Prof. Chandra Sekhar Chakraborty
Former Vice-Chancellor
University of Animal & Fishery Science
csc_chakcs@yahoo.co.in

Did bacteria play an important role in evolution? A Review

Chandrasekhar Chakrabarti

Abstract:

Bacteria are the oldest form of living organisms on the earth. Primitive bacteria were evolved only one billion years after the earth was formed. Till then, bacterial progenies are found in every sphere of the earth. There is a big question, whether bacteria were evolved on the earth or they were evolved in other planets and brought to the earth by some ways. The concept of Panspermia suggested that life in the form of minute spores (microspores) came on the earth from outside. The exact nature of the microspores, are not known. Hoyle (1981)[1] , Hoyle and Wickramasinghe (1982,[2] 1986[3]), Hoyle (1999)[4.] , Wickramasinghe (2011)[5] described them as the desiccated genetic materials .Some people said them as virus like objects. Most probably they were primitive form of bacteria like organisms having their genetic material encapsulated within tough coats. Though it is not clear whether these types of living forms were evolved outside the earth or within the earth but definitely they were evolved following chemical process of evolution. Most probably bacteria with their multifaceted qualities had performed important roles in the process of evolution of bio diversities on the earth.

Key words: panspermia, microspores, chemical evolution, bio-diversity.

1. Introduction:

Human being is always eager to know about the origin of the universe as well as their own. Starting from the ancient Vedic Sages to the Greek philosophers' various ideas had been propagated regarding the origin of the universe, earth and man. Even the modern-day scientists and philosophers have given new ideas about origin of the universe. Nasodiya sukta cited in Rig Veda Samhita, stated that the universe was evolved from 'nothingness' to the existence of only vibration and concentration of energy that had created Brahma, who in turn created everything. Similarly in many scriptures, it has been mentioned that the God was the creator of the universe and everything including man was created by the god. Greek philosopher Democritus (465-372 BC) propagated the concept of Abiosis. Aristotle (384-322BC) opined that the life was created by a chance event. He believed that aphids came from dew in plants, flies from putrid matter. His concept was supported by many western scholars till 17th century. Louis Pasteur (1822-1895),

hypothesized that all living organisms were originated from the cells of organisms on dust particles in the air, not from the air itself.

Belgian priest cum physicist Gorges Lemaitre (1894-1966) proposed the Big Bang concept to explain the origin of the universe. According to Big bang concept, around 13.7 billion years ago, everything in the universe was condensed in an infinitesimally small singularity, a point of infinite denseness and heat. Suddenly an explosion began, ballooning the universe outwards faster than speed of light. At this stage the universe was covered by dark clouds. About 380000 years after big bang, light first shines. The Panspermia concept propagated that the life in the form of microspores were originated outside the earth and had entered into the atmosphere of the earth (Hoyle 1985,[6] Wesson 2010[7]), then diversified into various forms. Another concept was Abiogenesis. This concept suggested that life was originated on the earth, especially in the hot ocean and was evolved into various forms through several steps of biochemical changes. The concept of abiogenesis stated that life arises from non-living matters such as inorganic compounds through natural process. Abiogenesis concept was separately proposed by J B S Haldane (1929)[8] and AI Oparin (1938)[9]. Both of them theorized that organic molecules could arise in a reducing atmosphere, in presence of external energy sources. Their concepts were experimentally tested by Miller (1953)[10]. Dickerson (1978)[11] extended this concept as the theory of chemical biosynthesis. This article will try to explain that the microspores were nothing but primitive form of encapsulated bacterial genome that played a very important role in the process of evolution of life on earth.

2. Review of various concepts on the Origin of Life:

The Nasodiya Sukta was described in the 129th episode of the 10th section of Rig Veda Samhita, later explained in detail in Upanishads. The meaning of Nasodiya is 'no asit' or 'nothing existed'. At the beginning there was absolute darkness. The first layer of darkness was covered by thicker layer of darkness and the whole was inundated. The 'Atma' was morbid at this stage. Later on, Atma gave rise to Paramatma and Bhrama. The Bhrama was the source of all creation.

The concept of absolute darkness and existence of vibration and concentration of energy mentioned in the Nasodiya Sukta had some similarities with the core concept of Lemaitre Big bang theory; where it has been stated that at a very early stage the universe was condensed in an infinitesimally small singularity, a point of infinite denseness and heat.

The second part of Nasodiya Sukta is comparable to some extent with the concept of special creation, which suggested that everything was created by the 'creator' or 'god' including human being.

Till 19th century there has been a considerable support for the concept of spontaneous generation, which stated that lower animals such as insects arose from decaying

matters(Sheldon, Robert B,2005)[12].However Louise Pasteur's swan-neck flask experiment(1859) disproved the the spontaneous generation concept. Louise Pasteur believed that life comes from life .He said, "Omni Vivum ex Vivo." His concept is popularly known as law of Biogenesis[13].Charles Darwin published the "Origin of Species" in 1859 where he had explained mechanism of biological evolution (Darwin. C 1859)14. However, for want of concreate evidences both the Nasodiya Sukta and the concept of special creation were discarded by the theory of organic evolution.

