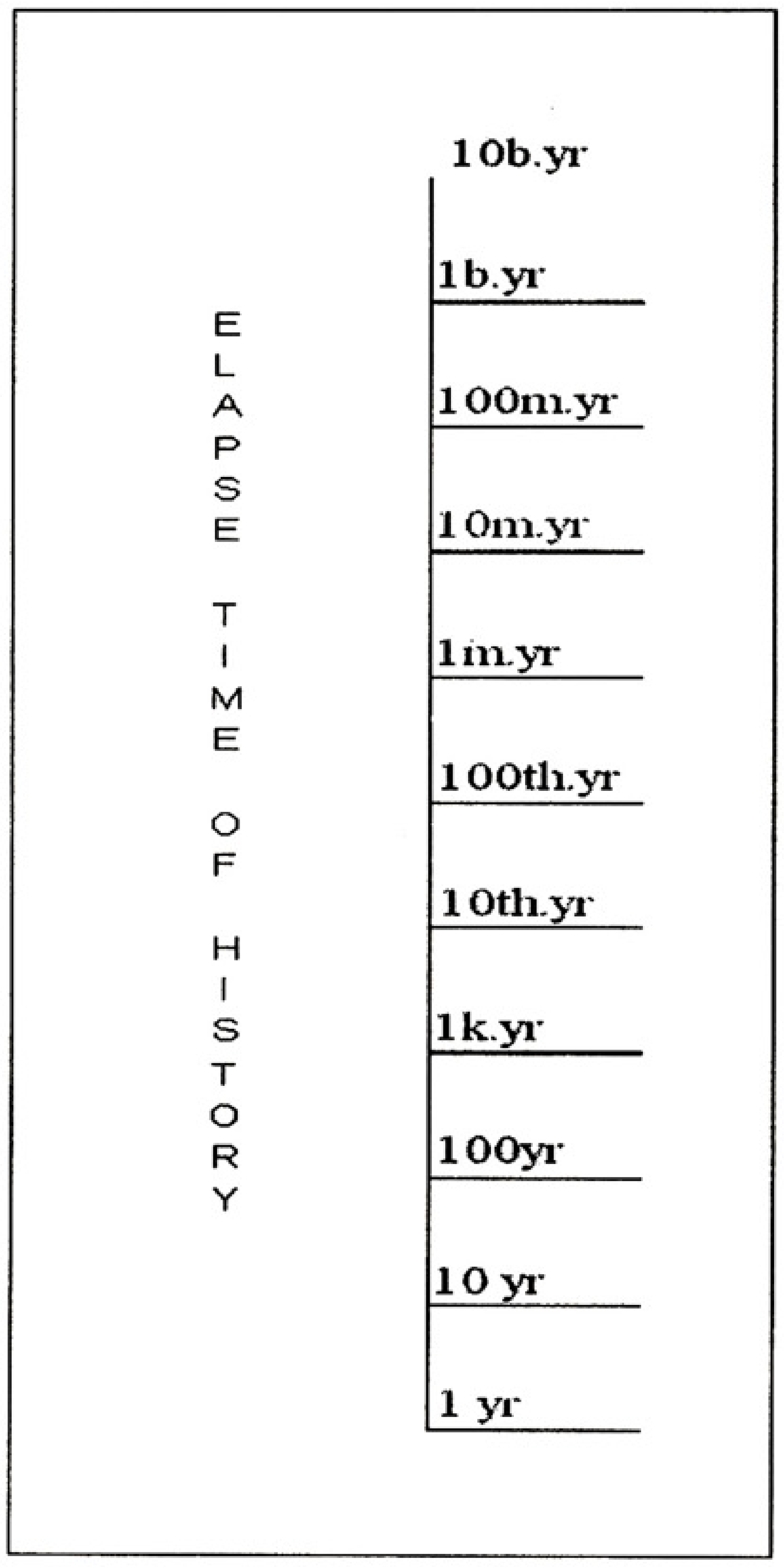

Fig.1 The logarithmic presentation of time in years

Presentation of the main aspects of history on the logarithmic scale time chart

The idea of creating a single chart to represent the integrality of history came from reading a book entitled *L'invention de L'humanité* [1]. In this book, the author attempted to cite chronologically, the series of historical events from the Big Bang to date. He wrote his book without presenting any graphic representation of the time. Reading the book, and trying to select the main events that summarize different aspects of history on a chart, led to this very interesting presentation of history

This new presentation of historical events, allows different aspects of history to be shown equally on the same chart. It gives a different flavor and interpretation to the historical aspects that would not be seen at all on a linear scale. The logarithmic scale that was chosen is based on the power of ten for the elapsed time of history as shown in figure 1.

Figure1 shows the presentation of the elapsed time of history on a logarithmic base of 10, which means that each centimeter represents elapsed time equivalent to 10 to the power of the number of centimeters i.e. two centimeters from the origin is equivalent to $(10)^2$ or 100 years; six centimeters from the origin is equivalent to $(10)^6$, i.e. one million years, etc.

