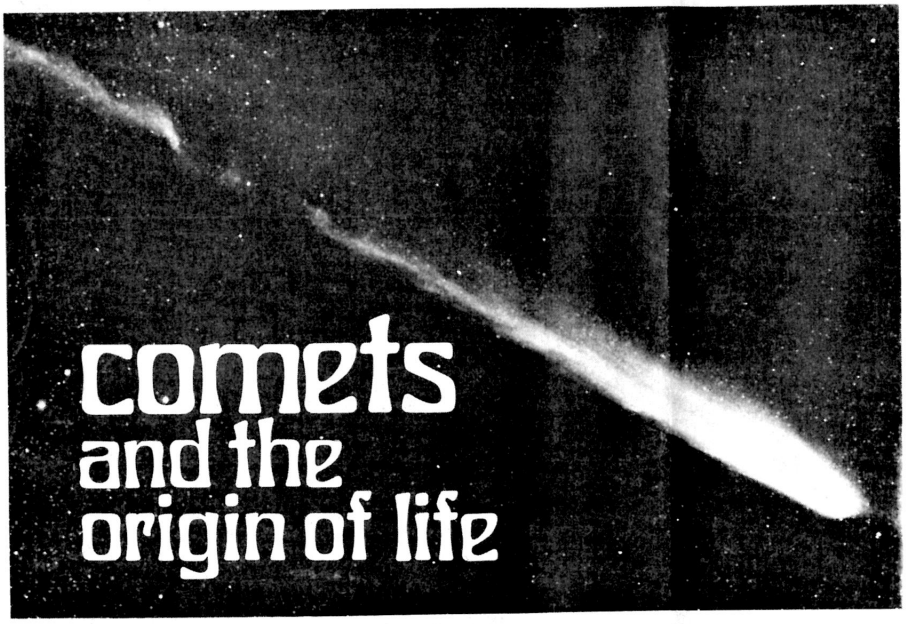

comets and the origin of life

Did life begin on Earth as conventionally believed? Or, could it be that the building blocks — the organic molecules — came from the nuclei of comets? After all, superstitious beliefs do link comets with afflictions on the Earth. . .

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SUPERSTITIOUS beliefs in many cultures, ancient and modern, associate comets with evils in the form of pestilence and death. A scientific theory linking terrestrial epidemics to comets was recently put forward by two internationally known astrophysicists Sir Fred Hoyle and Professor Nalin Chandra Wickramasinghe in a couple of special preprints from University College, Cardiff, UK, and through an article in the *New Scientist* (17 November 1977, p. 402).

The theory of Hoyle and Wickramasinghe (H & W) in fact goes further than that. It challenges the long-held concept that life on Earth originated on the Earth. According to Hoyle and Wickramasinghe, this was not the case; life started here because its basic building blocks were deposited on the Earth through cometary debris.

The conventional theory of origin of life due to A.I. Oparin and J. B. S. Haldane is based on the idea that the simple inorganic molecules of water, ammonia, methane, etc were converted into prebiotic molecules (that is, molecules forming the basic building blocks of life) in a 'primeval soup'. This process requires energising events like thunderstorms to occur frequently on the primitive Earth. Also, it is assumed that the prebiotic molecules are stable, which requires the primitive atmosphere to be of reducing rather than oxidising type, with a predominance of molecular hydrogen.

Hoyle and Wickramasinghe challenge this concept. Hoyle has argued that the original atmosphere is more likely to be oxidising rather than reducing and this inhibits the development of the primeval soup. There seems to be no astronomical or geological basis for early excess hydrogen. Hoyle and Wickramasinghe also question the validity of interpreting the results of the various laboratory experiments in prebiotic chemistry in support of the Oparin-Haldane idea since the conditions of the primitive Earth may have been different from the controlled conditions of these experiments. What then is the alternative?

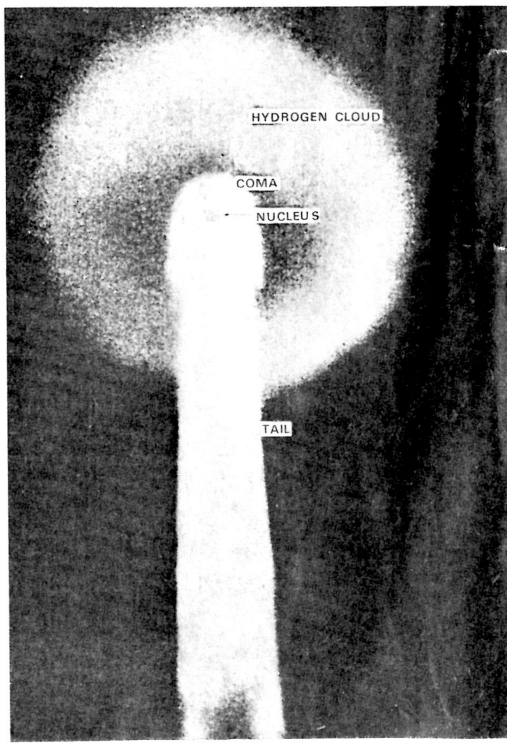
According to these authors the alternative lies in the cometary nuclei. Cometary nuclei are a few kilometres in radius and are known to contain organic molecules as complex as CH_3CN (methyl cyanide) and HCN (hydrogen cyanide). Smaller molecules and radicals like CO^+, CO^+_2, N^+_2,C_2, C_3,OH, CH, CH_2, NH, NH_2, CN and H_2O^+ are present in cometary comas and tails. These could be degradation products of complex bipolymers and of H_2O. There are indirect indications of the presence of polyformaldehyde or polysaccharides in dust tails of comets.

