

## *Henneguya salminicola* The animal that doesn't Need Oxygen to Breathe



Image Credit: Dr Stephen Atkinson, Senior Researcher, Department of Microbiology, Oregon State University, Corvallis, Oregon USA

**O**XYGEN is vital for the functioning of all multi-cellular organisms, however, scientists have recently found a species of animal that exists without oxygen.

The animal is a parasite called *Henneguya salminicola*, a member of the jellyfish family. It survives in the muscles of salmon and trout, resulting in little white nodules known as “tapioca disease.” This discovery was led by Dorothee Huchon, Zoology Professor in the Faculty of Life Sciences and the Steinhardt Museum of Natural History at Tel Aviv University, Israel.

According to the scientists, it will bring a whole new dimension to the understanding of animals. While many microbes have evolved the ability to live without oxygen, animals are much more complex with different kinds of tissues and organelles. Till date, it was believed that all animals undergo a process called ‘cellular respiration’, which is the conversion of sugars and oxygen to energy molecules known as ATP by an organelle called mitochondria, and these organelles possess their own “mitochondrial” genes.

The discovered parasite is also known to infect coho, pink, sock-eye and chum salmon as well as rainbow trout. The parasite completes its life cycle in two organisms — fish and worm. The parasite is comprised of

about ten cells and can live without the machinery to turn oxygen into energy.

The researchers reported these findings in the journal *Proceedings of the National Academy of Sciences*.

While sequencing the genomes of *Henneguya*, extracted from a Chinook salmon and related fish parasites, it was noticed that *Henneguya*'s mitochondrial genes were missing. Initially, the scientists thought it was an error but DNA fluorescent staining also revealed the absence of mitochondrial DNA. Many of the genes of enzymes involved in respiration were also found to be missing with the mitochondrial DNA.

However, the scientists are still not sure from where this animal derives its energy. There is a lot to look forward to in this unfolding story.

Contributed by Harshada H., MSc Science Communication student, CSIR-NISCAIR

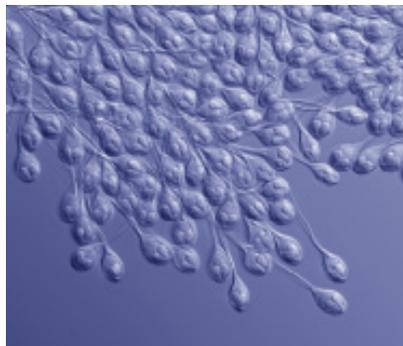


Image Credit: Dr Stephen Atkinson, Senior Researcher, Department of Microbiology, Oregon State University, Corvallis, Oregon USA

## ‘Good News’ for Treating Female Infertility

**I**N recent times, there has been a dramatic increase in the number of women experiencing infertility issues. According to the World Health Organization, infertility is a global public health issue. In India alone, 27.5 million couples suffer from infertility (*Times of India*, 2018). In fact, this serious issue has also been talked about in the latest commercial Bollywood movie ‘*Good Newwz*’.

In most cases, this situation arises because unlike males, females significantly lose fertility with increasing chronological age and female subfertility or infertility is often related to ovarian ageing.

Ovarian ageing or age-related physiological decline in the functioning

## IISc Team Builds Through-the- wall Radar on Tiny Chip

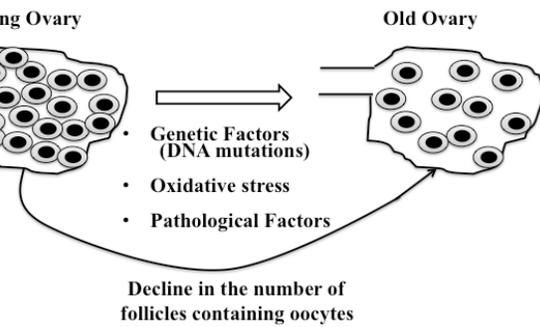
**A** team of researchers at the Indian Institute of Science (IISc) has built a through-the-wall radar on a chip smaller than a grain of rice. The researchers led by Gaurab Banerjee, Associate Professor at the Department of Electrical Communication Engineering, developed the radar using Complementary Metal Oxide Semiconductor (CMOS) technology.

The radar has a single transmitter, three receivers and an advanced frequency synthesizer capable of generating complex radar signals, all packed together into a tiny chip. Its small size can enable mass production at a low cost. Such radars can have wide-ranging applications in the defence sector, as well as areas such



A photon

Figure 1. A schematic depiction of ovarian ageing



of ovary is typically exhibited by an increase in the fibrous tissue and a gradual decrease in the number as well as the quality of oocytes/follicle pool/ovarian reserve in the ovaries. In other words, the ovaries fail to produce oocytes, which are competent enough for fertilization and further development. Thus, in such a scenario, assisted reproductive technologies like IVF became quite useful.