In this chart **th.yr** denotes *thousands of years*, **m.yr** denotes *millions of years*, and **b.yr** denotes *billions of years*. This is a standard notation used in various branches of physical sciences.

Using the same scale to represent different aspects of history, figure 2 shows the major events that have occurred across history since the Big Bang until today. About 10 billion years ago, there was the Big Bang; it was followed by a series of cosmological events beginning with the formation of atomic elements and ending with the creation of cosmic bodies, such as galaxies, stars, and planets (including our solar system). One billion years ago, the earth started to be inhabited by life such as plants, invertebrates, and later, vertebrates and dinosaurs. About a hundred million years ago, by which time the earth was covered with plants, a major event took place. Scientists believe that the earth may have been hit by a huge meteorite, which caused the disappearance of the giant reptiles. This paved the way for the appearance of human beings. About ten million years ago, the first bipedal hominid existed with the possibility of the appearance of a series of pre *Homo erectus* species, such as *Homo* *habilis*. About one million years ago, *Homo habilis* straightened his back to become the creature we call *Homo erectus*. *Homo erectus* developed some vocal ability and became *Homo loquens*. He then developed into *Homo pre-sapiens* and *Homo para-sapiens*. About a hundred thousand years ago, a star was born! It was then that *Homo sapiens sapiens* came into being and heralded the beginning of our era of humanity.

