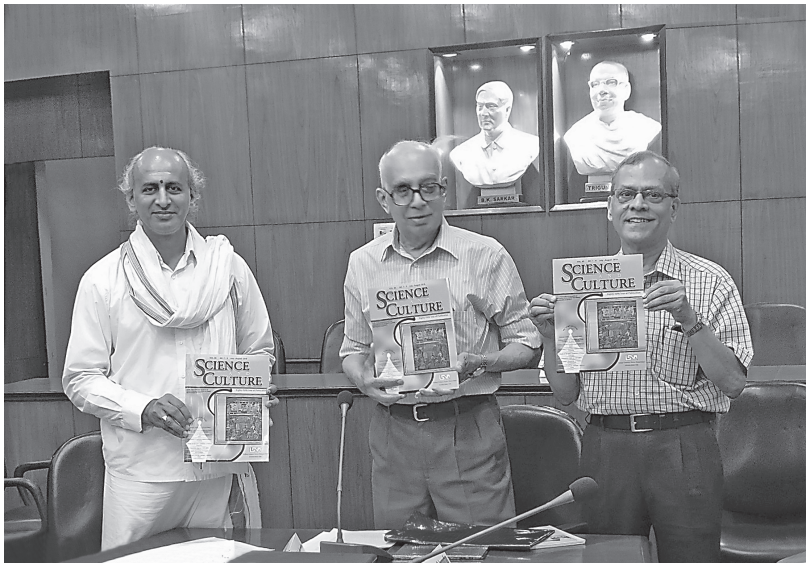
Notes and News

Release of Science and Culture

A one-day seminar on Studies in History and Philosophy of Science under the aegis of History of Science (HOS) division of the Indian National Science Academy (INSA) and the meeting of the Research Council and National Commission of History of Science were held at Jadavpur University, Kolkata during July 18-19. The report of the seminar has been presented separately on this page.



Professor D. Balasubramanian, Chairman Research Council for History of Science, INSA releasing the latest issue of *Science and Culture* accompanied by Professors K. Ramasubramanian, Editor, *IJHS* (left) and S. C. Roy, Editor-in-Chief, Science and Culture (right).

History of Science studies in India originated in Kolkata with the formation of History Science Board at The Asiatic Society in the year 1960 under the Chairmanship of Prof. A.C. Ukil with an aim to reconstruct Indian scientific heritage. The Board of History of Science was later enlarged and renamed as 'National Commission for the Compilation of History of Science in India'. In 1989 the name was changed to 'National Commission of History of Science in India'. *Indian Journal of History of Science*, the only journal of its kind in India, was started in 1966 by INSA of which Prof. D.M. Bose was the first Editor.

It is a matter of great pleasure that INSA decided to hold the mid-year seminar and the meeting of the Research Council and National Commission of History of Science (RCNC), INSA in Kolkata after many years. In order to mark this special relationship with HOS, INSA, with Indian Science News Association (ISNA), ISNA decided to showcase its journal *Science and Culture* during the meeting of the RCNC by releasing the recent issue (July-August 2019) on July 19, 2019 at Aurobindo Bhavan at Jadavpur University. Incidentally, these two venerable societies INSA and ISNA are of the same age, both born in the year 1935.

Professor D. Balasubramaniam, Chairman Research Council for History of Science, INSA and Director of Research at the Prof. Brien Holden Eye Research Centre of L. V. Prasad Eye Institute, Hyderabad released the journal before the start of the RCNC meeting. It is to be noted in this connection that Prof. Balasubramaniam was on the Editorial Board of *Science and Culture* for many years and is currently an editorial collaborator of the journal. ❐

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Seminar on Studies in History and Philosophy of Science

A day-long Seminar on *Studies in History and Philosophy of Science in India* organized by Indian National Science Academy (INSA) in collaboration with Jadavpur University was held on 18th July 2019 at Department of Philosophy, Jadavpur University, Kolkata. It was coordinated by Professor Samir Saha, Member, Research Council for History of Science, INSA.

Professor Suranjan Das, Vice Chancellor, Jadavpur University in his inaugural address highlighted the importance of interdisciplinary approach in studies of history and philosophy of science. In his opinion science begins where speculation ends and science is nothing but

refinement of everyday thinking. Having drawn the definition between history and philosophy of science, he stressed the need for development of science communication policies for generating scientific temper.

Professor D Balasubramanian, Chairman Research Council highlighted the activities of National Commission since the formation of History of Science Board in 1960. Later in the year 1965 the board was rechristened as National Commission for History of Science with annual grants from government. Professor Balasubramanian also highlighted the activities of the Commission such as supporting research projects, publication of authoritative volumes like the Concise History of Science in India, History of Technology (three volumes), History of Astronomy, History of Medicine and many others. He also stressed the role of *Indian Journal of History of Science* in promoting quality researches in areas related to history of science.

Professor NR Jagannathan, Vice President, INSA welcomed the members, speakers and students attending the seminar and conveyed warm greetings from Professor A K Sood, President, INSA. Professor Pradip Kumar Ghosh, Pro-VC, Jadavpur University welcomed the guests and highlighted the research activities of the Philosophy department.