Various studies have reported different factors involved in ovarian ageing like genetic and environmental factors or some gynecologic disorders or diseases and treatments. Among

these factors, ‘oxidative stress’ has been shown to play a critical role in the regulation of ovarian ageing (Fig. 1). The term “oxidative stress” states a physiological imbalance between the creation and the ability to detoxify free radicals or Reactive Oxygen Species (ROS, like superoxide anion radicals, hydroxyl radicals, and hydrogen peroxide), thus leading to resultant stress and damage to the cellular systems.

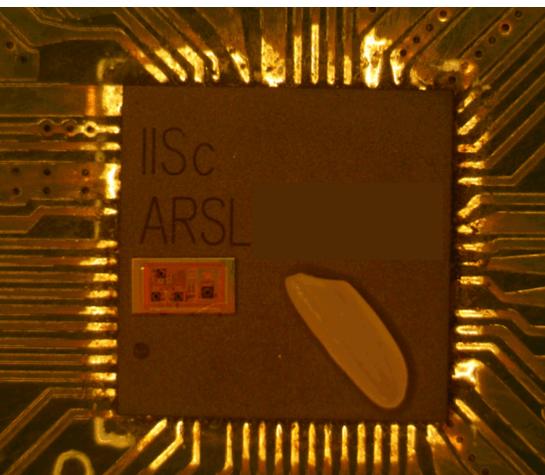
In a recent study by the Institute of Zoology of the Chinese Academy of Sciences, Peking University, and Salk Institute for Biological Studies, USA, the actual molecular mechanisms underlying the basis of human ovarian ageing have been elucidated using primates (cynomolgus monkeys) as animal models, followed by experimental validation in human ovarian cells (Wang, Si. *et al.* 2020. Single-Cell Transcriptomic Atlas of Primate Ovarian Aging. *Cell*, 180: 1-16).

In contrast to previous diagnostic methods (follicle count, measurement

of ovarian hormones, etc.), which provided an indirect estimate of ovarian reserve of a female, this study has revealed several important genes associated with age-related decline of the ovaries. Among these, there were two key antioxidant genes (IDH1 and NDUFB10), which showed decreased function in the old ovaries due to oxidative stress which simply means that these genes play an important role in protecting non-human primates as well as human ovarian cells from cellular damage during ageing.

They can be used as biomarkers for the early diagnosis and treatment of female infertility as well as age-related ovarian diseases like ovarian cancer in humans. The detection of antioxidant genes will help in finding out the actual ‘biological ovarian age’, which will definitely be a more reliable measure of ovarian health rather than the chronological age.

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Micrograph of the TWR radar-on-chip compared to a grain of rice (Photo Credit: ARSL, IISc)

as healthcare, transportation and agriculture.

“Only a handful of countries in the world today have the ability to put the entire electronics of radar on a chip,” says Banerjee.

Radars work on the principle of bouncing a signal off an object and measuring the delay in the signal’s return. These signals are analysed to identify the object — even reconstruct

a crude image of it — or determine where it is or how fast it is moving. An extension of this technology is a Through-the-wall radar (TWR), which works on the principle that radio waves can penetrate walls when light cannot.

“TWR imaging has always been one of the most challenging radar design problems,” says Banerjee. For one, the signal can get significantly damped while passing through walls. To overcome this, radio waves consisting of a large number of frequencies need to be used, which can complicate the design. These radars also use a more complex signal, known as a chirp, which requires customised electronics such as a microwave transmitter, a receiver and a frequency synthesizer.

With their design, the IISc team has now managed to squeeze all of these electronic components into a single, tiny chip. They used new architectural and circuit design techniques to overcome challenges specific to radars — such as the design of a wide fractional bandwidth transceiver. “The same design techniques that have enabled smaller and cheaper smartphones can

now be used to miniaturise the complex electronics of a radar system into a small chip,” says Banerjee.

Although the chip was originally developed for airport security-related applications, Banerjee’s group is also exploring applications in other areas such as healthcare.

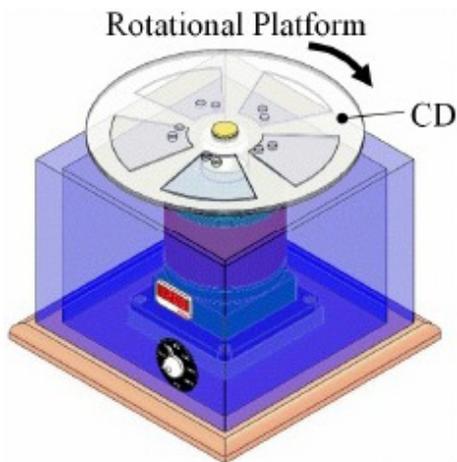
For instance, it can be used to monitor the health of elderly people. There are more than 10 crore elderly people in India, with many living on their own. If they slip and fall, and it goes undetected, it can lead to severe long-term problems. Although cameras and wearables have been used to monitor their movements, there are concerns about privacy and inconvenience. TWR radar systems, therefore, offer a convenient alternative.