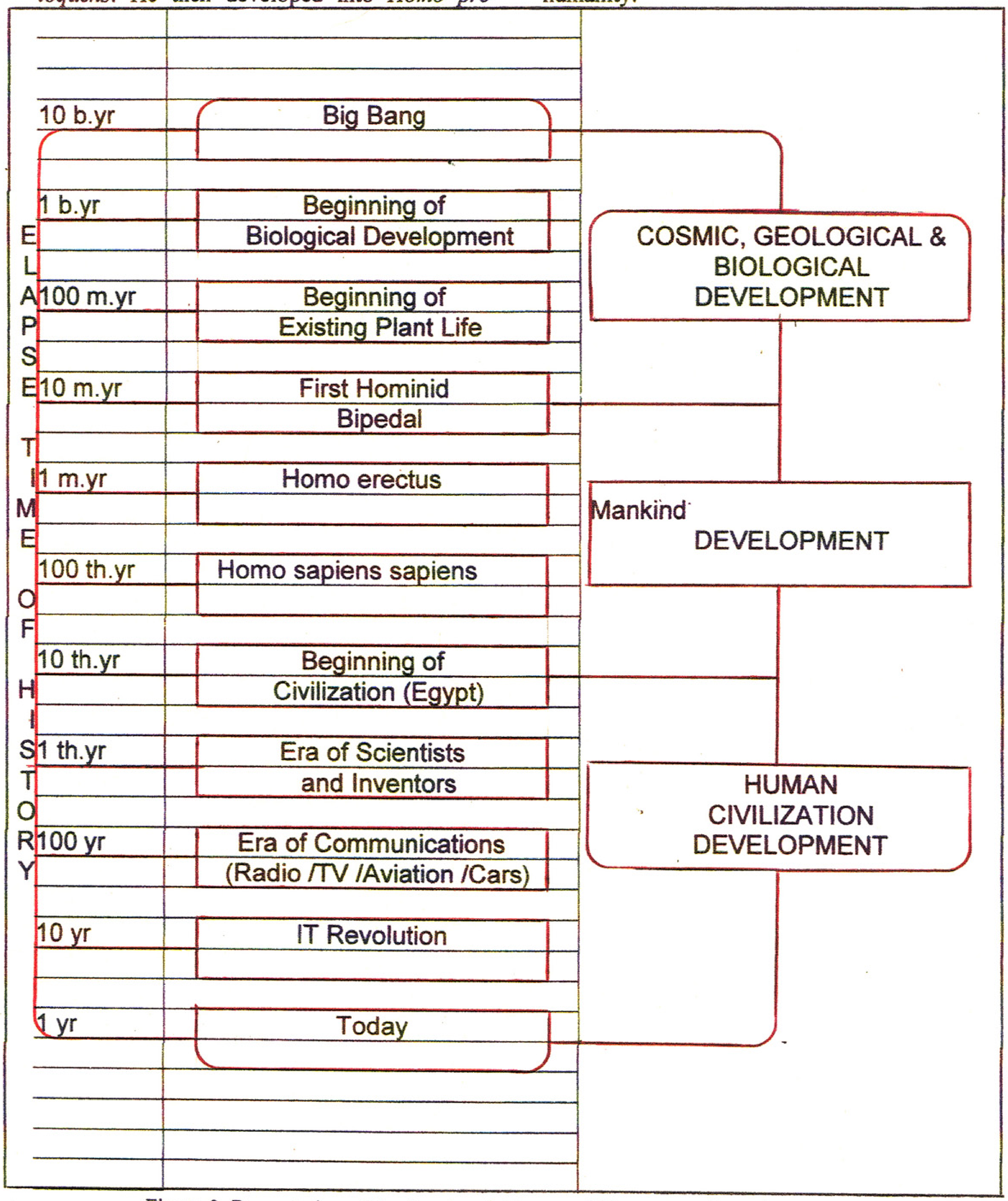

Figure 2: Presentation of the Landmark Events of History on a Logarithmic Scale

About ten thousand years ago, humans began to take part in collective activities, thus forming the first societies. These early societies gave rise to various civilizations including the Egyptian, Mesopotamian, Chinese, and Indus Valley cultures. It also created the conditions for the development of religions, such as Judaism, Christianity, Islam, Hinduism, and Buddhism among others.

About two thousand years ago, scientists and inventors began to develop such innovations as navigational devices, the printing press, the telescope, steam engines, voltaic cells, dynamos, and numerous other devices. A hundred years ago a new era began that saw innovations in communication and transportation. The motorcar was invented followed by the airplane; communications were revolutionized by the invention of the telephone, radio, and television.. Finally, in the last ten years, there has been the revolution in which we are living today: the revolution in information technology.

The events shown in figure 2 are with large approximations of time values. For example, the Big Bang is located at 10 billion years. Scientists are debating whether it is at 10 billion, 15 billion or 20 billion years. On this chart of logarithmic timescales, there are small differences in distance between these three values.

Figure 2 suggests also, that there are three distinct periods in History of equal logarithmic distance. These periods are:

- The cosmological/geological/biological development period (development of life).
- The human development period.
- The human civilization development period.

In the following sections we will discuss in greater detail the contents of the three cycles and show the sub-details of each one.

This is best demonstrated in figure 3. In this figure, within each step of the scale, there is a subscale of logarithmic divisions, which represent the true logarithmic scale, or there are the linear divisions, which we have used in the final figure. We can call this a *log-lin scale,* because at the global level it is logarithmic, while on the detailed level it is linear.

I. Cosmological/Geological/Biological Cycle of History

This is the period of history that starts with the Big Bang, about 10 billion years ago and progresses until the appearance of the first hominid about ten million years ago (figure 3a)

This cycle can also be seen as three separate periods. The first is mainly cosmological, and caused the formation of matter, which was condensed with time into cosmic bodies including galaxies, stars, planets, and moons. The second period encompassed the biological developments on earth that gave rise, at first, to primitive forms of life, and later to giant reptiles. The third period is considered to have been preparation for the earth to receive human beings. It was marked first by the dramatic disappearance of the dinosaurs, and then by the appearance of primitive hominids.

I.1 Cosmological and atomic development period: (From 10 billion years to 1 billion year ago. Unit of time: billions of years.)

Modern theory says that the universe began to exist in an abrupt manner with a gigantic explosion known as the *Big Bang*. The exact moment of this explosion, is estimated by scientists as somewhere between 10 and 20 billion years ago [2, 3]. The most likely figure is 14 billion years ago. Sometime after the Big Bang occurred, the universe would have contained primitive particles such as photons, electrons, neutrinos, protons and neutrons. Later, these particles were able to combine to form simple nuclei of atoms such as the nucleus of heavy hydrogen (one proton + one neutron) or helium (two protons + two neutrons). The universe filled with clouds of hydrogen and helium and continued to expand and to cool for about a billon years. At that time, the universe was just a dark place. In some regions of high-density clouds of atoms, gravitational attraction between atoms pulled them together into tightly bound packets of atoms, which formed what we might call embryonic stars. The pulling of atoms towards the center of the cloud would increase its energy, and thus the temperature of the surrounding gas. After about a million years, the center of the shrinking cloud heats to a critical temperature that would allow a nuclear reaction to start. A new source of light would then appear in the heavens declaring the birth of a new star. The process continued and led to the formation of celestial bodies such as galaxies, stars and planets. Our own solar system was formed about five billion years ago.

When earth started to form, it did not have any atmosphere to protect it. Thus it was subject to bombardment by thousands of comets. This bombardment brought the water, which we have today in the oceans together with organic materials, i.e. molecules containing carbon, oxygen, azotes, and hydrogen that were necessary for the development of life. Volcanic activities also contributed to the miracle of nature. With the flow of volcanic lava in great quantities on the earth's surface, large amounts of gas reached the atmosphere. As the earth cooled, water vapor started to condense, primitive plants began to cover the surface and the oceans were formed.

About 1.9 billion years ago, the first super continent was formed. In the deep water the first unicellular life appeared.

I.2 Terrestrial biological development period: (From 1 billion years to 100 million year ago. Unit of time: 100 million years.)