The inaugural session was followed by two invited lectures paying tribute to Professor S. N. Sen and Dr. B. V. Subbarayappa for their contributions to history of science. The lecture on Professor Sen whose birth centenary was observed last year was delivered by Professors M D Srinivas (Center for Policy Studies, Chennai). Professor K. Ramasubramanian (Department of Humanities and Social Sciences, IIT, Bombay) paid rich tribute to Dr. Subbarayappa who died recently at the age of 94 while narrating his pioneering works in the field of history of science.

Paying rich tribute to academic contributions of Dr. Subbarayappa, Professor Ramasubramanian informed the audience that Dr. Subbarayappa did his Ph.D. on *Studies in Indian Concepts in Physical Sciences* from University of Mysore (1964) which is regarded as the first thesis on history of Indian Science and commended by the scholars. Dr. Subbarayappa served as head of the department of chemistry, Vijaya College, Bangalore; Senior Scientific Officer, Research survey and planning division of the CSIR; Executive secretary, INSA; Director, Nehru Centre, Bombay, Visiting Professor, BITS, Pilani (Rajasthan) and Honorary Professor at the National Institute of Advanced Studies, Bangalore. He was the recipient of numerous awards from India and abroad. Some of the seminal works of Dr. Subbarayappa include *Science in India: A Historical Perspective* (2013); *Modern Science: A Historical and Social Perspective* (2016); *Indus Script: Its Nature and Structure* (1996) and *A Concise History of Science in India* (with D M Bose and S N Sen). Apart from this he published more than hundred papers in various Indian and International journals.

Post Lunch session was devoted to the seminar in which following papers were presented:

Sisir Roy, (Visiting Professor, National Institute of Advance Studies, Bengaluru) spoke on *Ontology of Time: Dôgen to Einstein*. As the title suggests Professor Roy dwelt on various perceptions of time such as subjective and objective, proper, sidereal and space, time dilation, reaction time etc. which has troubled great minds, both scientific and philosophic like Nagarjuna to Dogen, Aristotle and Sophocles to Heidegger, Newton and Einstein to Prigogine. He highlighted the Dogen's metaphor which proposes that there is no existence within time but existence itself is time. He emphasised that the universe is continuously evolving through irreversible time into self-organizing pattern, order and complexity from the moment of Big Bang to until now from radiation to elementary particles, atoms, molecules, galaxy, stars etc. to human being. Ilya Prigogine calls it order out of chaos. While philosophers ponder what time is, and whether it is a single moment or a full blown dimension, physicists grapple with why time appears to flow in only one direction.

Prajit Kumar Basu (Centre for Neural and Cognitive Sciences, University of Hyderabad) presented a paper on *Chemistry, chemistry or chemical philosophy: An intra- and interdisciplinary engagement in natural philosophy through the lens of some 18th century chemical philosophers*. Professor Basu proposed that the historical scholarships between sixteenth and eighteenth centuries have shown both continuity and discontinuity of chemical practices. The practitioners exchanged their ideas across countries and attempted to develop a view about chemistry or chemical philosophy and by the eighteenth century also attempted to rebuff a research programme to reduce chemistry (chemical philosophy)to mechanics (Newtonian mechanical philosophy). The assumption that only chemical operations, as opposed to mechanical operations, bring about chemical phenomena and to draw a reasonable distinction between chemical and mechanical operation were fraught with difficulties.

K Ramasubramanian (Department of Humanities and Social Sciences, IIT, Bombay) presented some excerpts from Munîúvara's commentary *Niṣṛṣṭârthadûtî*on *Lîlâvatî* of

Bhâskarâcârya. The pre-eminence of this commentary has been indicated by the use of the appellation *uttamottamâ* by Pandit Sudhakara Dvivedi. Munîúvara, also known as Viúvarûpa, was a 17th-century astronomer of great repute who resided in VârâGasî. He is known to have composed several works—both original as well as commentaries on important treatises such as the *Lîlâvatî*. Professor Ramasubramanian commented that besides explaining the basic import of Bhâskara's verses, Munîúvara further adds proofs of various results given by Bhâskara. He also highlights the proofs given by earlier scholars (critiques them if needed), explains the grammatical peculiarities of the words employed in Lîlâvatî, and so on.

Deepak Kumar's (Former Professor, Zakir Hussain Center for Historical Studies, Jawaharlal Nehru University, Delhi) paper on *Science in Modern India: A Note on Sources*highlighted the significance of sources (information) in any reconstruction of the past which is now universally accepted and appreciated. Primary data (i.e. the first-hand information) is always the prime material for such reconstruction. Modern science in India or alternatively science in modern India does not suffer from lack of valid sources, unlike that of ancient and medieval times. His talk was based on the primary sources that he used in understanding of the Histories of Science, Technology, Environment, and Medicine (HISTEM) in the context of colonial India.