“It might be possible for a centrally-placed TWR system to scan the house, and construct a model of when a person is standing or sitting down. If there is a sudden change in gait due to a fall, it can trigger an alarm,” says Banerjee. “It could also monitor breathing and respiration rates and assess the severity of a fall.”

## IIT-KGP Develops Cost-effective CBC Test Kit

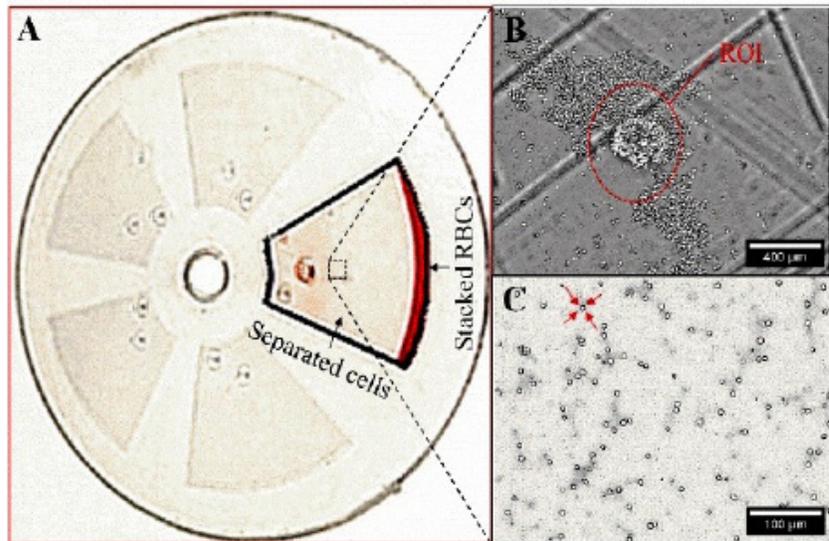
**R**ESearchers at the Indian Institute of Technology-Kharagpur (IIT-KGP) have come up with the innovation of a simple low-cost motorized spinning disc-based kit that can perform Complete Blood Count (CBC) Test. It costs a nominal 10 rupees, whereas the same tests cost around Rs 150-200 in government and private laboratories.

Complete blood count (CBC) is one of the common blood tests prescribed by doctors for clinical diagnosis and prognosis from anaemia, infection, viral fever, cancer, etc.



Set-up of the device

Separated Cells in CD grids



The project on the pocket-friendly disc-based CBC kit was led by Prof. Suman Chakraborty from the Department of Mechanical Engineering, IIT-KGP.

The researchers have redefined the usage of the compact disc altogether. Different cells have different densities and thus these can be separated in transparent micro-fluidic channels by applying centrifugal force. After separation of cells, an innovative label-free imaging method is used to count the cells in different segregated regions. The accuracy of counting the cell in this arrangement is up to 95%.

This test is generally expensive because it needs an expensive microscope and a trained person. However, IIT-KGP's innovative

method replaces the traditional manual counting of cells by a trained person by image processing by a trained software mechanism. This process also does not require any post-processing of separated blood – the disc of the micro-fluidic device can be disposed of after several tests.

The researchers have published the methodology and results in the journal *Biosensors and Bioelectronics (Elsevier)*. The researchers are now reaching out to MSMEs or related industrial organizations for commercial product development for the market.

*Contributed by Hemant Kumar, Student, M.Sc. Science and Technology Communication, CSIR-NISCAIR, New Delhi*

## World's Fastest Ant

**O**F the 1200 species of ants known, a species known as Saharan Silver ant found in the desert are the world's fastest ants. These ants routinely brave the blazing hot-midday sun to forage for



Image credit: commoms.wikimedia.org

The location of the star on the sky and the direction of its motion. The star is flying away from the Galactic centre, from which it was ejected 5 million years ago.

