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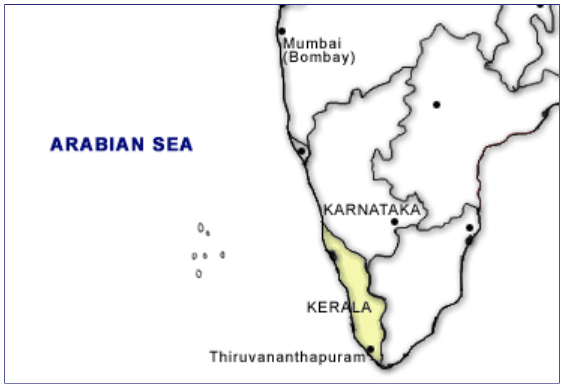
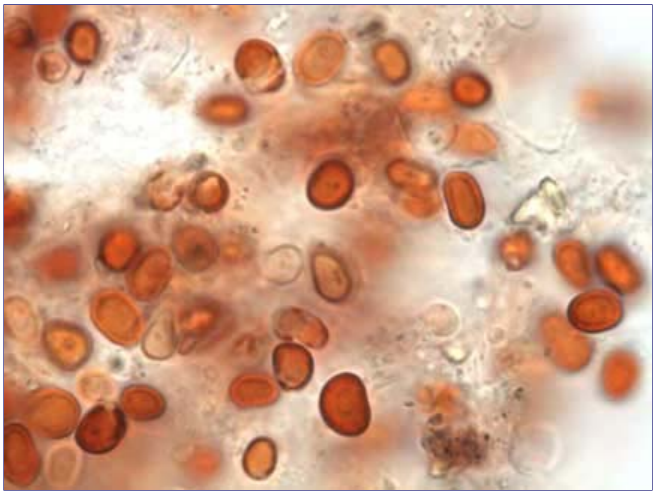
Fluorescence Mystery in Red Rain Cells of Kerala, India

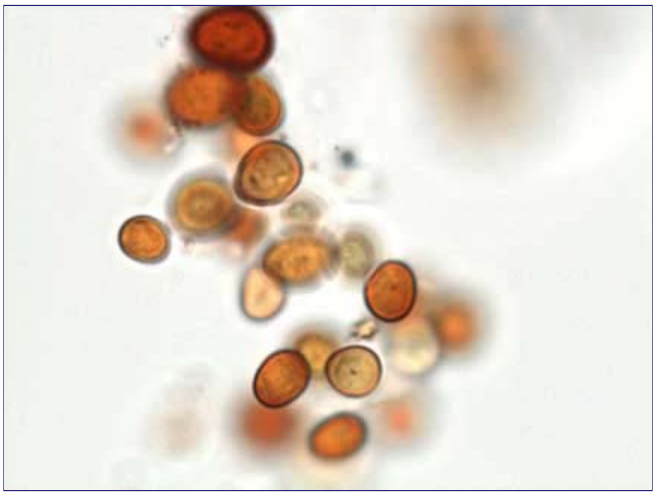
" ...Organisms replicating at 300 degrees Celsius and showing this kind of autofluorescence are currently unknown to exist on earth, which is again an indication supporting the view that these cells are possibly extraterrestrial."
- Godfrey Louis, Ph.D., Physics, Cochin University, Kerala, India



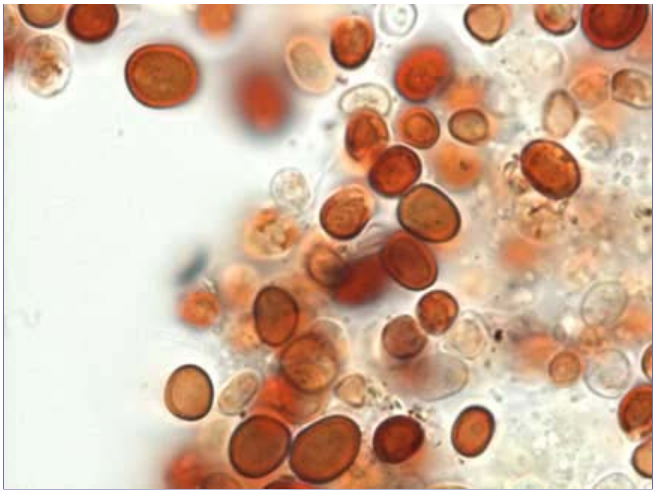
South of Bombay, the state of Kerala, India, is in the southwestern tip of the country bordered on the west by the Arabian Sea. Its capital is Thiruvananthapuram. Map © by **mapsofindia.com.**



2001 summer, red and white cells collected from red rain that fell for first time on the state of Kerala, India. Photomicrograph © 2007 by Godfrey Louis, Ph.D.



2006 summer, red and white cells collected from red rain that fell for a second time on the state of Kerala, India. Photomicrograph © 2007 by Godfrey Louis, Ph.D.