The commencement of biological development on earth did not wait until the earth was stabilized in the continental form that we know today. On the contrary, biological development went in parallel with continental and atmospheric developments. The development of the modern continents started about 200 million years ago with the formation of the super continent known as Pangea. It began to break up about 94 million years ago, rifting into three parts: Eurasia, North America, Africa-South America and Antarctica-Australia-India. About 50 million years ago, Pangaea's breakup ended and a new cycle of continental collision began. Africa hit Europe, and India rammed into Asia, thrusting out the Alps and Himalayas. Continental compression led to widened ocean basins, which lowered sea level. The continents took forms that were very similar to the ones that exist today.

Parallel to the evolution of the continents, a number of biological developments took place. The first organisms were likely to have been prokaryotes, which still exist; stromatolites dating back to 3500 million years provide evidence for this. These are the simplest life forms usually ranging in size from 1–10 microns in length and are single-celled. They reproduce by expanding, and then dividing into two.

These organisms would have arrived on the planet via evolution around half a billion years ago, gently diversifying over time from their ancestral forms into distinct new species occupying unique ecological niches[4 & 5].

The majority of modern life forms are eukaryotes. These differ from prokaryotes because they have membrane-bound nuclei in their cells, which contain their DNA. Plants, animals, fungi and algae are all eukaryotes. The earliest fossil evidence for eukaryotes dates back to 2700 million years. Looking at the sheer number of eukaryotic organisms that have evolved since, this was a very significant event! The oldest fossil that is significant in a discussion of plant evolution is an alga called *Grypania* which is from 2100 million years. Algae were the earliest plants.

The number of life forms altered considerably between 1000 and 540 million years when several glacial periods (ice ages) occurred and led to significant extinctions. Nevertheless, there was always a relatively quick increase in the number of species. Because algae are photosynthetic organisms and their numbers increased over time, oxygen (O_2) was produced and significantly increased the concentration of O_2 in the Earth's atmosphere. It also had a major impact on the life it supported.

Arachnids were among the first creatures to occupy dry land, and make the transition from the sea, where animal life originated. Due to the actions of these bold creatures, their ancestors successfully realized their species' goal of survival, occupying previously sterile environments unchallenged.

As life originated in the sea, the oceans formed valuable ecological niches for the numerous species of the time. The ability of plants to emerge from the water and colonize land required major changes in the environment and in the algae and sea lettuces that would evolve into terrestrial plants.

While insects and similar organisms strove to occupy dry land, the sea was teaming with creatures aiming to secure their long-term survival. As a consequence of this, reproduction occurred and genetic variation increased. This resulted in the arrival of fish, which were adapted to life in the largest ecosystem on earth, water.

The most primitive fish were invertebrates. These would most likely have been the first fish to occupy the seas, having diversified from the primitive crustaceans that occupied the sea beforehand.

The first fossilized evidence for terrestrial plants dates from the middle Ordovician to the Silurian periods (470–430Ma); these fossils contain evidence of specialized cells, which could carry water and nutrients. They also had morphological features including structural support and protection from desiccation. Since terrestrial plants do not live in an aqueous environment, it is critical that they have vascular systems and be able to control water loss. Fossils from this period also show reproductive systems that no longer relied on external water.

By the late Devonian and early Carboniferous periods (385–290 million years), plants had developed the ability to produce secondary wood. Vascular plants were no longer restricted to heights of less than one meter and forests developed with trees as tall as 35 meters. An ideal climate helped the spread of the flora of this era, creating the Great Coal Forests. During the late Devonian (390–365 million years) there was massive diversification of plants and the creation of many new species.

The middle to late Carboniferous and early Permian periods saw the decline of the Giant Clubmoss Flora and the expansion and proliferation of the seed ferns. The climate was no longer so favorable, and many parts of the world experienced ice ages. During the Permian period (280–235 million years), this ice age period ended and the world warmed up. There was rapid evolution of a range of plants, and for the first time, seed plants became the dominant reproductive type.

The Triassic period (245–190 million years) was a time of major radiation of conifers. Also the first true dinosaurs occurred during the beginning of the period. Two distinct types of dinosaurs had evolved, some that were bird-like and some that were reptile-like. Within these two categories, dinosaurs diversified in habit to become carnivores, herbivores or omnivores.

The Jurassic period (190–144 million years) was mostly warm and moist worldwide, and the Gymnosperms were dominant.

The Cretaceous period (135–66.4 million years ago) saw another cooling of the climate. The Gymnosperms that had dominated began to decline, and make way for a new group of plants called the Angiosperms. The Cretaceous was the first period to include "modern" flora.

Meanwhile, the dinosaurs continued to evolve, and in some cases became bigger and stronger. Although they ruled the Earth, a competitor was emerging, the Mammalian class to which man belongs.

