

# Downside of panning for gold

THE GOVERNMENT OF PERU HAS DECLARED A 60-DAY EMERGENCY PERIOD TO DEAL WITH MERCURY POLLUTION, WRITES  
**S ANANTHANARAYANAN**

The crisis has arisen as a result of unregulated mining along the Madre de Dios river that flows through Peru in South America. This river is a major part of the Amazon watershed and the sand in its bed is rich in gold deposits. While limited panning for gold has been traditional, the rise in the metal's global prices in recent years, and also the recession, has created a boom in the activity.

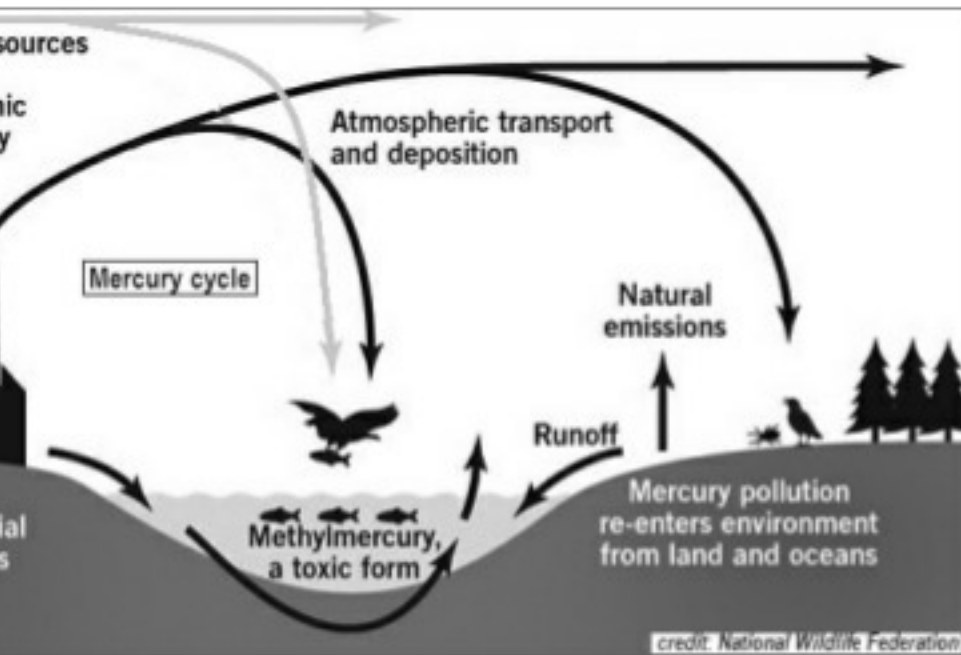
The process used is to pan the river so that the heavier, gold-bearing sand particles separate. Gold is then extracted using mercury, which readily forms an alloy, called an *amalgam*, with gold. The gold is recovered from the amalgam by heating, which vaporises the mercury and leaves metallic gold. In properly organised processing with mercury, the vapours are captured and condensed to partly recover the mercury. In unregulated, smallscale operations, however, the mercury just escapes into the surrounding air. There are now safer methods to extract gold, but mercury is still the way out for the illegal gold mining that has arisen in Peru.

Metallic mercury, which is a liquid at usual temperatures, is a heavy (it is denser than lead), silvery liquid that flows easily and does not wet

## The genes involved

How methyl mercury, the organic form of mercury, arises from natural processes in the environment was a mystery for decades. Scientists at the Oak Ridge National Laboratory have now discovered the genetic basis for the process. The cluster of two genes that have been identified is found in all bacteria that have the capacity to form the compound. The capacity disappears if the genes are removed and reappears when they are restored.

"This newly gained knowledge will allow scientists to study proteins responsible for the conversion process and learn what controls the activity," said Liyuan Liang, co-author of the paper in the journal *Science*, where the discovery was reported, in February 2013. The



glass, but forms droplets, like an oil. It is a fairly good conductor of electricity and this has made it useful in creating good electrical contacts. And

as it expands when heated, can flow through a narrow tube and is shiny and visible, it finds application in thermometers. Mercury is also used in fluorescent lamps and in CFL bulbs. But like most heavy metals, mercury compounds are poisonous if ingested. The metal itself is inert and does not directly cause serious harm,

but it needs to be carefully removed if it is spilled, as it can be absorbed by the skin or as vapour. In the form of soluble salts, and more so as organic compounds, it leads to severe disease, particularly brain or liver damage.

Mercury gets released into the environment naturally by volcanic action and also by manmade mechanisms. The manmade sources are mainly burning of coal, gold mining using mercury amalgam, the manufacture of cement, iron and steel and chemicals, incineration of garbage and by careless disposal of waste in the manufacture of batteries, thermometers, etc.

While mercury in the atmosphere is inhaled by people or animals or taken up by plants, the most serious damage is caused when mercury enters waterways, where certain bacteria convert metallic mercury into an organic and highly toxic form — *methyl mercury*. Bacteria are perhaps the only living organisms that can take metals and convert them from insoluble to soluble forms or other chemical forms. Certain bacteria, for instance, can turn the insoluble iron content of water into a soluble form when oxygen is scarce, and back to insoluble sludge when the water emerges into the air. While this is a case of salts of mercury being changed from one form to another, the change to an organic form enables mercury to be taken up by plants and fish. And where fish is an important part of human diet, as along the Madre de Dios river, this forms a channel by which human mercury accumulates and levels steadily build up.