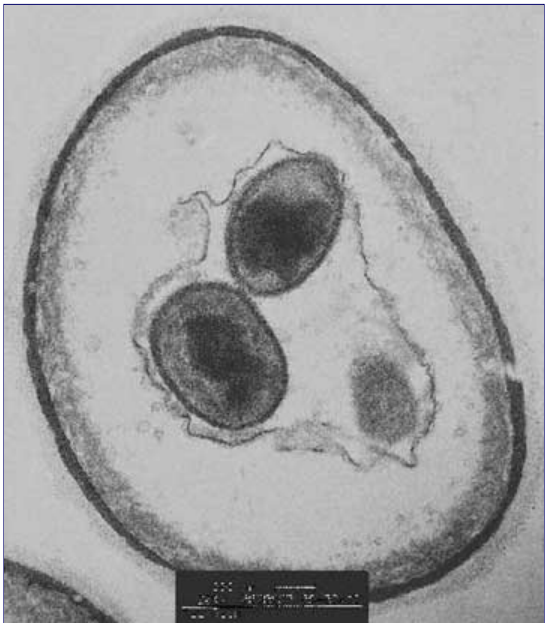
August 2007, red and white cells collected from red rain that fell for a third time on the state of Kerala, India. Photomicrograph © 2007 by Godfrey Louis, Ph.D.

February 14, 2009 Kerala, India - Three years ago in the April 4, 2006, journal *Astrophysics and Space Science* was a published paper entitled: "The Red Rain Phenomenon of Kerala and Its Possible Extraterrestrial Origin." Kerala is on the Malabar Coast in southwestern India. The astrophysical paper was about an event that occurred in July to September 2001 - and several summers since - when raindrops falling on Kerala stained peoples' clothes. White T-shirts were covered with pinkish-red rain splatters and residents wondered what was happening?

News of the red rain mystery reached Godfrey Louis, Ph.D., then a Professor of Pure and Applied Physics at Mahatma Ghandi University. He collected many test tubes of the red-colored rain water and put some under a microscope. He thought he was looking at biological cells with red walls.

Over several months, Prof. Louis experimented with different temperatures to see if the cells would respond. As the temperature rose, he saw more activity. Eventually he got up to 300 degrees Celsius, which is 572 degrees Fahrenheit. He also increased the pressure to 300 pounds per square centimeter. It is assumed that normal Earth life would die at such a high temperature and pressure. But the red-walled cells in the Kerala rain water seemed to thrive.

Under his microscope, Dr. Louis watched the red cells produce smaller cells internally that were colorless, or whitish. He called the new cells "daughters" of the original "mother" cells. Once he counted as many as fifteen daughter cells inside one of the adult "mother cells." As the daughter cells grew, their cell walls also became red and eventually, the daughter cells erupted through the wall of the mother cell. For Dr. Louis, this was replication, but in normal Earth biology, replication of cell life requires the presence of DNA. He and his colleagues had looked for DNA, but were puzzled when they could not find it.



This photomicrograph (scale bar is 300 nanometers) shows
"a cell with shrunken membrane containing 'daughters' (internal buds).
Two have well-defined cell walls, while the third (paler) structure (lower right)
might be a further daughter in the process of development."
Photomicrograph courtesy Cardiff University.

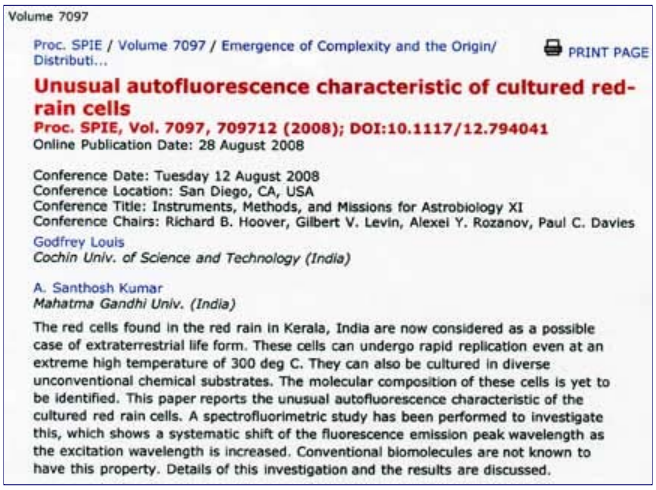
For outside help, Prof. Louis sent samples of the red rain cells to astrobiologist, Chandra Wickramasinghe at Cardiff University in Wales, to biologists at Sheffield University in England and to scientists at Cornell University in the United States for isotopic ratio studies of the elemental composition of the red rain water. Elements confirmed were hydrogen, silicon, oxygen, carbon, and aluminum. But the carbon 12 to carbon 13 isotopic ratio in the red rain cells were not definitively extraterrestrial – further confusing the situation.

I saw the red rain for myself in Prof. Wickramasinghe's Cardiff University laboratory in August 7 to 8, 2006. His graduate student at the time had tried to break open the cells to amplify whatever DNA might be there, but found the cell walls too hard and thick to penetrate adequately. In other lab tests, there was some fluorescence, but the source was inconclusive.

However, the Cardiff work provoked Prof. Louis in Kerala, India, to experiment further with the red rain cells in different combinations of UV light wavelengths and emission filters. The effects on the red rain cells was recorded by a spectrofluorimeter.