Dinosaurs disappeared around 65 million years ago; no one really knows why they became extinct, but the suggestion that an asteroid or meteorite hit the Earth would make it plausible to suggest that mammals survived because they were smaller and many species lived underground, and required less energy to survive. This could mean that the mammals were better prepared for such an occurrence, and would be the reason that they survived through the dinosaur extinction. At about this time, the first true signs of mammals appeared. This marked the beginning of the Tertiary period, which lasted from 66.4–2.5Ma and was the time during which the Angiosperms established dominance of the plant kingdom in many parts of the world. The most significant development over this period was the evolution of the grasses.

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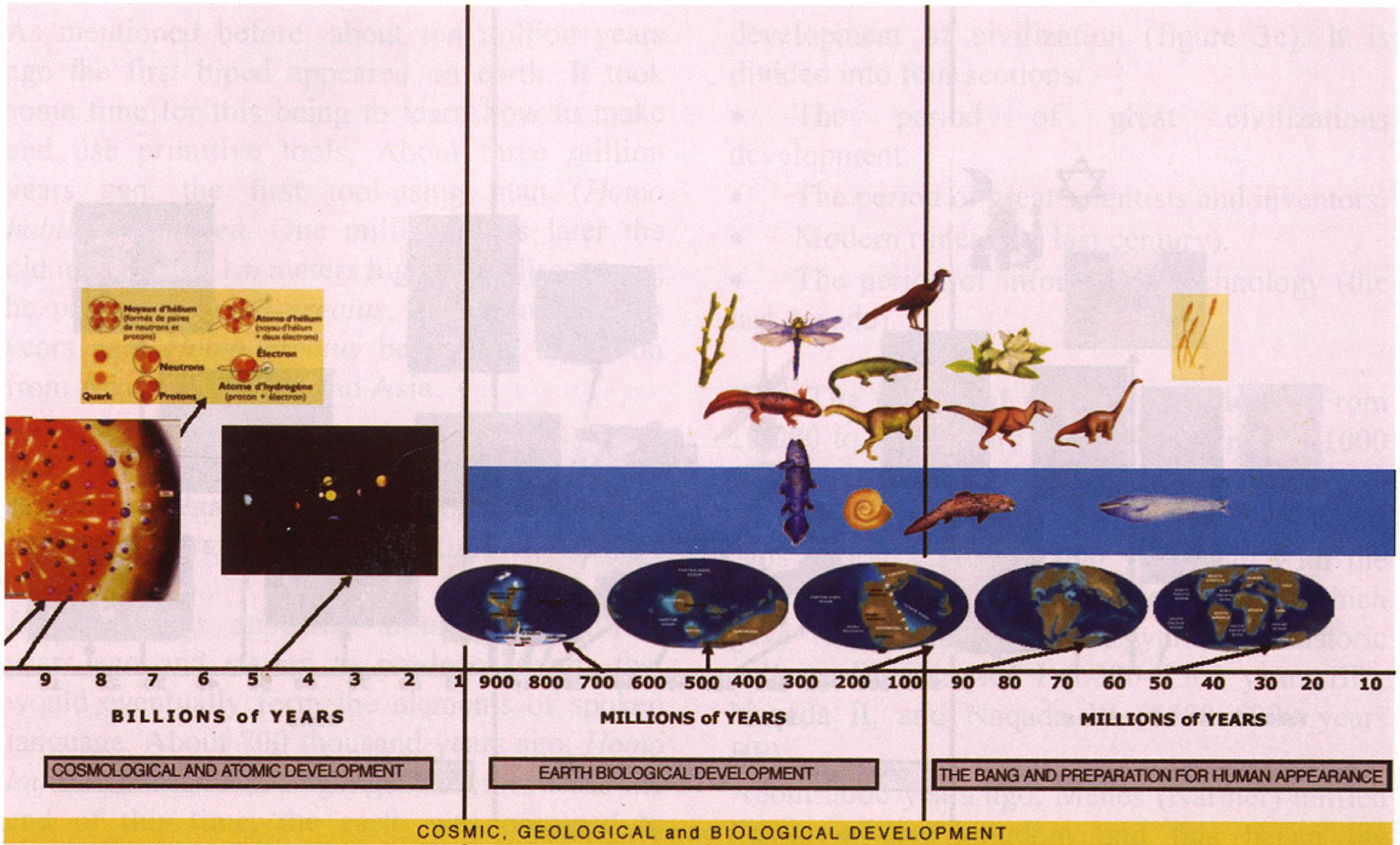