It has been estimated that 40-50 tonnes of mercury are used every year in gold mining, much of which ends up in the waterways of the Madre de Dios region, which bacteria convert to methyl mercury. A team from the University of North Carolina at Durham has tested nearly 3,000 people in the region and found that levels of mercury in hair samples of 40 per cent of them were above the maximum prescribed by the World Health Organisation. Studies have also shown high mercury levels in larger fish that prey on smaller fish and a close correlation



Heating the amalgam releases mercury into the environment.

between high mercury exposure and fish consumption has been proved.

The Peru government has used the Duke University study to decide which of the riverside communities has priority for emergency aid. The relief includes supply of food, which has canned ocean fish, to replace their usual high-risk diet and also multi-vitamins to combat anemia. The aid is to roughly 15,000 of the 48,000 people affected. The emergency declared is for 60 days only because the government is due to change. Relief action, however, is sure to continue under the new administration.

Closer home, Kodaikanal, a hill station in Tamil Nadu, is dealing with a case of severe mercury poisoning of the environment since 1982. This was the year a thermometer factory owned by cosmetics maker Chesebrough-Ponds and later acquired by Hindustan Lever Ltd was moved to India following objections in the USA to the pollution that the plant caused. When factory workers complained of kidney disease and there was an accidental discovery of mercury in samples of plants purchased by a laboratory in Hyderabad, it came to light that mercury levels were elevated in Kodaikanal.

A further probe revealed the disposal of thermometer production waste in the nearby forest and the factory finally admitted to having been responsible. It was then shut down and remediation of the area is continuing, with the mercury level in the air, even after the closure of the factory, being found to be 1.32 micrograms per cubic metre — about 1,000 times higher than what is found in uncontaminated areas.

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## PLUS POINTS



### Joint action needed

A study, published recently in *Proceedings of the Royal Society B*, found that awareness of the geographic origin of major food crops is shrinking, threatening conservation and breeding efforts. Governments should spend more money and effort on joint research and conservation to protect both original crop species and their wild relatives, says lead author Colin Khoury, a researcher at the International Center for Tropical Agriculture in Colombia. "We all need each other because there is no country that uses only native crop plants," Khoury explains, "China, as the world's biggest producer of peanut, should, for example, be interested in conservation in Brazil, where peanut crops originally come from."

Nearly 70 per cent of the world's crops are grown outside their country of origin say the international team of biologists behind the study. So-called foreign crop use is particularly high on island nations, which can rely almost exclusively on introduced crops. The countries with the highest use of local crops are Bangladesh, Cambodia and Niger, where only around a fifth of the calories people eat, come from crops that originated elsewhere.

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### All around us

For an exhibit currently on display at Wood Street Galleries in Pittsburgh, Pennsylvania, USA, Matthijs Munnik's instructions are a bit unconventional — they include a protocol for maintaining



mutant *C. elegans* nematodes in petri dishes. Jennifer Angus's include a request to preserve stray antennae, wings, and other specimens. And Ivana Adame-Makac's include how to replenish meticulously arranged ornamental and edible plant matter as it is consumed by house crickets.

*All Around Us*, curated by Ali Momeni, urges viewers to appreciate animals we're largely conditioned to disregard or worse — detest, fear, swat or kill. With projected video, glass sculpture, and dioramas, Momeni and the other exhibiting artists remind us that insects and arachnids outnumber humans by orders of magnitude and that their ecological significance cannot be ignored. Evolutionary biologist Nathan Morehouse and colleagues at the University of Pittsburgh contributed a high-resolution video of a male *Habronattus pyrithrix* spider performing a courtship dance for a female. In a live demonstration this spring, this arachnid behavior was filmed atop a podium-mounted stage. Momeni said, "The other really cool thing that has happened with these pieces is that the gallery attendants and museum staff are starting to build relationships with the organisms."

TRACY VENCE/THE SCIENTIST

### Accessible information

Reproducibility problems plague scientific literature — several recent analyses have suggested that large swaths of published work in some fields are irreproducible. Some pundits are calling for a complete overhaul of the scientific publishing process to make researchers more accountable for their methodologies and publications.

One project, supported in part by a US \$5 million, five-year grant from the National Science Foundation, aims to



take a step in that direction. Dubbed *Whole Tale*, the effort seeks to establish electronic infrastructure that researchers can use to access, test, and republish data. "It's almost expected nowadays that when you publish a paper, you link the paper to data," said project co-organiser Matthew Turk, a research scientist at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign, USA. *Whole Tale* will create tools for researchers to link code and raw data to papers they publish online. All of that information will then be accessible to peer reviewers whether they are conducting pre or post-publication reviews, according to the NCSA.

