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ORIGIN OF LIFE

Emergence of Photoautotrophic Minimal Protocell-Like Supramolecular Assemblies, *"Jeewanu"* Synthesied Photo Chemically in an Irradiated Sterilised Aqueous Mixture of Some Inorganic and Organic Substances

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Abstract Sunlight exposed sterilised aqueous mixture of ammonium molybdate, diammonium hydrogen phosphate, biological minerals and formaldehyde showed photochemical formation of self-sustaining biomimetic protocell-like supramolecular assemblies "Jeewanu" (Bahadur and Ranganayaki J Brit Interplanet Soc 23:813–829 1970). The structural and functional characteristics of Jeewanu suggests that in possible prebiotic atmosphere photosy nergistic collaboration of non-linear processes at mesoscopic level established autocatalytic pathways on mineral surfaces by selforganisation and self recognition and led to emergence of similar earliest energy transducing supramolecular assemblies which might have given rise to common universal ancestor on the earth or elsewhere.

Keywords Jeewanu · Self-organisation · Supramolecular assemblies · Biomimetic · Self-sustaining · Chemoton

The pioneering work of Molecular and Chemical Evolution (Oparin 1924; Haldane 1929) provided the scientific basis for the study of origin of life. The term chemical evolution has been used by Bahadur in a restricted sense and defined it as ultimate formation of molecules by chemical transformation of substances with the condition that the earliest living systems were made up of the same material of which are found in the present day cells (Bahadur 1964). Haldane discussed a genetic view of life that first living or half living things were probably large molecules synthesized under the influence of sun's radiation (Haldane 1929). Matter has inherent properties of duplication under suitable conditions (Bahadur 1964, 1967; Bahadur and Ranganayaki 1966.

One of the main problems of origin of life is study the physico-chemical conditions which led to organization of molecules in specific-stearic positions and emergence of protocell-like microstructures which might have given rise to living systems (Bahadur et al. 1980).

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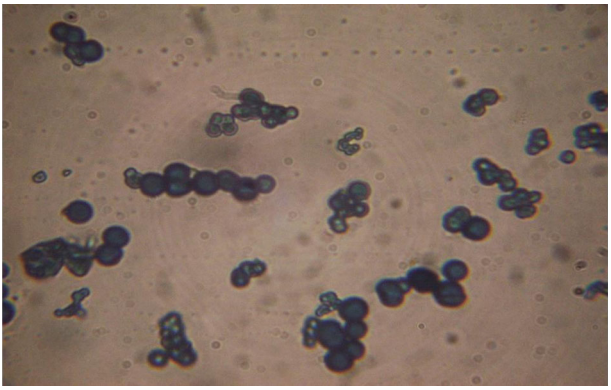

Fig. 1 Optical micrograph of Jeewanu showing their morphological characteristics and stages of their formation (1500×)

Criteria's for a Minimal Living System

"Chemoton" concept postulated that a minimal living system is a chemical super system comprising of three systems: a metabolic network, template replication and a boundary system. It is instructive to look at the abstract minimal version of Chemoton (Ganti 2004). The criteria's for a protocell have been discussed (Pohorille and Deamer 2002).

One way to produce a protocell is to produce an appropriate mix of non-living molecules and then let them react and self-assemble into a living protocell. This process begins with molecular constituents and so may considered a bottom-up approach to protocell (Rasmussen et al. 2008).

Various types of Proto-Cell models (Oparin 1959; Fox 1960; Eschenmoser 1999; Szostak et al. 2001; Orgel 2004; Hanky and Szostak 2004; Joyce and Orgel 2006) have been synthesized to theorise the transformation of lifeless materials into living systems.

Photochemical Synthesis of Autoreplicative Supramolecular Protocell-Like Assemblies, Jeewanu

The photochemical formation of self-sustaining proto-cell-like supramolecular assemblies, "Jeewanu" in an irradiated sterilized aqueous mixture of some inorganic and organic substances

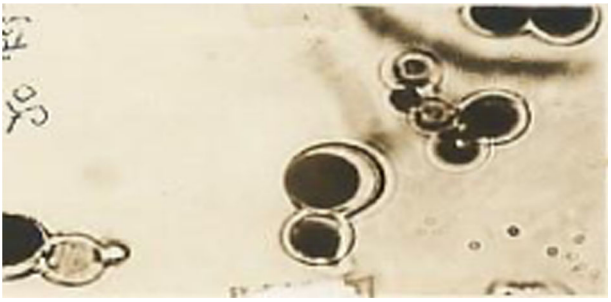

Fig. 2 Jeewanu stained with Sudan Black B showing a definite boundary wall and intricate internal structure (1500×)