On Earth, proteins and biomolecules can fluoresce, but no proteins or biomolecules have yet been confirmed in the red rain cells. And yet, the red rain cells showed unusual fluorescence emission peaks shifting with each change in the excitation wavelength – a shifting not seen in terrestrial biomolecules.

Dr. Louis presented his fluorescence research at the August 12 – 14, 2008, meeting of the Society of Photo-Optical Instrumentation Engineers in San Diego. [See entire PDF under Websites at end of this report.]



Volume 7097

Proc. SPIE / Volume 7097 / Emergence of Complexity and the Origin/ Distributi...

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Unusual autofluorescence characteristic of cultured red-rain cells

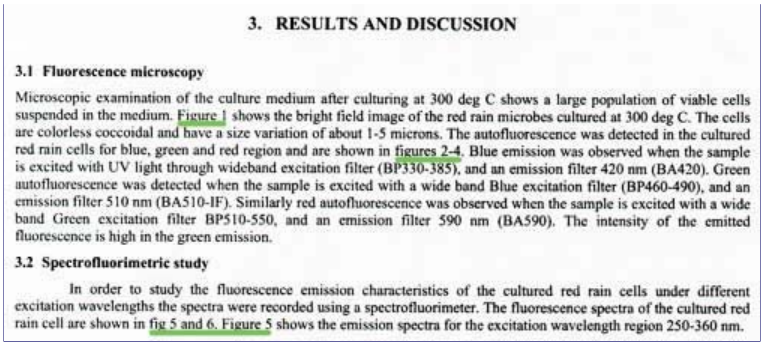
Proc. SPIE, Vol. 7097, 709712 (2008); DOI:10.1117/12.794041
Online Publication Date: 28 August 2008

Conference Date: Tuesday 12 August 2008
Conference Location: San Diego, CA, USA
Conference Title: Instruments, Methods, and Missions for Astrobiology XI
Conference Chairs: Richard B. Hoover, Gilbert V. Levin, Alexei Y. Rozanov, Paul C. Davies

Godfrey Louis
Cochin Univ. of Science and Technology (India)

A. Santhosh Kumar
Mahatma Gandhi Univ. (India)

The red cells found in the red rain in Kerala, India are now considered as a possible case of extraterrestrial life form. These cells can undergo rapid replication even at an extreme high temperature of 300 deg C. They can also be cultured in diverse unconventional chemical substrates. The molecular composition of these cells is yet to be identified. This paper reports the unusual autofluorescence characteristic of the cultured red rain cells. A spectrofluorimetric study has been performed to investigate this, which shows a systematic shift of the fluorescence emission peak wavelength as the excitation wavelength is increased. Conventional biomolecules are not known to have this property. Details of this investigation and the results are discussed.



3. RESULTS AND DISCUSSION

3.1 Fluorescence microscopy

Microscopic examination of the culture medium after culturing at 300 deg C shows a large population of viable cells suspended in the medium. Figure 1 shows the bright field image of the red rain microbes cultured at 300 deg C. The cells are colorless coccoidal and have a size variation of about 1-5 microns. The autofluorescence was detected in the cultured red rain cells for blue, green and red region and are shown in figures 2-4. Blue emission was observed when the sample is excited with UV light through wideband excitation filter (BP330-385), and an emission filter 420 nm (BA420). Green autofluorescence was detected when the sample is excited with a wide band Blue excitation filter (BP460-490), and an emission filter 510 nm (BA510-IF). Similarly red autofluorescence was observed when the sample is excited with a wide band Green excitation filter BP510-550, and an emission filter 590 nm (BA590). The intensity of the emitted fluorescence is high in the green emission.

3.2 Spectrofluorimetric study

In order to study the fluorescence emission characteristics of the cultured red rain cells under different excitation wavelengths the spectra were recorded using a spectrofluorimeter. The fluorescence spectra of the cultured red rain cell are shown in fig 5 and 6. Figure 5 shows the emission spectra for the excitation wavelength region 250-360 nm.

See Figures 1 through 6 below.

Cultured Rain Red Cells Exhibit Autofluorescence In Wide Range of Wavelengths.

Images below show the autofluorescence of the cells cultured at high temperature (300 Degrees Celsius = 572 degrees Fahrenheit).

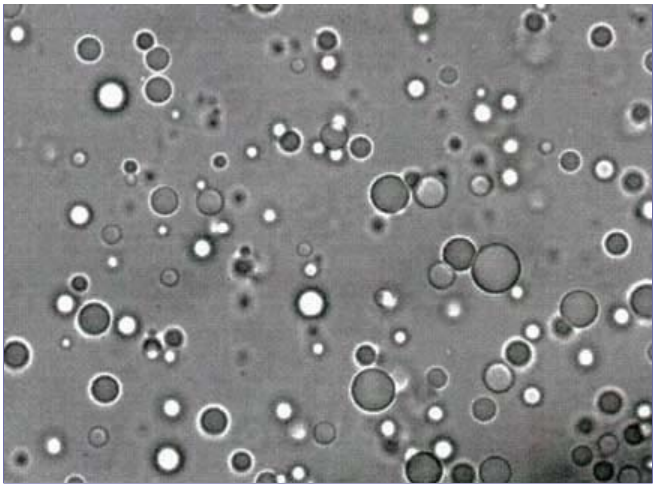


Fig. 1. Photomicrograph of the Kerala red rain cultured cells.
Cells have sizes ranging from approximately 1 to 5 micrometers [1 micrometer = 0.001 millimeters].
Cells were cultured in aqueous medium containing cedar wood oil as nutrient at
300 degrees Celsius, 572 degrees Fahrenheit, in hydrothermal condition. Cells cultured
using glycine as nutrient also have the same appearance.