Samir Kumar Saha, (Former Professor, Department of Mechanical Engineering, Jadavpur University) in his paper on*Studies in History and Philosophy of Science in India* underlined the importance of history of science studies with philosophy as an integral part in Indian context. Professor Saha in his lecture chronicled the endeavors made in India to introduce HPS as a formal discipline, first by Sri Satish Chandra Mukherjee and then by Sri Pramath Nath Bose. Professor Samarendra Nath Sen made persistent effort to start a formal Post Graduate Course in 1950s but it was not accepted at the Calcutta University. A similar attempt was made in 1990s by the Asiatic Society to start a post graduate course but instead short term courses were conducted. In the end he underlined the need for development of multidisciplinary formal course in History and Philosophy of Science so that science education, scientific literacy and scientific activism could be combined together to prepare global citizens.

Srimoyi Bhattacharyya Banerjee (Ph.D. Scholar, School of Cognitive Science, Jadavpur University) in her paper on *History of Cognitive Science* drafted an account of the history and historiography of cognitive science. Ms. Banerjeeoutlined the origin, meaning, and disciplinary growth of Cognitive Science, contributors and their contributions, the technology it has inspired and the plethora of uses of applied cognition.She attempted to bring out state of affairs of cognitive science and how more works of history could fill in the knowledge gaps between different disciplines. While emphasising the need for interdisciplinary linkages, the presentation hoped that the frontiers of the history of science may expand to incorporate the history of new emerging sciences in this grand narratives.

Annie Mukherjee (M. Phil. Scholar, Department of Philosophy, Jadavpur University) in her paper on *Parallels between History of Science and History of Philosophy: Some Reflections*tried to show that science and philosophy have a history of mutual interaction and can not be talked about either of them in isolation. She tried to dispel the general notion of distinguishing science and philosophy on the strict basis of methodology, as in experiment-observation versus armchair thinking. Many of the eminent philosophers from Aristotle to Descartes and Hume had engaged themselves in empirical methodology to support their philosophical accounts and this trend is being revived by the empirical and experimental philosophers who are using empirical methods to study intuitions regarding philosophically interesting scenarios.

Professor Maushumi Guha, Department of Philosophy, in her concluding remarks stressed the need for organizing such interdisciplinary seminars and symposia more often which brings together the scholars form diverse disciplines at one platform. The need is to create synergy between historians and scientists and such engagements will enable the scholars to look at history with a scientific approach and science in a historical perspective. She thanked the speakers and chairs for the each papers of the seminar, members of the National Commission, invited scholars, students and faculty from Jadavpur University for attending the seminar and making it a success. ❐

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Discussion on Disease Management in Shrimp Culture in APA 2019

The International Conference 'Asian Pacific Aquaculture 2019' (APA 2019) was organized by World Aquaculture Society - Asian Pacific Chapter and Tamil Nadu Dr J.

Jayalalitha Fisheries University (TNJFU) at Chennai Trade Centre during June 19-21, 2019. In the Session 'Disease management in shrimp culture', Dr S. V. Alavandi, Principal Scientist, ICAR-CIBA, Chennai gave invited talk on: 'Metagenomic studies suggest that microbial diversity influences shrimp health in brackishwater aquaculture'.

Outbreaks of diseases and related crop losses have been impeding shrimp aquaculture. Dr Alavandi highlighted on Acute hepatopancreatic necrosis disease (AHPND), disease caused by parasite *Enterocytozoon hepatopenaei* (EHP), White faeces syndrome (WFS; observed on 50th-60th day of culture), White spot disease, Running mortality syndrome (RMS; non-reproducable in lab) and stunted growth as predominating diseases in Indian brackishwater aquaculture; emergence of Infectious Myonecrosis virus in 2016 and zoea-2 syndrome in shrimp hatcheries. Active Disease Surveillance Programme in shrimp aquaculture and epidemiological investigations by ICAR-CIBA suggest the association of WFS affected shrimp ponds (WFSasp) with EHP infection leading to stunted shrimp growth. Shrimps with WFS were positive for EHP. In India, since 2015, 21% of shrimp farms in Andhra Pradesh (AP) and Tamil Nadu (TN) are WFS-affected.

Dr Alavandi spoke about ICAR-CIBA's survey on prevalence of viral, bacterial and fungal diseases in shrimp in 523 farms of TN, AP and West Bengal during 2015-2018; outbreak of diseases irrespective of season; factors influencing diversity of microbiome in aquaculture; dysbiosis on emergence of diseases; bacterial diversity of healthy and WFSasp as revealed by metagenomic analysis, using NGS of 16S V3-V4 regions. Considering increasing incidences of WFS in Indian shrimp farming, where aetiology is unfixed, this metagenomics study was undertaken to understand microbial diversity and role of microbes in WFS. Different families of bacteria are associated with WFS, having possible role in it. He discussed about bacterial diversity of healthy and WFSasp at family level; top ten organisms decreasing more than 2-folds in WFSasp. Numbers of bacterial and fungal species in healthy ponds recorded to be high and those in disease-affected ponds were low. Study on fungal diversity based on ribosomal ITS region indicated variation in WFSasp compared to healthy pond. According to metagenomics, microbial diversity is significantly reduced in WFSasp. Dr Alavandi will investigate into molecular mechanisms involved in communication between host and its microbiome.