fig 3a

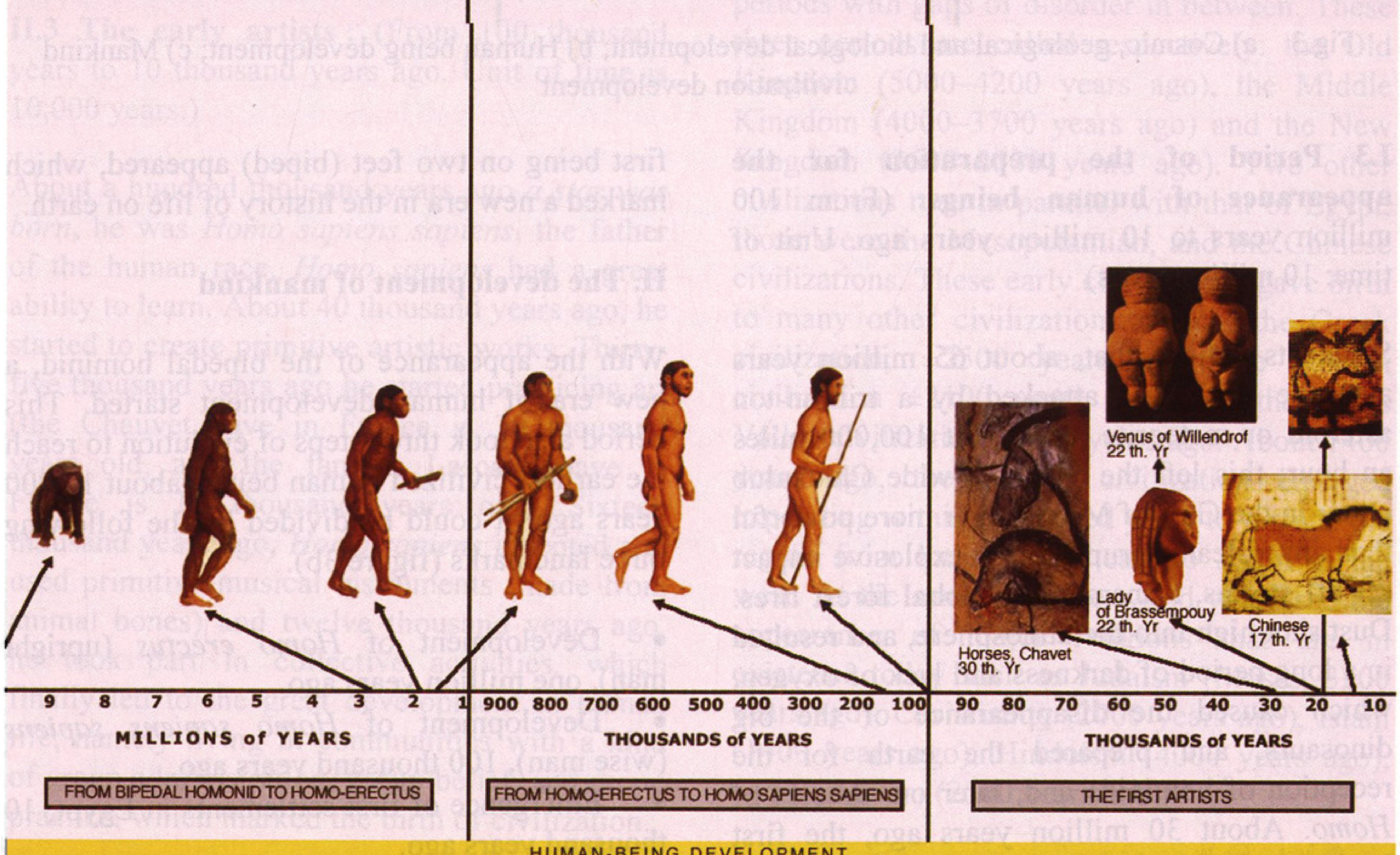

fig 3b

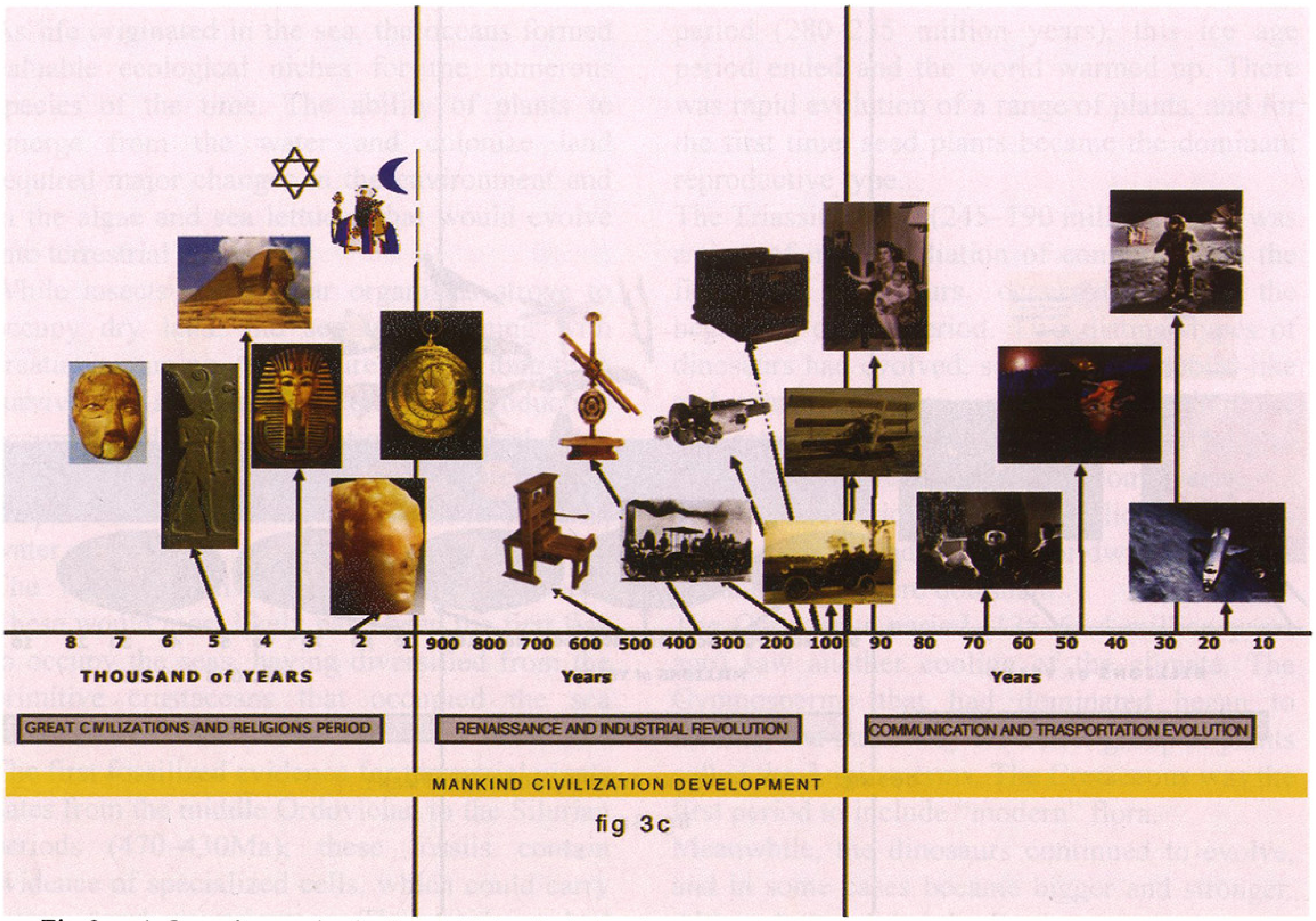

Fig.3 a) Cosmic, geological and biological development; b) Human being development; c) Mankind civilization development

I.3 Period of the preparation for the appearance of human beings: (From 100 million years to 10 million years ago. Unit of time: 10 million years)

Scientists believe that, about 65 million years ago, the earth was attacked by a trillion-ton asteroid or meteorite moving at 100,000 miles an hour; this left the 113-mile-wide Chicxulub crater in the Gulf of Mexico. Far more powerful than any volcanic eruption, the explosive impact set off storms, tsunamis and global forest fires. Dust shot high into the atmosphere, and resulted in a long period of darkness and lack of oxygen, which caused the disappearance of the big dinosaurs, and prepared the earth for the reception of hominids and, later on, species of *Homo*. About 30 million years ago, the first hominid creature was detected in Egypt; it is known as *Egyptopithecus*, and was followed (± twelve million years ago) by the first pre-human in Kenya. About ten million years ago [1], the first being on two feet (biped) appeared, which marked a new era in the history of life on earth.

II. The development of mankind

