COMMENTARY

Dr. S. Shivaji – A Zoologist turned Microbiologist

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Our country has seen many renowned biologists who have contributed to specific and specialized area of research interest such as microbiology, biochemistry, molecular biology. It is very rare that we come across a professional scientist who has pursued two very distinct and different areas of research and has accomplished and achieved recognition in both. One such scientist, in my opinion, is Dr. S. Shivaji who started his career as a Zoologist with a Ph. D. in Cell Biology from the University of Delhi in 1978, and moved on to become a Microbiologist at the Centre for Cellular and Molecular Biology (CCMB), Hyderabad in 1980. His research interest is in the area of mammalian gamete biology and microbiology of extremophiles. He is very well known for his research and other accomplishments. I would like to highlight Dr. Shivaji's contributions to microbiology research in our country.

In the mid-eighties, Dr. Shivaji pioneered research on Microbial Biodiversity of Antarctica, at CCMB, Hyderabad. His studies were focused towards establishing the microbial biodiversity in Antarctica to understand the molecular basis of survival and growth of life forms at low temperatures. He emphasized that the study of the cold loving microorganisms from Antarctica in respect to their diversity, distribution, seasonal variation and identity would lead to identification of new species of bacteria with unique biotechnological potential and also unveils the molecular basis of their ability to survive and multiply under low temperatures. Rightly so, his efforts have led to the identification of 25 new species of bacteria from the icy continent, which is something every microbiologist of our country could be proud of, because as of now only 125 new species of bacteria have been described from Antarctica by scientists from all over the world.

Dr. Shivaji used these cold loving bacteria as model systems to unravel the molecular mechanisms influencing low temperature survival with respect to temperature sensing, temperature perception and the downstream events involving up or down regulation of the essential genes. His research established the following:

- a) ability to transcribe genes at 0°C is essential for survival at low temperature,
- b) differential phosphorylation of membrane proteins and lipopolysaccharide are involved in low temperature sensing and
- c) in pigmented bacteria, membrane fluidity is modulated by the differential synthesis of polar and non-polar carotenoids, thus highlighting a new function for carotenoid pigments for low temperature survival.

His recent discovery of a new desaturase gene, *desC2*, in a psychophilic cyanobacterium and the demonstration that all the *des* genes are constitutively expressed in psychophilic organisms compared to mesophiles, establishes a very important role for these genes in cold adaptation. His work on the psychophilic bacteria from Antarctica has attracted worldwide recognition as evidenced by collaborations both within the country and other countries such as Japan, Germany and France. Our own country has recognized his research work by conferring "The Antarctic Award for excellence in the field of Biological Sciences", awarded by the Department of Ocean Development, Government of India, in 2002.

Dr. Shivaji is also among the first to study the bacterial diversity of Himalayan glaciers located at heights greater than 15,000 ft and which are ice covered all through the year. His efforts have led to the identification of four new psychophilic species of bacteria and established that bacteria are not restricted to any particular geographical region with respect to their distribution. His interest in microbes has taken him to very diverse habitats like the arsenic

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polluted waters of the Bengal basin to identify bacteria with capabilities to degrade arsenate and arsenic and to the depths of the Indian Ocean to identify novel bacterial species.

As a biologist Dr. Shivaji has a very inquisitive mind and is involved in raising questions and seeking answers for much of what we don't know about, e.g., where did life originate on land or in sea or in sky? He recently provided the first ever evidence of bacteria in the stratosphere using air samples collected at a height of 41 km from sea level. All the four bacterial isolates were new species of *Bacillus*, viz., *Bacillus aerius*, *Bacillus aerophilus*, *Bacillus stratosphericus* and *Bacillus altitudinus* with high resistance to UV radiations and possessed membrane lipids which were unique and did not match with lipids of the nearest phy-

logenetic neighbour. In his own words "It is tempting to speculate that the four new species are the gift of space to us but more earthly explanations such as their terrestrial origin cannot be ruled out".

Dr. Shivaji has contributed immensely to microbiology and has enhanced our appreciation of the hitherto unknown bacterial diversity of extreme habitats. His studies also demonstrate how difficult questions in biology could be resolved using simple and logical approach. He has published more than 150 scientific papers and is a member of the editorial board of "Cellular and Molecular Biology" and "Indian Journal of Microbiology" and a fellow of the National Academy of Sciences, India and the Andhra Pradesh Academy of Sciences.