This study indicated differences in bacterial and fungal signature of healthy and WFSasp. Changes in bacterial communities bring deterioration in disease-affected shrimp pond environment. In shrimp culture, management of pond and host microbiomes can mitigate losses due to diseases. Dr Alavandi feels that in ameliorating shrimp health management-related disease syndromes, if microbial diversity in shrimp pond ecosystems is manipulated with beneficial microbes (which helps in decomposing organic matter, mitigating NH_3 and N_2 and maintain ideal pond water quality favourable for shrimp growth), it may promote proliferation of certain desired microbes present in healthy ponds and improve pond bottom condition. External application of suitable microbial consortia is known to accelerate mitigation of toxic nitrogenous wastes in shrimp ponds.

In this session, Dr M. Rajalekshmi, Scientist at Kemin AquaScience, Chennai spoke on: 'Control of vibriosis and associated syndromes in white leg shrimp *L. vannamei*'. AHPND is a devastating Vibrio infection in shrimps; she conducted *in-vitro* antimicrobial assays to screen selected phytobiotic compounds (pc) for their activity against AHPND and non-AHPND strains of *Vibrio parahaemolyticus* (Vp). Supplementation of product prototype included in feed improved survival rates in Vp-challenged *L. vannamei* on 120th hour post-challenge. Selected product formulation based on pc was tested in conditions of suspected Vibrio infections and associated syndromes in shrimp farms; shrimps showed significant improvement in recovery. Dr K. Leong Wee from WeeAqua Consultancy, NSW, Australia spoke on: 'Current status on development of a sustainable shrimp feed'. He emphasized on research efforts in production of shrimp feeds for commercial culture without using fish meal and/or fish oil. With increase in cultured shrimp production, more animal-based feed is required. As alternative raw materials, insects like black soldier fly larvae (BSFL), locust, house cricket, silkworm pupae were used to produce insect meal as shrimp feed. He explained benefits of insect meal and examined BSFL meal in shrimp feed trials, it mitigated some symptoms of WFS in disease-challenged shrimps.

Dr A. Uma from TNJFU, Nagapattinam spoke on: 'Prevalence of hepatopancreatic microsporidiosis caused by EHP in *L. vannamei* farms of TN'. She undertook disease surveillance to screen for important pathogens in intensive *L. vannamei* farms of Tiruvallur and Nagapattinam districts. Samples included *L. vannamei* PL, juveniles/adults, pond soil and white faeces from ponds. Overall prevalence of EHP found to be highest (17.11%, recorded max^{m} in white faeces) in total samples, followed by White Spot Syndrome Virus (WSSV). Dr A. Vidya from Kemin AquaScience spoke on: 'Algal 1,3 α glucan - an effective immune modulator for improving survival in shrimp farms'. She

spoke about α glucan from algae *Euglena* sp and yeast; mode of action of algal α glucan (aαg) on immune cells in *L. vannamei*; effect of aαg on growth and survival of *L. vannamei* and on WSSV. Aαg in the form of dried *E. viridis* cells enriched with Vitamin-C, when used @ 5gm/kg feed and fed to *L. vannamei* in ponds caused mean weight increase on 28th day by 1.1gm in comparison to control. Feed supplemented with this product increased non-specific immune response and resistance to white gut disease in shrimp in commercial trials.

Dr O. Jintasataporn, Professor of Aquaculture at Kasetsart University, Bangkok spoke on: 'Disease challenge and sustainability in shrimp culture'. She described cellular and humoral components in innate immunity in shrimp; pattern recognition proteins, clotting protein cascade, production of lysosomal enzymes, phenol and prophenol; antimicrobial peptides in shrimp; reduction in total haemocyte count normally upon infection. Prebiotics and antioxidants improve shrimp survival during viral infection and carotenoids reduce formation of harmful free radicals in shrimp cells. ❐

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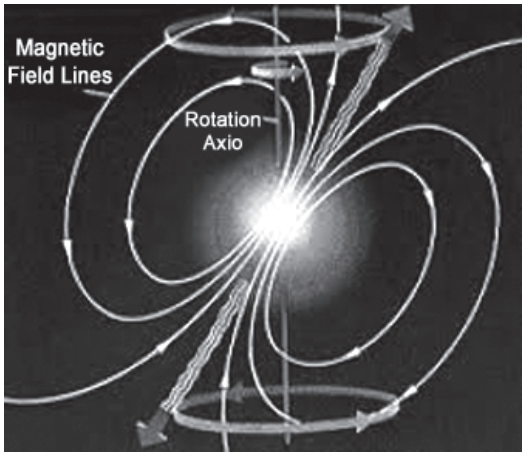
Women of Impact: Jocelyn Bell Burnell, The First Discoverer of Pulsars

National Geographic has just launched a Facebook project 'Women of Impact' in order 'to discover women who are breaking barriers in their fields, changing their communities, and inspiring global action'. The series started with the highlighting of the life and work of Jocelyn Bell Burnell (née Susan Jocelyn Bell), the first discoverer of pulsars. In view of the immense scientific and societal contributions of this lady, her life and work are briefly presented herein.