With the appearance of the bipedal hominid, a new era of human development started. This period also took three steps of evolution to reach the earliest civilized human beings about 10,000 years ago. It could be divided by the following three landmarks (figure 3b).

- Development of *Homo erectus* (upright man), one million years ago .
- Development of *Homo sapiens sapiens* (wise man), 100 thousand years ago.
- Emergence of first settlements in Egypt, 10 thousand years ago.

II.1 From bipedal hominid to Homo erectus:

(From 10 million years to 1 million years ago. Unit of time is millions of years.)

As mentioned before, about ten million years ago the first biped appeared on earth. It took some time for this being to learn how to make and use primitive tools. About three million years ago, the first tool-using man (*Homo habilis*) appeared. One million years later the old man (1.2 to 1.6 meters high) was discovered; he preceded *Homo erectus*, about one million years ago. *Homo erectus* began the migration from Africa to Europe and Asia.

II.2 From Homo erectus to Homo sapiens sapiens: (From 1 million years to 100 thousand years ago. Unit of time is 100,000 years)

Homo erectus appeared around one million years ago and started to produce sounds that would eventually form the elements of spoken language. About 700 thousand years ago, *Homo loquens* who used language was there. At the end of this time, the earth was prepared to receive the first *Homo sapiens sapiens* (our ancestor).