UV Excitation with Blue Emission

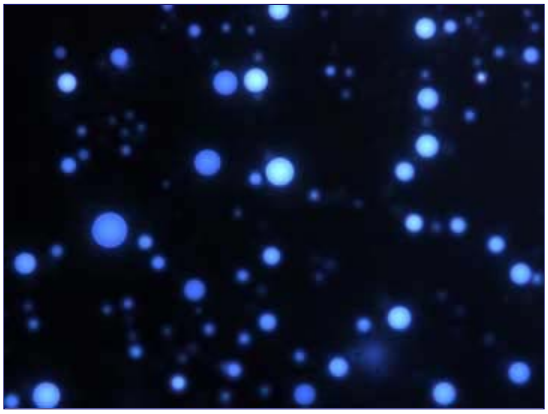


Fig. 2. Fluorescence microscopy image of the Kerala red rain cultured cells under UV light excitation that produced blue fluorescence. Photomicrograph © 2008 by Godfrey Louis, Ph.D.

Blue Excitation with Green Emission

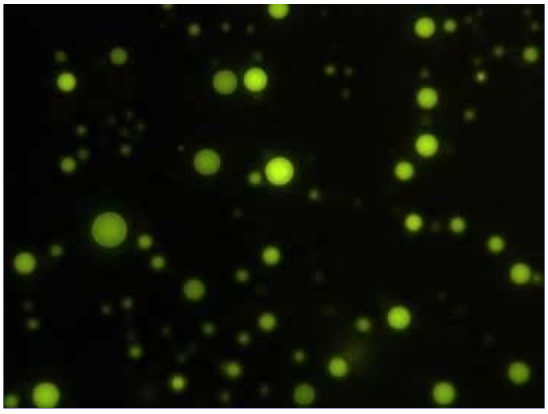


Fig. 3. Fluorescence microscopy image of the Kerala red rain cultured cells under UV light excitation that produced green fluorescence. Photomicrograph © 2008 by Godfrey Louis, Ph.D.

Green Excitation with Red Emission

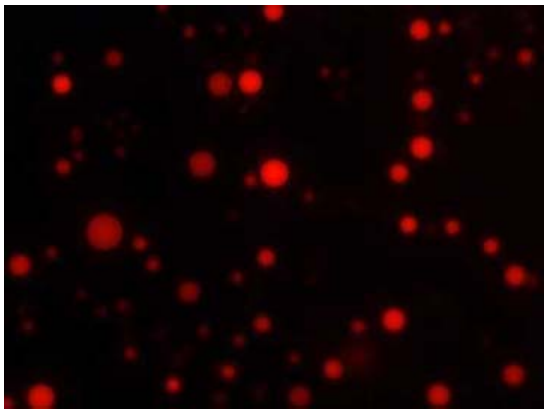


Fig. 4. Fluorescence microscopy image of the Kerala red rain cultured cells under UV light excitation that produced red fluorescence. Photomicrograph © 2008 by Godfrey Louis, Ph.D.

Red Rain Cells Fluorescence Emission Spectrums

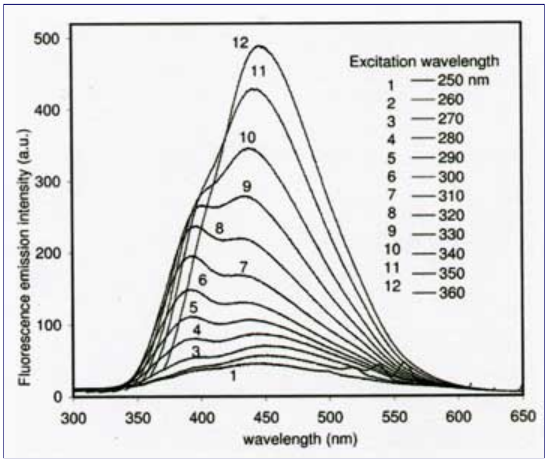


Fig. 5. Fluorescence emission spectrums of an aqueous suspension of the Kerala red rain cells for different excitation wavelengths ranging from 250 to 360 nm. The curves show that in this region of excitation wavelengths, there is no significant systematic shift of the emission peak with excitation wavelength.

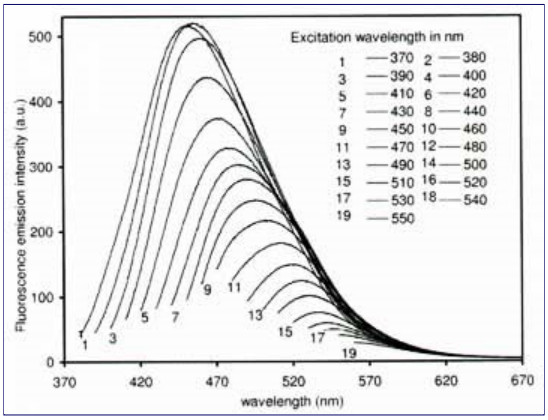


Fig. 6. Fluorescence emission spectrums of an aqueous suspension of the Kerala red rain cells for different excitation wavelengths ranging from 370 to 550 nm. The curves show a systematic shift of the emission peak with excitation wavelength.