Born to M. Allison and G. Phillip Bell on July 15, 1943 in Belfast, Northern Ireland, Jocelyn was one of the first few girls who were allowed to study science at a Christian grammar school at Armagh, Northern Ireland. At the age of 11, when she failed the examination required for students to pursue higher education in British schools, she was sent to Mount School, a Quaker boarding school for girls in York. In 1965, she got a Bachelor's degree in physics from the University of Glasgow. In 1967, Bell was working as a Research Assistant at Cambridge University. Her doctoral supervisor Anthony Hewish was then trying to find out more quasars (i.e. quasi-stellar radio sources) by scanning the sky for the radio waves emitted by quasars. Hewish entrusted Jocelyn, one of the few women studying astronomy at that time, to help him and other astrophysicists to construct a 81.5 MHz radio telescope. It went into operation in 1967.

Susan Jocelyn Bell Burnell (b. 15-07-1943)

Jocelyn used to operate the telescope and analyse data recorded in *ca.* 120 meters of chart papers every four days. After weeks of analysis sometime in 1967, Jocelyn noticed a strange bit of "scruff" (unusual markings) covering only 2.5 cm on the chart paper. She noted that the signal was pulsating in a regular manner - @ *ca.* 1 pulse at every 1.3 seconds from the same part of the sky. The scruff was too fast and too regular to be coming from a quasar. She realised, the observation pointed to a new cosmic mystery. Hewish, however, believed that the signals were coming from aliens and accordingly dubbed the "scruff" Little Green Men-1 or LGM-1 (now known as PSR B1919+21). In the same year, Jocelyn traced three more pulsating objects. In 1968, all these objects came to be known as pulsating quasars or pulsars and identified as rapidly spinning neutron stars. Pulsars now constitute one of the



Artist's Impression of Pulsar

most powerful quantitative tools in astrophysics to explore extreme physics and test the theories of general relativity.

In early 1968, Hewish and Jocelyn (second author), along with three others, published their work in the February, 1968 issue of *Nature*. This discovery fetched Hewish and his collaborator Sir Martin Ryle (but not Jocelyn) Nobel Prize in Physics in 1974. That Jocelyn did not get the Nobel Prize created quite a fuss. Even Sir Fred Hoyle, a renowned astronomer, dubbed this Nobel Award as the "*No-Bell Nobel Prize*." Ironically, her discovery is now-a-days universally acknowledged as one of the most significant astronomical discoveries of the 20th century.

In 1969, Jocelyn received Doctorate degree in radio astronomy from the University of Cambridge. She became Professor of Physics at the University of Southampton (1970-1973) and the University College London ((1974-1982), worked at the Royal Observatory at Edinburgh (1982-1991), a Project Manager for James Clerk Maxwell Telescope on Mauna Kea, Hawaii, Professor of Physics at the Open University (1991-2001) and the Dean of Science, University of Bath (2001-2004).

Expectedly, she received many awards and honours – too numerous to be cited here. She became the President of the Royal Astronomical Society (2002-2004). Her life and work were presented in the BBC in various ways. Her name was enlisted in the BBC Radio 4 Woman's Hour 'Power List' of '100 Most Influential Women in U.K.' (2013). She became the first woman President of the Royal Society of Edinburgh (2014). In 2018, the Institute of Physics (IoP) awarded a 'Special Breakthrough Prize in Fundamental Physics' to Jocelyn "*for fundamental contributions to the discovery of pulsars, and a lifetime of inspiring leadership in the scientific community*." She donated the entire prize money (£ 2.3 million) to the IoP for UK and Ireland for creating research opportunities to students from underrepresented groups in physics.

Although Jocelyn was unfairly snubbed in the Nobel Prize issue, she did not bear any grudge against anybody. But she acknowledged that gender discrimination might have been a factor. Jocelyn has been an influential campaigner for increasing the number of women professionals in physics and astronomy.

Jocelyn married Martin Burnell in 1968, and the marriage lasted till 1993. Their son Gavin is a physicist. Currently, Jocelyn is serving as a Visiting Professor of Astrophysics, University of Oxford and the Chancellor of the University of Dundee (since 2018). Although a large number of pulsars have now been discovered, the pioneering contribution of Dame Jocelyn Bell Burnell still dazzles after more than fifty years of her first discovery. ❐

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A Deadly Superfungus and Global Warming

Clueless about the connection between the two stated above? Well, a deadly superbug has been reported to be detected in human pathogens simultaneously across several continents in the globe. According to a recent report in *mBio*, a journal of the American Society of Microbiology, global warming may have contributed, at least in part, to this phenomenon. The present brief write-up is an attempt to shade light on this ominous situation.

Way back in 2009, a highly drug-resistant fungus was first isolated from the ear of a Japanese woman. The bug was identified as the fungus *Candida auris*, 'auris' being the Latin word for ear. During 2012-2015 this human pathogen was isolated from hospitalised patients, mostly debilitating ones with weak immune systems, in the Indian subcontinent, Venezuela and South Africa. The first cases in USA were reported in 2016, but by July, 2019 more than 700 cases of this human pathogenic fungus have been reported mainly from New York City area, New Jersey and Chicago area.