II.3 The early artists : (From 100 thousand years to 10 thousand years ago. Unit of time is 10,000 years.)

About a hundred thousand years ago *a star was born*, he was *Homo sapiens sapiens*, the father of the human race. *Homo sapiens* had a great ability to learn. About 40 thousand years ago, he started to create primitive artistic works. Thirty-five thousand years ago he started practicing art (the Chauvet cave in France is 30 thousand years old, and the famous Lascaux cave in France is 17 thousand years old). Sixteen thousand years ago, *Homo sapiens* invented and used primitive musical instruments (made from animal bones) and twelve thousand years ago, he took part in collective activities, which finally led to the great development in human life, namely living in communities with a kind of group administration, group belief, and group practice, which marked the birth of civilization.

III. The Development of Human Civilization

This part of history concerns human the development of civilization (figure 3c). It is divided into four sections:

- The period of great civilizations development.
- The period of great scientists and inventors.
- Modern times (the last century).
- The period of information technology (the last decade).

III.1 The period of great civilizations: (From 10,000 to 1000 years ago. Unit of time is 1000 years.)

This period started 10,000 years ago with the emergence of small communities in Egypt which gave rise to the known Egyptian prehistoric cultures like Naqada I (6000–5500 years BP), Naqada II, and Naqada III (5500–5000 years BP).

About 5000 years ago, Menes (Narmer) unified Egypt in one kingdom and this began the Pharaonic era.

Egyptian civilization went through three main periods with gaps of disorder in between. These three periods are called respectively: the Old Kingdom (5000–4200 years ago), the Middle Kingdom (4000–3700 years ago) and the New Kingdom (3500–2500 years ago). Two other civilizations rose in parallel with that of Egypt, those were the Mesopotamian, and the Chinese civilizations. These early civilizations gave birth to many other civilizations such as the Greek civilization, ±2500 years ago, the Roman civilization ±2100 years ago, and the Indus Valley civilization ±3000 years ago. About 1400 years ago, the Arabic civilization emerged expanding within a hundred years to include the region from India in the east to Spain in the west. At the same time the world witnessed the appearance of major religions that are in existence today such as Judaism (Moses, 3200 years ago), Christianity (2000 years ago), Islam (1400 years ago), Hinduism (4000 years ago), and Buddhism (2500 years ago).

III.2 The period of great scientists & inventors (The Renaissance and The Industrial Revolution) (From 1000 years to 100 years ago. Unit of time is 100 years.)

Four hundred years ago three men made major contributions to science. The theory of Copernicus for the *True System of Revolution and Celestial Bodies*; the invention of the telescope by Galileo, which proved by observation the existence of the solar system, and finally Newton's revolutionary law of gravity.
It took another hundred years to reach what we call the industrial revolution. Two hundred and fifty years ago Watt developed the power of steam, the first steam engine was built 200 years ago, and about a hundred years ago internal-combustion and diesel engines were in action. The electrical revolution started two hundred years ago when Volta devised the voltaic pile. Thirty years later, Faraday constructed the first dynamo; hydraulic power was used to generate electricity around 1880.

III.3 Modern Times: Communication/Transportation (Twentieth Century): (From 100 years to 10 year ago. Unit of time is 10 years.)

A hundred years ago a new era of communication and transportation began. Transportation was revolutionized by means of the internal-combustion engine, in 1885, the diesel engine in 1892, and the invention of aircraft by the Wright Brothers in 1903. The latter subsequently developed into passenger planes, jet engines, supersonic airplanes, and missiles. In 1959 the first satellite was launched into orbit; in 1969 the first man stepped onto the moon, and in 1981 the first space shuttle was used.
Visual communication through cinematography started in 1895; sound broadcasting with wire and then wireless in 1920 developed, over time, into image transmission by means of television in 1926, and eventually into satellite communications in the last decade. The beginning of the century also witnessed a revolution in science. Einstein's theory of relativity in 1905 was a major achievement. Computers were being manufactured in the middle of the century, and by the end of the century there was full-fledged information technology.

Conclusion

If we consider that human life is counted from the appearance of the first *Homo sapiens*, a hundred thousand years ago, and that the beginning of the universe (the Big Bang) was about 10 billion years ago, this would mean that the life of humanity required one hundredth of a thousandth of the total existence of the universe. That is almost what a second represents with respect to a full day (24 hours); it is why we used to say that human beings live at "the last second of the universe." This statement is true only when we consider the scale of time as a linear scale, but does not reflect the real importance of man and his existence. The proposed logarithmic scale of time with its subdivision into three parts, as shown in figure 2, would give the proper value to the existence of man and would emphasis his existence not at the last second of the universe, but at the higher frequency of time and that the time scale when treated logarithmically can show equal importance to the cosmological development of the universe, human beings' development, and the development of civilization. They occupy the same amount of time on the logarithmic scale.

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