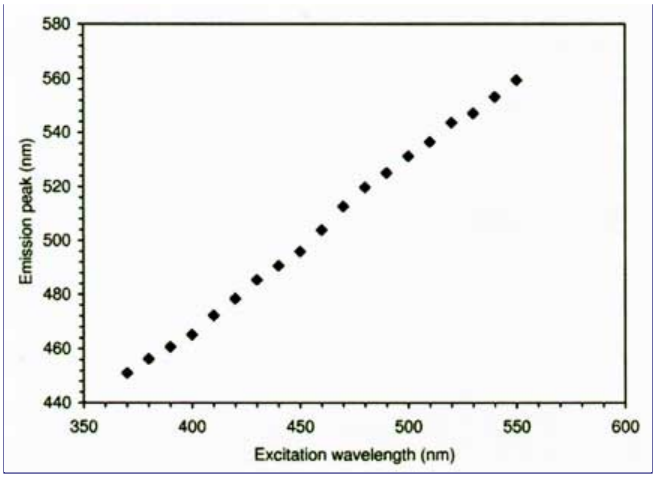


Fig. 11. Excitation wavelength dependent shift of fluorescence emission peak. Figure shows the almost linear shift of the fluorescent emission peak for the cells as the excitation wavelength is changed from 370 to 550 nm. This shift is unusual and apparently violates Kasha's Rule, which requires the emission peak to remain constant.

[Editor's Note: *Wikipedia* - "Kasha's rule is a principle in the chemistry of electronically excited molecules. The rule states that photon emission (fluorescence or phosphorescence) occurs only from the lowest-energy excited electronic state of a molecule. Kasha's rule is relevant in understanding the emission spectrum of an excited molecule. Upon absorbing a photon, a molecule in its electronic ground state can be excited to any of a set of higher electronic states. However, according to Kasha's rule, photon emission is expected only from the lowest excited state."]

In his paper entitled, “Unusual autofluorescence characteristic of cultured red-rain cells,” physicist Godfrey Louis summarized this way: “The observed excitation wavelength dependent emission peak shifting is an unusual result, which is against the Kash's rule. This appears to be a unique property of the red rain cells. Conventional biomolecules or organisms are not known to have this kind of unusual autofluorescence and hence, the presence of new kind of biomolecules can be inferred in the red rain cells. ...Organisms replicating at 300 degrees Celsius and showing this kind of autofluorescence are currently unknown to exist on earth, which is again an indication supporting the view that these cells are possibly extraterrestrial.”

Interview:

Godfrey Louis, Ph.D., holding vial of red rain water.
Photo courtesy Prof. Godfrey Louis.

Godfrey Louis, Ph.D., Professor and Head, Department of Physics, Cochin University of Science and Technology, Kochi, Kerala, India: “This kind of fluorescence is not shown by conventional biomolecules. In this case, you can see the fluorescence in so many different wavelengths. So, there is a possible combination of several biomolecules present in these cells, which are continuously responsible for this kind of behavior. Or the biomolecules have special properties, which we don’t understand why it should behave like this. So it is a very interesting property shown by the red rain cells and it requires more investigation to find out what is the reason for this.

I THINK ONE OF THE MOST IMPORTANT ASPECTS OF YOUR RESEARCH WITH THE RED RAIN CELLS HAS LONG BEEN THE FACT THAT YOU HAVE CULTURED THEM AT SUCH A HIGH TEMPERATURE OF 300 DEGREES CELSIUS. WHEN YOU CONVERT THAT TO FAHRENHEIT IS 572 DEGREES F. EARTH LIFE, AS WE KNOW IT, WOULD DIE AT 300 DEGREES CELSIUS. WHY DO YOU THINK THAT THESE RED RAIN CELLS CAN GROW AND REPLICATE AT SUCH A HIGH TEMPERATURE?

Ah, that’s a very interesting question because according to our hypothesis (of extraterrestrial origin), this is growing inside a comet possibly. So, if it is coming from such a body, we think this (red rain cells) has grown inside the comet. If you take a comet of size diameter 10 (6 miles) to 50 kilometers (31 miles) then inside the comet, even if it is an icy body, inside the comet there can be higher temperature due to radioactive heating or biological heating. So, inside such a comet, higher temperature and pressure can exist. That could be a natural habitat of these red rain cell organisms.

AT THIS POINT IN FEBRUARY 2009, ARE YOU CONVINCED, DR. LOUIS, THAT THE RED RAIN CELLS ARE EXTRATERRESTRIALS, PERHAPS FROM A COMET?

Yes, I am personally convinced about this. These red rain cells have not been identified by anybody. That is one point that is important.

Another thing is the peculiar manner in which this has happened in Kerala, these red rains in different parts of Kerala.