There are a few strange things about this fungus. Firstly, these are highly drug-resistant, can infect bloodstream heart and brain, can spread very quickly and can become fatal in 30-60% of patients. Secondly, this yeast has been able to adapt to the comparatively high body temperature of human beings. In fact, patients can carry this fungus for a month and even more. Thirdly, they came from nowhere in 2009, but by now they have appeared simultaneously in more than 30 countries across several continents.

Scientists believe that the widespread use of antifungal chemicals as drugs and on crops are probably responsible for the global emergence of this yeast. But two questions bother the scientists very much. Fungal infections in the *Homo sapiens* are rare simply because mammals in general have a more advanced immune system than other organisms and most environmental fungi can't grow at the body temperature of human beings. Why are then more and more human beings getting infected by this fungus? The second

question revolves round the possible cause of the simultaneous appearance of this virus across many countries with different populations and different societies.

In the *mBio* report, scientists from USA and the Netherlands have suggested that global warming may have contributed, at least in part, to the adaptation of the fungus to warmer temperatures, thereby facilitating its occurrence and survival in human beings. But it is only a theory that needs to be proven. They believe, if scientists can find the swamp or lake, where this deadly yeast-like fungus originated, and analyse its close relatives, they could unveil how *C. auris* adapted to grow in warmer temperatures. That fungal species in cities have been found to be more thermotolerant than their rural counterparts lends support to this belief.

A word of caution - fungal diseases are likely to be more rampant in the flora and fauna of a warmer globe in this 21st century. ❐

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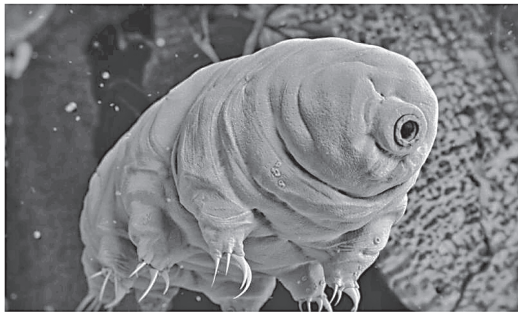
Water Bears on the Moon – A Matter of Concern?

The first successful mission to moon was achieved by USSR when it achieved a soft landing of an unmanned spacecraft, Luna 9, on the moon in 1966. This was followed by similar successful soft landings of unmanned spacecrafts on moon by USA (on the ocean of storms by Surveyor 1 on June 2, 1966) and China (on the far side of moon by Chang'e 4 on January 3, 2019). In a privately funded project, the Israeli Space Agency, SpaceIL, launched on February 22, 2019 an uncrewed spacecraft, Beresheet, from Cape Canaveral, Florida for its soft landing on moon. But the mission failed because Beresheet crashed on moon on April 11. Pertinently, this failure marks the first crash of spacecraft on moon after 48 years of the last crash – that of the Russian spacecraft Luna 18 on lunar mountains near the edge of Mare Fecunditatis in 1971.

This failed Israeli attempt has assumed a unique significance because it has now been revealed that thousands of dehydrated tardigrades, also known as water bears or moss piglets, along with human DNA samples and 30 million small digitised pages of information on human society and culture, were being carried by the spacecraft. Since the moon lander crashed on the surface of moon, it remains to be seen whether particularly the tardigrades survived the crash. The big question is: 'why were the tardigrades sent to moon and why are we worried about their presence on the moon surface?' We need to know a bit about tardigrades in order to realise the fall out of the tardigrades' existence on moon.

Tardigrades are cute, near-microscopic animals, 0.05-1.2 mm long, with eight legs, and 4-8 claws on each. Their mouth can protrude outward to reveal sharp teeth and grab food. They can also swim. They survive on juices from algae, lichens and moss. Some of the species are carnivorous, even preying on other tardigrades. Their usual habitats are the sediment at the bottom of a lake, moist pieces of moss and other wet environments. They reproduce both by sexual and asexual means. In the former, they lay l-30 eggs at a time.

These creatures were first discovered by Johann August Ephraim Goeze, a German pastor, in 1773. He named them tardigrades, meaning 'slow stepper', since they belong to the phylum 'Tardigrada'. But the most important fact about the tardigrades, discovered by an Italian biologist, Lazzaro Spallanzani, in 1776, is that they can survive extreme conditions by making a transformation.



By now it has been found out that he tardigrades can withstand a variety of extreme conditions like very low (-200°C) to very high temperature (*ca.* 150°C), radiation, boiling liquids, very high pressure (up to six times the pressure of the deepest part of an ocean) and the vacuum of space without any protection. It is also known that under extreme conditions they undergo 'cryptobiosis', during which the tardigrades are dehydrated, retract their

head and legs and curl into a ball known as a 'tun', and their metabolic activity becomes lower (down to 0.01% of their normal level) when their organs are protected by a gel of the sugar trehalose and a large amount of antioxidants which their body produces. At very cold temperatures, they transform into a 'special tun' that prevents the growth of ice crystals. They produce a protein that protects their DNA when they are exposed to radiation. When in water, they reduce their metabolic rate and absorbs oxygen and water enough for their survival. Using water, they can be recovered from their 'tun' stage even after 10 years. In 2016, two tuns and an egg of tardigrades were reported to have been reanimated even after 30 years of cryptobiosis.