How do comets happen to have such complex prebiotic molecules? It has been known for some years now that the interstellar medium contains many complex organic molecules and radicals. H & W suggest that during the process of formation of the Solar System from an interstellar molecular cloud, such material may have been picked up by cometary nuclei. Since comets make periodic trips to the vicinity of the Sun (their orbits are highly eccentric, unlike those of planets), during each such visit the volatile material in the nucleus tends to boil off. The temperature falls of and the material freezes as the comet moves away from the Sun. The cycle of 'hot and cold' phases preserves only those structures which can best withstand such extreme conditions (300°K to 100°K).

The prebiotic material is processed by sunlight during the passage of the comet near the Sun. The processed material is then frozen as the comet goes away from the Sun, to be reprocessed further during the next approach to the Sun. In this cyclic process — lasting for millions of years — may have evolved the photosynthetic bacteria and the thermophyllic bacteria, for example. The type of living organisms generated in a comet would have to be determined by the type of responses needed for survival in the changing conditions.

Finally, life could have been transplanted to the Earth by a soft landing

(Top, left) Comet Kohoutek photographed by Charles Kowal at Palomar Observatory, USA. The tail, blown by solar wind, was about 21 million kilometres long. (Below) The various parts of a comet. The "tail" is made up of large amount of dust. The "nucleus" within the head region, the "coma", is believed to be a dirty ice ball consisting of frozen gases and dust particles



of an icy comet carrying primitive organisms about four billion (4×10^9) years ago. And there is no reason to expect that this process is not occurring now! While the resistance of native life to new type of life forms must eventually destroy these invaders, Hoyle and Wickramasinghe suggest that this process may sometime result in the appearance of new epidemics of a global nature like the influenza of 1918-1919 or the plague of Athens in 429 BC. They suggest a microbiological vigil of the stratosphere to ward off such future invasions.

This idea is controversial and will no doubt evoke criticism from microbiologists, epidemiologists as well as from astrophysicists. Just as comet Kohoutek, though a visual flop, was nevertheless rich in scientific data including the existence of complex molecules, future comets will be studied more closely with a view to testing this hypothesis. It is also necessary to check whether some of the epidemics of untraced terrestrial origin can be linked to the passage of a particular comet in the past.

In response to my enquiries at the Virus Research Institute, Pune, its Deputy Director, Dr. Kalyan Banerjee informed me that the concept of celestial origin of life had been suggested earlier by Richter in 1865 and later propounded by Helmholtz in 1884 and by Arrhenius in 1903 and 1908. Arrhenius even suggested that bacterial spores could travel through the interstellar space under propulsion by pressure of light and attracted by gravitation. This might be possible for viruses like influenza also, although they may not be able to withstand as trying conditions as the spores can. Dr. Banerjee also pointed out that there have been epidemics whose origins are difficult to trace, for example, the Kyasanur Forest Disease (KFD) in 1957 in Karnataka. A similar virus (Langat virus) is found in Malaysia although it does not seem to be epidemiologically linked with the KFD virus.

Many medical experts will be reluctant to accept the extraterrestrial origin of diseases on the present evidence. The proponents of the theory will have to collect statistical evidence in support of any correlation between comets and epidemics. Simultaneously, attempts should be made to look for quantitative as well as qualitative data on the presence of complex organic molecules in passing comets. A theory of formation of complex organic molecules in the interstellar space is still to come, and the authors' qualitative considerations of how such molecules get into comets and evolve further need to be backed by quantitative estimates to convince the many sceptics. All the same, their idea linking comets to the origin of life and of epidemics is probably the first scientific attempt of its kind and deserves careful consideration.

Professor Jayant Vishnu Narlikar (39) has had a distinguished academic and research career, much of it at Cambridge University, UK, where he was awarded both his PhD and DSc. He was a staff member of the Institute of Theoretical Astronomy at Cambridge University till 1972 before joining the Tata Institute of Fundamental Research at Bombay where he is now Professor of Astrophysics. Fellow of the Royal Astronomical Society and the Cambridge Philosophical Society since 1963, he was elected Fellow of the Indian Academy of Sciences in 1974 and of the Indian National Science Academy in 1976. He was also Jawaharlal Nehru Fellow from 1973 to 1975. His publications include both research papers and popular articles on topics in theoretical physics, gravitation, cosmology, astrophysics, etc.