Then the extraordinary properties of the cells. They are able to be grown at high temperature, so these are properties not exhibited by any known organism on Earth. It has to be an extraterrestrial organism.

AND THE FLUORESCENCE THAT YOU’VE REPORTED ABOUT IN AUGUST 2008, HOW UNUSUAL IS THE FLUORESCENCE IN THE RED RAIN CELLS COMPARED TO

PROTEINS AND OTHER SUBSTANCES ON EARTH?

Yes, proteins and other substances do not have this shifting of peak behavior. If normal Earth proteins and substances are fluorescing at a particular green color, then they go on fluorescing at that color. They don't fluoresce and then emit red light.

This particular material (red rain cells) is fluorescing like this (shifting peak behavior). To the best of our knowledge, I don't think there is an (Earth) organism, which is doing this. That has not been seen. The conventional organisms are not showing this kind of fluorescence.

WHAT DO YOU SAY TO YOUR CRITICS WHO SAY THAT THE RED RAIN CELLS ARE NOTHING MORE THAN RED YEAST CELLS?

If it is yeast cells, then how do they grow at such high temperatures? These red rain cells can withstand quite extreme conditions. We have put them in liquid nitrogen, as we have heated them and the cells are quite stable after these treatments. So, the cells are capable of withstanding high temperature and low temperature. There is no problem for them and possibly the cells can withstand the UV radiation and might have developed for this, possibly.

IN YOUR LAB, WHAT IS THE LOWEST TEMPERATURE THAT YOU HAVE EXPOSED THE CELLS TO?

We have exposed them to the liquid nitrogen temperature that is something like 77 Kelvin.

DO YOU KNOW WHAT THAT IS IN MINUS CELSIUS?

That would be around minus 200 degrees C., I think.

SO, IN YOUR OWN LAB, YOU HAVE SUBJECTED THE RED RAIN CELLS FROM MINUS 200 DEGREES CELSIUS ALL THE WAY UP TO 300 DEGREES PLUS CELSIUS?

Yes, 300 degrees Celsius is the culturing temperature (for the red rain cells), and after the minus temperature, we have examined the cells under the microscope and they are not damaged after that exposure.

WHAT YOU ARE SAYING IS THAT YOUR LAB EXPERIMENTATION WITH THE HUGE RANGE OF TEMPERATURE FROM EXTREME COLD TO EXTREME HEAT HAS NOT DAMAGED THE RED RAIN CELLS AND SUGGESTS THAT THE CELLS COULD COME IN ON A COMET OR METEORITIC DUST AND BE UP IN THE UPPER STRATOSPHERE, WHICH IS VERY COLD, AND EVENTUALLY WORK THEIR WAY DOWN TO INDIA AND STILL SURVIVE.

Ah, yes!

Why Red Rains in Kerala, India?

THEN IS THE QUESTION: WHY WOULD THESE RED RAIN CELLS SINCE 2001 KEEP RAINING DOWN ON KERALA, INDIA, AND NOT OTHER PARTS OF THE WORLD?

Cochin, Kerala, India is Latitude: 09° 59' 49 N; Longitude 076° 02' 30 E.

[Editor's Note: Dr. Louis reports that the state of Kerala has had confirmed red rains in 2001, 2006, 2007, 2008, and there might have been other unreported red rains in July to August 2002 to 2005.

On July 29, 2003, in Nghe An, Vietnam (Latitude: 16° 28' 0 N, Longitude: 107° 35' 60 E), a red rain lasted 30 minutes. One local media report said, "Scientists in

Vietnam are baffled why red coloured rain fell from the skies last week over the central province of Nghe An. Water samples have been sent to laboratories in the provincial capital Vinh for further analysis, with results expected within a week." There was no reported follow up on the lab results.

On July 31, 2008 an incident of red colored rain occurred in the municipality of Bagadó, Chocó, Colombia (Latitude: 5° 28' 0" North, Longitude: 76° 9' 0" West). It has been reported that an individual took a sample of the rain to a laboratory and subsequently it was reported to be “blood.”]

Godfrey Louis, Ph.D.: “That question is very important because if you take this particular latitude of Kerala, you can see there are oceans on both sides of that southern tip of India. If something is falling in the sea, nobody is going to notice. And the place where the red cells have fallen in the state of Kerala, it is important to know that people there have reported the event to the press. In Kerala, the population is more and you have so many houses nearby and many people are having connections with the news reporters, so there is a high level of reporting here. But, if the cells are falling in the seas or in the same latitude in Africa, I don’t think those are going to be reported to the press.

Another question are other recent red rains reported in Vietnam in 2003 and Colombia in 2008, near the same latitude region north of the equator.

Still No DNA Confirmed in Kerala Red Rain Cells

WHAT WAS THE REACTION OF THE CONFERENCE THAT YOU ATTENDED IN AUGUST 2008 IN SAN DIEGO OF THE OPTICAL ENGINEERS – WHAT WAS THEIR REACTION TO YOUR PRESENTATION ABOUT THE FLUORESCENCE OF THE RED RAIN CELLS?

Oh, many people were interested and many have collected papers from me and are waiting for more results from me to come out.