S Arrhenius (1903)[15] proposed Panspermia concept. The concept suggested that life was originated in space, distributed throughout the universe in the form of 'microspores. Some of them carried to the earth by electrostatic ejection. In an appropriate time under favourable condition microspores propagated life on the earth. FHC Crick and N Orgel (1973)[16] opined that microspores were deliberately brought to the earth by higher intelligent being. They called it as 'directed Panspermia'. Before them directed panspermia concept was proposed by Shklovskii and Sagan (1966).[17] F. Hoyle and C. Wickramasinghe (1978[18], 1982[2],1986[3]), supported panspermia concept with modification. To them the microspores like extraterrestrial life forms entered the earth's atmosphere and induced macro evolution. Hoyle (1979[19],1999[4], 2000[20], Hoyle et al., (1986)[21] suggested that the extra-terrestrial life forms were responsible for epidemic outbreaks. They also believed that dominant viruses and desiccated DNA and RNA can survive unprotected in space (Secker et al., (1996),[22] Napier (2004)[23], Wallis and Wrickramsinghe (2004),[24] Wesson (2010),[7]Wickramsinghe (2011).[5]

The concept of biogenesis subsequently was replaced by the concept of 'Abiogenesis'. The concept of abiogenesis introduced by J B S Haldane (1929)[8].He proposed that life had originated in the primitive ocean, which was actually acted as vast chemical laboratory, containing mixtures of organic compounds like hot dilute soup. A I Oparin (1938)[9] was also a propagator of the abiogenesis concept, demonstrated that early life was originated from the 'coacervate' like substance- a special aggregates of lipid molecules, held together by electrostatic forces. Miller (1953)[10] did a massive experiment simulating the primitive condition of the earth in the laboratory. From their experiment they got a number of organic molecules including amino acids from a mixture of some inorganic components (Miller and Urey 1959[25], Miller and Cleaves,[26)] . Much ahead, Walter Lob (1913)[27] synthesized amino acids by exposing formaldehyde to silent electric discharges. In the 1920s Leoland Troland hypothesized that a primordial enzyme could have formed by chance in the primitive ocean. Later on Haldane (1932)[28] and Oparin (1938)[9] opined that organic compounds were formed in the primitive earth, from non-living matters only once. Dickerson (1978)[11] stated that there was no or very little oxygen in the primitive atmosphere. In this reducing condition energy needed for chemical synthesis came

from the solar light (UV). Dickerson also suggested that life was formed through some steps of chemical reactions. He called it as chemical evolution. To him atmospheric gases of the primitive planet supplied raw materials for life. At the first step biological monomers such as amino acids, sugars, organic bases were formed. Then polymerization of the monomers took place, resulting in the formation of primitive proteins and nucleic acids in aqueous medium. This was followed by the formation of replicative machinery, the RNA and DNA. Polymerization was followed by the formation of coacervate droplets and protobionts with distinct features.

H J Muller (1935)[29] suggested that the formation of a gene with catalytic and auto replicative properties could have set evolution on motion. T. Dobzhansky (1970)[30] was one of the supporters of organic evolution. He emphasized that hereditary mutations were the cause of evolution. The life was developed through evolutionary processes.

3. Discussion:

Both Nasodiya Sukta and the concept of Special creation were discarded by the evolutionary biologists due to lack of evidences in favour of them. Some orthodox biochemists supported Louis Pasteur's concept of biogenesis. Pasteur propagated his views as "omni vivum ex vivo". This means that life was originated on the earth from existing living form. Contrary to this J B S Haldane (1929,[8] 1932[28], 1933,[31]1951[32]) and A I Oparin (1938,[9]) independently proposed that first life took its origin from the chemical evolution of inorganic components. This abiogenesis concept was strongly supported by the noble experiments of Miller (1953)[10], Miller and Urey (1959),[25] Miller and Cleaves (2006)[26]. Dickerson[11] explained the abiogenesis hypothesis by suggesting that the origin of life occurred through some steps of chemical synthesis. During the course of chemical changes some replicative materials were formed. At present by the term replicative material, we understand only the DNA because only the DNA possess the power of replication. But replication of DNA requires the functioning of specific enzymes. These enzymes are special types of proteins. So, it is obvious that DNA replication was not possible without proteins. Similarly for the replication of DNA, activities of RNA as primers were also needed. Therefore, it can be presumed that primitive replicative forms were not the DNA. Possibly both RNA and Proteins were formed independently through chemical evolution. These RNA and the Proteins had the power of replication. At present, ribozymes are the examples of RNA having replicating properties. Similarly, Prions are the examples of replicative proteins. In course of time RNP world was formed, then the DNA world was created. Once evolved, the DNA took the authority to act as the genetic material. The DNA could synthesize DNA with the help of protein enzymes and RNA by the process called replication. DNA then produce RNA by a process called transcription. Proteins are synthesized by the RNAs under the directives of DNA by the process called translation. FHC Crick explained these phenomena by the Central Dogma model.