Fig. 3 Scanning Electron Micrograph of Jeewanu (SCM) showing multiplication by budding and growth from within

have been reported (Bahadur and Ranganyaki 1970). These microstructures have a definite boundary wall and intricate internal structure. They multiply by budding, grow from within by actual synthesis of material and are also capable of showing various metabolic activities (Bahadur 1975a, b) (Figures 1, 2, 3, & 4). Jeewanu have been analysed to contain a number of biochemicals-like materials in them viz. amino acids which are present in free as well as in peptide combination (Bahadur and Ranganyaki 1970; Briggs 1965; Bahadur et al. 1965, 1958; Bahadur 1954), nucleic acid bases as ribose as well as deoxyribose (Ranganayaki et al. 1972) and phospholipid-like material in them (Bahadur and Ranganyaki 1970). The EPR spectra of Jeewanu showed the presence of ferredoxin-like material in the mixture (Rao et al. 1978). The presence of various enzyme-like activities viz. phosphatase, peroxidase, esterase, urease-like activities have been detected in the mixture (Briggs 1965; Bahadur and Ranganyaki 1970; Bahadur and Gupta 1984). The photochemical reduction of acetylene by Jeewanu, indicated the presence of nitrogenase-like in the mixture (Smith et al. 1981). The presence of ATP-ase like acitivity in Jeewanu mixture using radio labeled ATP and AMP have been investigated (Gupta 2014). The cytochemical and histochemical studies of abiogenically synthesied microstructures, "Jeewanu" showed that they can be fixed with biological fixatives and can be stained with acidic and basic dyes (Gupta and Chaturvedi 2013; Gupta and Rai 2013; Gupta 2002).

The Optical and electron microscopic studies (SCM & TEM) investigations have confirmed that Jeewanu are spherical in shape, have a definite boundary wall and intricate internal

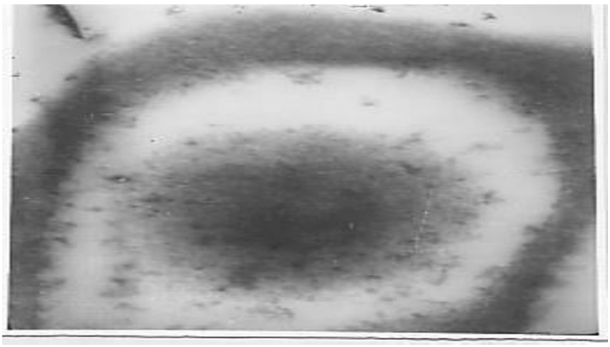

Fig. 4 Transmission Electron Micrograph (TEM) of Jeewanu showing a limiting boundary and a intricate internal structure

structure. The atomic force microscopic (AFM) studies have revealed organised configuration of Jeewanu at nanoscale. The ultrafast laser induced flash photolysis studies in Jeewanu mixture showed the formation of photoproducts on giving flashes of 10^{-9}–10^{-20} nano seconds.

Jeewanu have been found to catalyse photocatalytic decomposition of water using sunlight as a source of energy. It was found that hydrogen thus evolved was utilised in photochemical fixation of nitrogen and carbon dioxide (Smith et al. 1981; Bahadur et al. 1980).

The Cytochemical and ultrafast laser induced flash photolysis investigations have confirmed the photochemical formation of autoreplicative supramolecular assemblies "Jeewanu" in an irradiated sterisliesd aqueous mixture of some inorganic and organic substances. They have a definite boundary wall for charge separation and an intricate internal structure. The ferredoxin-like material mediates the electron transfer processes in the mixture. The X- Ray crystallographic studies of Jeewanu showed its amourphous nature and suggested that it possesses an organized structural configuration desired for being a minimal living system.

In prebiotic atmosphere possibly photosynergistic collaboration of non-linear processes at mesoscopic level established autocatalytic pathways on mineral surfaces by self-organisation and led to emergence of primordial supramolecular photoautotrophic assemblies similar to Jeewanu which might have given rise to earliest energy transducing common universal ancestor on the earth or elsewhere.

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