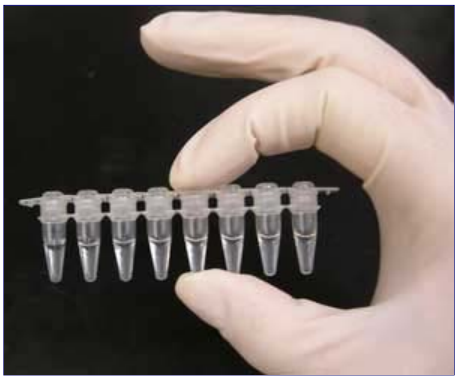
MORE RESULTS?

Yes, we have to do models on this and that is going on now. Also some time back, I gave a sample to Norway, one microbiologist. He also looked for DNA and could not get it. So, we need people who are really interested to pursue this.

MOST SCIENTISTS AGREE THAT LIFE AS WE KNOW IT CANNOT EXIST WITHOUT DNA AS THE STOREHOUSE OF GENETIC CODE; RNA AS THE GENETIC MESSENGER; AND PROTEINS TO CARRY OUT THE CHEMISTRY OF REPRODUCTION. SO, DO I UNDERSTAND CORRECTLY TO DATE THAT NO ONE HAS DISCOVERED ANY DNA IN THE RED RAIN CELLS OF KERALA?

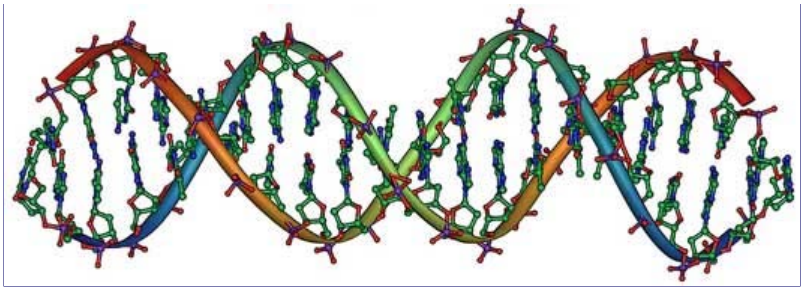
Yes. No one has given any clear indication of DNA. And then in Cardiff University, they did some PCR analysis and they also could not get the DNA. So, the question about DNA is still open and anybody willing to look at it can look at it and it has not been proved that there is DNA in the red rain cells.

[Editor’s Note: *Wikipedia* – “The polymerase chain reaction (PCR) is a technique widely used in molecular biology. It derives its name from one of its key components, a DNA polymerase used to amplify a piece of DNA by in vitro enzymatic replication. As PCR progresses, the DNA generated is used as a template for replication. This sets in motion a chain reaction in which the DNA template is exponentially amplified. With PCR it is possible to amplify a single or few copies of a piece of DNA across several orders of magnitude, generating millions or more copies of the DNA piece. PCR can be extensively modified to perform a wide array of genetic manipulations.



PCR tubes for polymerase chain reaction analysis.

Developed in 1984 by Kary Mullis, PCR is now a common and often indispensable technique used in medical and biological research labs for a variety of applications. These include DNA cloning for sequencing, DNA-based phylogeny, or functional analysis of genes; the diagnosis of hereditary diseases; the identification of genetic fingerprints (used in forensic sciences and paternity testing); and the detection and diagnosis of infectious diseases. In 1993 Mullis was awarded the Nobel Prize in Chemistry for his work on PCR.



The structure of part of a DNA double helix.

Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints or a recipe, or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information."]

IN TERMS OF EARTH SCIENCE, DOES IT SEEM IMPOSSIBLE THAT DNA, AS WE KNOW DNA IN LIFE ON EARTH, COULD SURVIVE EXPOSURE TO 300 DEGREES CELSIUS FOR ANY LENGTH OF TIME?

That is also the reason that I'm thinking there is no DNA because the red rain cells are surviving and growing at 300 degrees Centigrade/Celsius – there is some kind of other biomolecule involved, possibly. So, DNA might not be the mechanism that is operating in the red rain cells. If so, our whole biological idea we will have to change if you accept the no-DNA results. And that gives me more difficulty to publish about the red rain cells - the lack of DNA. That deviates from our current understanding of biology. So, this is a difficulty.

Could Unusual Fluorescence Be from Extraterrestrial Biomolecules?

IS THE IMPORTANCE OF YOUR FLUORESCENCE WORK REPORTED IN AUGUST 2008, THAT IF THERE ARE EXTRAORDINARY EXTRATERRESTRIAL BIOMOLECULES IN THE RED RAIN CELLS OF KERALA, THOSE STRANGE, OR NEW, OR EXTRATERRESTRIAL BIOMOLECULES MIGHT BE FLUORESCES SO STRANGELY?

Yes, that is what I am also saying – this organism might be containing an unknown type of biomolecules, which need to be investigated and which need to be identified. So, we have to extract these biomolecules and identify them. All organisms and all known biological material on Earth have DNA. And the life currently known to us all has DNA. There is no organism that

is known that is without DNA.