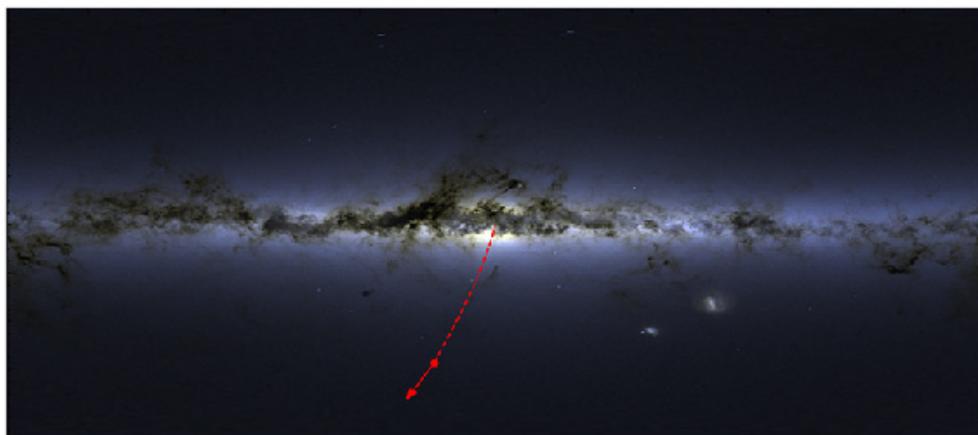
Image credit: Sergey Koposov; www.cmu.edu

## A Runaway Star Ejected by a Supermassive Black Hole

**A**N international team of astronomers has recently discovered a hypervelocity star whizzing out of the galactic core of our Milky Way at a staggering speed. The star was found to be moving ten times faster than most stars in the Milky Way and is headed for the darkest, loneliest depths of the intergalactic space. The results of this discovery were published online in the *Monthly Notices of the Royal Astronomical Society*.

Researchers led by Sergey Koposov of Carnegie Mellon University's McWilliams Centre for Cosmology have spotted the star, known as S5HVS1, in the Crane-shaped constellation Grus. According to researchers, the star is unprecedented due to its high speed (60 million kilometres per hour) and close proximity to the Earth; it is currently 29,000 light-years from Earth. Douglas Boubert from the University of Oxford and a co-author of the study, said, "The velocity of the discovered star is so high that it will inevitably leave the galaxy and never return."

The star S5HVS1 was discovered with observations made with the help of the 3.9 metre Anglo-Australian Telescope (AAT) near Coonabarabran,



New South Wales, Australia, coupled with superb observations from the European Space agency's Gaia satellite. The discovery was made as part of a study, known as Southern Stellar Stream Spectroscopic Survey (S5) — a collaboration of astronomers from the U.S., U.K., Australia and Chile. According to Ting Li, who is from Carnegie Observatories and leader of S5 collaboration, the star S5HVS1 is about twice as massive as our Sun and ten times more luminous.

The astronomers could trace the streaking star back to the galactic centre which is home to a supermassive black hole, known as Sagittarius A\*, with a mass of four million suns. Actually, hypervelocity stars can be ejected by black holes through a phenomenon called Hills mechanism. First proposed by Jack Hills, a theorist at Los Alamos National Laboratory in 1988, Hills mechanism is a phenomenon that occurs when a binary star system is

disrupted by a supermassive black hole. Tidal forces of the black hole cause one of the stars to be captured by it and fall into an orbit around it while the other star is jettisoned away from the black hole at a very high speed.

According to Li, the runaway star S5HVS1—an A-type main-sequence star—was ejected by the supermassive black hole, Sagittarius A\*, at the heart of the Milky Way five million years ago, when humankind's ancestors were just learning to walk upright. "This is the first clear demonstration of the Hills mechanism in action," said Li, adding, "Seeing the star is really amazing as we know it must have formed in the galactic centre, in a place very different to our local environment. It is a visitor from a strange world."

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food. They are technically known as *Cataglyphis bombycina* and commonly known as Saharan silver ants.

These ants are one of the most heat-resistant animals known. Their critical thermal maximum is 56°C and they run at a speed up to 0.7 m/second. Their body is covered on the top and sides with uniquely triangular shaped hairs which serve as an antireflection layer that enhances the ants' ability to offload excess heat by thermal radiation which is emitted from the hot body of the ants to the air.

These ants have long legs to keep their bodies away from the sand. While running at high speed they use only

four of their six legs, raising their front pair of legs.

This ant is the fastest of all well-known ant species. It covers 108 times its own body length per second. This is quicker than an Olympic 100 m runner.

They are active outside their nest for about ten minutes/day due to pressure of predation and temperature. They come outside in midday when the temperature is around 47°C. The whole colony of ants leaves the nest in search of food and have to complete their work before the temperature reaches 53°C.

The navigational capabilities of these ants have been the subject of numerous scientific investigations. The

suggestion that the ants use polarized light as a guide, is contradicted by the observation that they are able to assess how far they have walked even in the dark. Another experiment concluded that the ants measure the distance travelled by sensory ability called proprioception that counted the number of steps taken.

The study was published in the *Journal of Experimental Biology* (October 2019).

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