In reply to the first question raised earlier, the dehydrated tardigrades were sent to moon with a view to providing a depository of life forms and DNA to moon so that they could be transported back to earth to repopulate this planet in case a colossal natural disaster wipes out life from earth. Regarding the second question, unless the dehydrated tardigrades on moon are rescued, rehydrated and revived within a decade or so, they may simply perish. In that case, the very purpose of sending them to moon becomes fruitless. Besides, they may destroy other life forms, if there be any, on moon. A more important concern is that by sending them to moon we are polluting the surface of moon which is already polluted by abandoned as well as crashed spacecrafts and litter left behind by the 12 astronauts who successfully landed on moon so far.

We wonder if the water bears are right now walking on moon. ❐

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Toxic: Oxford Word of the Year 2018

Ever heard of 'Word of the Year'? If not, please don't bother because it is not a very common knowledge after all. Before digging information on what it means, who else announces word of the year, what its origin is, how often this announcement is made and the like, let us just concentrate on Oxford Dictionaries' Word of the Year 2018. The word is "Toxic" whose logo is shown below. The Word of the Year is also sometimes represented as "WOTY" or "WotY".

To quote the Oxford Dictionaries website, "*The Oxford Word of the Year is a word or expression that is judged to reflect the ethos, mood, or preoccupations of the passing year, and have lasting potential as a term of cultural significance.*" According to oxforddictionaries.com, the word 'toxic' was mentioned in most talked about topics in that year. It was used in a variety of contexts in both its literal sense and metaphorical sense. The word toxic originates from medieval Latin word "toxicus" which means 'poisoned'. A video released by Oxford Dictionaries on Twitter said, "*Our research shows that this year (2018), more than ever, people have been using 'toxic' to describe a vast array of things, situations, concerns and events.*"

The top ten contexts in which this word was used are chemical, masculinity, substance, gas, environment, relationship, culture, waste, algae and air. Nerve gas poisoning and stockpiling of 'toxic chemicals' pertained to the 'chemical' context. The burning of 'toxic waste' (especially in India) and the consequent release of 'toxic gases' were identified as the crucial causes of 'toxic air'. This was relevant to the pollution of 'environment'. Besides, the term 'toxic environment' was more frequently used with regard to detrimental workplace environments and their consequent effect on the mental health of the workforce. The declaration of a state of emergency in Florida in 1918 when a red tide of 'toxic algae' bloomed along its western coastline killing marine animals, disrupting tourism and causing respiratory problems to its citizens led to the rampant reference to 'toxic algae'. 'Toxic culture' surfaced mainly from overwork and sexual harassment in factories, offices, educational institutions and the like. The walkouts at Google, the disgrace of Philip Green (a fashion baron) and the accusation of the Speaker of the House of Commons in Westminster, U.K. are glaring incidences of 'toxic culture'. The year 1918 witnessed widespread discussions about 'toxic relationships' amongst cross sections of the society, viz. amongst parents, partners, politicians, etc. 'Toxic masculinity' was often referred to not only in discussions on toxic relationships but also in #MeToo movements across the globe.

Pertinently, the 'runners up', i.e. other words that were shortlisted for this purpose are: Big Dick Energy, Cakeism, Gammon, Gaslighting, Incel, Orbiting, Overtourism and Techlash. For a curious reader, the Oxford Word of the Year for the last five years were: Youthquake (2017), Post-truth (2016), 'Face with Tears of Joy' Emoji (2015), Vape (2014) and Selfie (2013).

One may be curious to know how the Word of the Year is chosen. Oxford Dictionaries have got an extensive language research programme, including the Oxford

Corpus, which gathers nearly 150 million words of current English from web-based publications each month. Their expert lexicographers then use sophisticated software to identify new and emerging words. Feedbacks from different sources are also taken into account. The final selection is made by the Oxford Dictionaries team based on all the available information.

In all fairness, the oldest WOTY can be traced to the German "Wort des Jahres" which started in 1971. The oldest English language version of WOTY is one by the American Dialect Society which started in 1991. Other versions of WOTY are by Global Language Monitor (since 2000), Merriam-Webster (2003), Grant Barrett (2004), the Australian National Dictionry Centre (2006), Macquarie Dictionary (2006) and Collins English Dictionary (2013).

Thank God that we have overcome the 'toxic year'. ❐

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First Evidence of Planet-wide Groundwater System on Mars

There have been wide speculations about the presence of water on Mars with occasional evidence from space missions. Now European Space Agency's *Mars Express* has revealed the first geological evidence of a system of ancient interconnected lakes that once lay deep beneath the Red Planet's surface, five of which may contain minerals crucial to life.