SO, IF THE RED RAIN CELLS OF KERALA DO NOT HAVE DNA, THEY REALLY ARE A VERY UNUSUAL SUBSTANCE THAT HAS THE ABILITY TO DIVIDE ITSELF THROUGH THE DAUGHTER CELLS AT 300 DEGREES CELSIUS.

Yes. That is very unusual and without DNA, that would change our concept of biology. An organism without DNA means that we would get more understanding about life.

DR. LOUIS, YOU ARE PERSONALLY CONVINCED THAT THE RED RAIN CELLS OF KERALA, INDIA, ARE EXTRATERRESTRIAL?

Yes, I am convinced of that because I have done so many experiments on the cells. I don't find any terrestrial explanation for this. I have tried to hard and I don't find any source that can explain this kind of phenomenon. So, I am personally convinced about it.

WHAT DO YOU THINK IT WOULD TAKE TO CONVINCE THE GLOBAL SCIENTIFIC COMMUNITY THAT WHAT YOU HAVE IN THE RED RAIN CELLS ARE EXTRATERRESTRIAL?

When more papers are published, the scientific world will no longer be able to resist the facts and they will have to take the red rain cell phenomenon seriously. Scientists have to do some analysis to identify the biomolecules. If they find that biomolecules are not present, than that will be a result.

IF THE CARDIFF RESEARCHERS DO NOT FIND DNA ON THE NEXT ROUND OF RESEARCH, IS THE NEXT BIG NEWS FROM YOU THAT THIS SEEMS TO BE ANOTHER PIECE OF EVIDENCE THAT THE RED RAIN CELLS OF KERALA ARE NOT FROM EARTH?

Yes, that the DNA – we have not been able to detect. Then that will be big news because it is a big question. Life without DNA is a very big question. So, that question might not be settled by just one paper.

HOW OLD ARE YOU NOW?

I am 53.

DO YOU EXPECT IN YOUR LIFETIME THAT THE RED RAIN CELLS OF KERALA WILL DEFINITIVELY BE DECIDED BY SCIENCE AS EITHER TERRESTRIAL OR EXTRATERRESTRIAL?

That is left to the scientific community and I think in a few years, it will happen.

ARE THE RED RAIN CELLS OF KERALA THE MOST FASCINATING THING THAT YOU HAVE STUDIED IN YOUR CAREER?

Exactly, because I am a solid state physicist and I have been teaching electronics and solid state physics that have no connection with biology. But I had to jump into this problem because this problem was not investigated well in Kerala. I found in studying the problem that it has great significance. And if the research is not done by me, the world is not going to know about it and it will be discarded as some pollution or something like that. So nobody is going to investigate it.

But now it has become a question that requires an answer. I'm putting this question to the entire scientific world: find an answer for this."

Beyond Prof. Louis's fluorescence research, he still seeks answers to the questions:
1) Do the Kerala red rain cells have DNA?
2) If DNA, are the red rain cells an unidentified form of yeast or lichen cells from Earth?

If the answer is "no" to the above questions, the red rain cells don't fit the panspermia hypothesis in which all life in the universe has been seeded from the same DNA. If the red rain cells do not have DNA and still replicate at 300 degrees Celsius, the red rain cells are outside the normal definition of Earth life. If the red rain cells came to Earth in ice from a comet that perhaps made the one sonic boom heard by Kerala residents in July 2001, where did the comet get the red cells?

Godfrey Louis, Ph.D.: "On first impression one may think that a microbe without DNA violates the Panspermia theory. But this need not be true. Panspermia can still be correct provided we have a much broader understanding of life. These hyperthermophilic red rain microbes can kick start life in a hot young planet. As the planet cools , there can be an evolutionary process connecting the currently known life and the red rain type life. So the red

rain type life is possibly connected with our type of life in a more fundamental way. This connection need not be in terms of DNA code. Currently there exists a great lack of understanding on how life originated in the Universe. Conversion of chemicals to Life may be having a much more longer history and steps than we presently imagine. I hope that detailed studies on the red rain microbes in future can bring in more understanding on the origin, evolution and distribution of life in the Universe."

More Information:

For further information about the red rain cells of Kerala, India, please see reports below in the **Earthfiles Archive**:

- **10/25/2007 — Red Rain Cells of Kerala, India: Physicist Says Still No DNA, But Replication At 300 Degrees Celsius (572 F.)**
- **08/19/2006 — Red Rain Cells of Kerala, India - Still No Definite DNA**
- **06/15/2006 — "Extraterrestrial Life" in Red Rain of Kerala, India?**

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2) Louis, G. and Kumar, A. S., "Cometary panspermia explains the red rain of Kerala" (2003) arXiv:astro-ph/0310120, arXiv.org e-Print archive http://arxiv.org/abs/astro-ph/0310120.

3) Louis, G. and Kumar, A. S., "New biology of red rain extremophiles prove cometary panspermia" (2003), arXiv:astro-ph/0310120, arXiv.org e-Print archive http://arxiv.org/abs/astro-ph/0312639.

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Godfrey Louis et al SPIE Paper, August 12, 2008: **PDF electronic reprint.**

Cardiff Univ. Centre for Astrobiology: **http://www.astrobiology.cf.ac.uk/chandra1.html**

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