T. Dobzhansky, a supporter of organic evolution, considered that the changes occurred through mutations of the genes from generation to generation were adapted in the changing environment. Complex forms of organisms were evolved from the simpler forms. However, in all cases populations with greater initial stores of genetic variations evolved at faster rates (Ayala 1968a,[33]1968b[34], 1969b[35]), Dobzhansky (1972,[36] Ayala and Dobzhansky (1974)[37]

Possibly the first living form that was evolved from the genetic materials were the primitive form of bacterium not the viruses, because all viruses are parasitic in nature. But free-living bacteria are a plenty. Bacteria like organisms might had evolved in many planets and remained there might be in the fossilized forms. The so-called microspore concept envisaged by Arrhenius (1903[14]) and modified by Crick and Orgel (1973[16]), Nibset (1991[38]) as directed panspermia and supported by Hoyle and Wickramasinghe (19863), in a different form, was nothing but the primitive type of bacterial genome. The microspores once came in the Earth's environment from outside or evolved separately in the environment of the earth through chemical evolution, were the progenitors of all the living organisms (plants and animals) of the Earth.

Reasons for considering microspores as bacteria are many folds. The bacteria are the unicellular organisms evolved on the earth 3.5 billion years ago and still they are present in various forms in different habitats. From Arctica to Antarctica, from desert to deep sea, in saline water of Dead Sea to high pressure zone of the Mariana trench, everywhere bacteria are found to live. Cyanobacteria are the organisms that created the world oxygenated approximately 2 billion years ago, helped evolution of animals in time and space. Photosynthetic bacteria were important for shaping the environment which also induced evolution of animals. The early cells of microorganisms gave rise to biochemical systems and oxygen rich atmosphere on which modern life depends (J W Schopf, 1992,[39] 1999,[40] 2002[41]).

Bacteria are autotrophic, heterotrophic, parasitic, commensals, symbiont, saprophytic as well as halophytic in nature. Bacteria live in the body of all organisms. In the body of a healthy man the number of own cells is 30 trillion whereas, the number of residential bacteria is more than 38 trillion. The number of bacterial genes is estimated to be 2 million,100 times the number of of approximately 20000 human genes. Possibly the bacterial plasmids, the plastids and the mitochondria of eukaryotic cells were the primitive free-living forms of bacteria. The bacteria living in human brain are very important for human health (Link,2021[42]). The brain gut axis, a bidirectional communication pathway between the gut and the brain influence the brain function and behaviour (Martin et al,2018[43]). Alternations in the brain microbiome could have implications for neurological disorders (Gilland 2014,[44] Westfall et al., 2020,[45] Goralczyk-Binkowska et al., 2022,[46] Nandwana et. al., 2020[47]).

Analyzing the diversity of bacteria, it can be suggested that bacteria like organisms might had evolved in various planets following evolutionary principles. Those who could not flourish further in other planets remained there as fossilized microspores form. Once the microspores came in the environment of the earth induced the process of evolution to a greater extent. Hoyle and Wickramsinghe suggested that dominant viruses and desiccated bacterial DNA and RNA could survive unprotected in space by the asteroids and comets as seeds of life (Hoyle and Wickramsinghe (1982[2]), Wesson P. et al., 2010[7]).

4. Concluding remarks:

The origin of the universe through Big Bang explosion and expansion has been accepted by most of the scholars but the mechanisms of the origin of life on the earth is still a controversial story. There are two schools; one believes that life was originated on the earth through chemical evolution from inorganic to organic forms. The other group believe that life was formed outside the earth and was sent to earth as microspores. These microspores acted as the seed of the life on earth.

As the exact features of the microspores are not known, it may be presumed that the microspores were very primitive form of bacteria like organisms having genetic material covered by tough wall. Origin of life began in the ocean of the earth following chemical synthesis methods. During the course of evolution RNA world, Protein world, and the RNP world were formed. At this juncture the microspores bearing DNA entered into the ocean atmosphere. These DNA ultimately took the responsibility of the genetic material. DNA started replication using the RNA and the Proteins available in the ocean environment. The DNA then started synthesizing RNA by transcription and the Proteins were synthesized by the process of translation. In course of time unicellular microorganisms including bacteria and acellular viruses were evolved on the earth.

Presence of huge number of residential bacteria in the body of man cannot be mere a case of co incidence rather definitely as a result of co evolution. Answer to this problem may be obtained by the application of artificial intelligence (A I) in this field of study.

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