On the surface, Mars appears to be an arid world, but its surface shows compelling signs that large amounts of water once existed across the planet. There are features that could have been formed only in the presence of water, such as branching flow channels and valleys, for example. Last year *Mars Express* detected a pool of liquid water beneath the planet's south pole (*Dream* 2047, September 2018). A new study now reveals the extent of underground water on ancient Mars that was previously only predicted by models (*Journal of Geophysical Research: Planets*, 21 January 2019 | DOI: 10.1029/2018JE005802).

The new finding is based on a detailed study by Salese and colleagues of 24 deep, enclosed craters in the northern hemisphere of Mars, with floors lying roughly 4,000 m below Martian 'sea level' (a level that, given the planet's lack of seas, is arbitrarily defined on Mars based on elevation and atmospheric pressure, where the zero elevation is defined by the mean Martian radius of 3382.9 kilometres).

They found features on the floors of these craters that could only have formed in the presence of water. Many craters contain multiple features, all at depths of 4,000 to 4,500 m – indicating that these craters once contained pools and flows of water that changed and receded over time.

Other features they discovered included "channels etched into crater walls, valleys carved out by sapping groundwater, dark, curved deltas thought to have formed as water levels rose and fell, ridged terraces within crater walls formed by standing water, and fanshaped deposits of sediment associated with flowing water". The water level aligns with the proposed shorelines of a putative Martian ocean thought to have existed on Mars between three and four billion years ago.

Mars Express was launched on 2 June 2003 and reached 15 years in space last year. The current study used observations from the High-Resolution Stereo Camera (HRSC) on ESA's *Mars Express*, the High- Resolution Imaging Science Experiment (HiRISE) and the Context Camera onboard NASA's *Mars Reconnaissance Orbiter*. A digital terrain model was used based on data from the HRSC and NASA's *Mars Orbiter* Laser Altimeter. ❐

Adapted from the article of Biman Basu in Dream 2047, May 2019, Vol. 21 No. 8

Methanol Converted to Ethanol Using Sunlight

Methanol is a colourless liquid that can be made from agricultural waste. It has long been considered as a green alternative to fossil fuels. But its main drawback is that it is toxic and can generate only half as much energy as the same volume of petrol. Researchers of McGill University in Montreal, Canada have found a potentially cheap way of converting methanol to ethanol using sunlight and gallium nitride nanowires "spiked" with magnesium as a catalyst. Ethanol is a more popular alternative fuel that is less harmful and packs more energy.

The basic idea of the new research initiated in 2014 when Chao-Jun Li, a chemist at McGill University and his colleagues showed that "a tiny forest of nanowires" made from the semiconductor gallium nitride (GaN) could be used as a catalyst to convert methane gas into benzene, a

chemical used to make dozens of other industrial compounds such as plastics, solvents, and adhesives. According to Li, in this case, the nanowires rearranged the chemical bonds between carbon atoms, which is also what is needed to convert methanol to ethanol (*Chem*, 14 February 2019|DOI:https:// doi.org/10.1016/j.chempr.2019.01.005).

The researchers, however, note that the process is just a proof of concept. Converting methanol to ethanol requires UV light, which is just a small fraction of the sunlight that reaches Earth. For the process to be commercially economical, they say, it may require tweaking the nanowires to get them to work with visible light, which has less energy than UV light, but is far more abundant in the Sun's rays.

The direct conversion of the more readily available methanol to the more user friendly, less toxic, and broadly applicable ethanol is an important landmark towards securing the sustainable "fossil alternative". At the same time, successfully turning it into a viable commercial process poses a tremendous scientific challenge. ❐

Adapted from the article of Biman Basu in Dream 2047, April 2019, Vol. 21 No. 7

Breakthrough 'Lab-On-A-Chip' Detects Cancer Faster

Cancer is one of the most dreaded diseases known to mankind. If detected early, some cancers may be cured completely. But detecting cancer early has been difficult till recent time and most cancers were detected when it was too late. Researchers at the University of Kansas Cancer Centre in USA have now come up with an ultrasensitive diagnostic device that could allow doctors to detect cancer quickly from a droplet of blood or plasma, leading to timelier interventions and better outcomes for patients (*Nature Biomedical Engineering*, 25 February 2019 | DOI: 10.1038/ s41551-019-0356-9). The "lab-on-a-chip" for "liquid biopsy" analysis detects exosomes"tiny parcels of biological information produced by tumour cells to stimulate tumour growth or metastasise.

According to Yong Zeng, associate professor of chemistry at Kansas University, who led the research, "the new lab-on-a-chip's key innovation is a 3-D nanoengineering method that mixes and senses biological elements based on a 'herringbone' pattern commonly found in nature, pushing exosomes into contact with the chip's sensing surface much more efficiently in a process called mass transfer".

The new microfluidic chips developed at Kansas University would be cheaper and easier to make than comparable designs, allowing for wider and less-costly testing for patients. According to Zeng, with the microfluidic chip's design now proven using ovarian cancer as a model, the chip could be useful in detecting a host of other diseases. He said. "Almost all mammalian cells release exosomes, so the application is not just limited to ovarian cancer or any one type of cancer. We're working with people to look at neurodegenerative diseases, breast and colorectal cancers, for example" ❐

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