THE SCIENTIST

# ARRESTING INFECTION

THE SMALL POX VIRUS ORIGINATED IN ANCIENT EGYPT BUT SUCCESSFUL VACCINATIONS ERADICATED IT COMPLETELY FROM THE WORLD IN 1978, WRITES  
**TAPAN KUMAR MAITRA**

There was smallpox in ancient Egypt because historians found traces of the disease on the skin of a mummy. In China and India, people have suffered because of it from time immemorial. From the works of ancient Chinese physicians, it is evident that the infection spread to Arabia as well and, in the sixth century, made its presence felt in France and Italy. The infectious character of smallpox was ascertained in the ninth century by Arabian physician Rhazes (850-923) and by Avicenna, the eminent physician and philosopher of Central Asia. The disease swept throughout large areas, becoming endemic during the Crusades. In 1507, it was introduced into America by the Spanish and more than 60 million people died from the infection in the 18th century.

In 1892, G Guarnieri discovered the presence of intracellular bodies in histological sections of the cornea of a rabbit inoculated with the smallpox virus. Those included bodies that measured four to 10 mm in size and were spherical or falciform. In 1906, E Paschen found viral particles measuring 125 to 180 nm in the smallpox vesicles. In the electron micrographs, they are seen in the form of cubes (bricks) with smoothed-out edges and are 260-180-150 nm in size. The smallpox virus consists of a nucleoid 140 x 230 nm in size and is enclosed in a three-layer membrane. There are two lateral bodies, resembling lenses and



measuring 30-40-100 nm, under the membrane on the opposite ends of the virion.

The source of infection in a patient takes place by the air-droplet route and through contact with infective material. The causative agent is spread by dust particles and certain objects (clothes, bedclothes, and dishes) and also when the patient talks, coughs, or sneezes. The virion penetrates the cell by pinocytosis. First the enzymes of the host cells destroy the outer membranes of the virion. The resulting products induce the activity of the gene responsible for the synthesis of the enzyme with the help of

which the remaining nucleoid proteins of the smallpox virus are destroyed and nucleic acid (DNA) is liberated.

This acid determines the formation of virions. The pathogenesis of smallpox has not been studied sufficiently. It is known that a virus which possesses extremely manifested dermatotropic properties is present in the blood at the time of the disease. It also affects the mucous membranes and other tissues and organs. Virusæmia is frequently accompanied with bacteraemia caused by streptococci and staphylococci. Smallpox is characterised by fever; the appearance of a rash and development of pustules and scars on the skin. After the prodromal period and a fall in temperature, the true rash makes its appearance on the face, trunk and extremities. Initially the rash is papular but later it becomes vesicular and pustular. The smallpox vesicles are multilocular and their translucent content gives them an appearance of a pearl, which has a mother-of-pearl hue and is surrounded by a narrow red areola.

Smallpox leaves a lasting immunity and reinfections are extremely rare. Agglutinins, precipitins, lysins, and complement-fixing and virus-neutralising antibodies are found to be present in the blood of individuals who have suffered from the disease and in those who have been vaccinated. At the present time, a specific gamma-globulin, together with symptomatic and pathogenic drugs, is used for treating patients. In India, good results have been obtained with a derivative of methylisatin-tiosemicarbazone-marboran, which significantly reduced mortality among contacts. Secondary infection is treated with antibiotics (penicillin, chloramphenicol, streptomycin); oxychlorotetracycline renders a good effect. General measures include timely diagnosis, hospitalisation of smallpox patients, and disinfection of the focus.

Inoculation against smallpox was known in the East many years before Christ. From time immemorial, inoculations were performed in India, Iran and Georgia by means of variolation (inoculation with infective material derived from smallpox patients). This method was introduced in European countries in the 18th century. However, variolation was frequently accompanied by infection with other diseases.

The smallpox vaccine contains the natural virus of cowpox, which possesses antigenic properties common to the smallpox virus, and is capable of producing a lasting immunity with no manifested general disease. The smallpox vaccine is prepared by artificial epicutaneous infection of calves. Only a dry smallpox vaccine is produced today, which can be stored for 12 months. The vaccine is applied epicutaneously.

In 1976 individual cases of the disease were registered only in Ethiopia, whereas in 1978, smallpox was completely eradicated across the world.

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# More research called for

CHIRAYU MOHINDROO AND PARUL ICHHPUJANI DWELL ON THE BLOOD PRESSURE-GLAUCOMA CONUNDRUM

Glaucoma comprises a group of disorders caused by increased eye pressure (intraocular pressure) and damage to the optic nerve that ultimately leads to irreversible blindness. Traditionally, cause has been attributed to higher eye pressure, advancing age, a family history of glaucoma and some specific races (African-Americans, Hispanics). The increase in eye pressure is probably the only factor an ophthalmologist would treat so it comes as no surprise that research on this factor alone has been so extensive and current treatment modalities for both medical and surgical therapy aim at lowering eye pressure.

Not anymore! Of late, blood pressure is being considered another modifiable risk



factor and the association is not what you may think. Usually, high blood pressure is known for its notoriety to spawn a wide spectrum of diseases; however, disease progression for glaucoma is associated with low blood pressure rather than high. Ocular perfusion pressure is the term used by ophthalmologists when accounting for blood pressure in relation to the eye and denotes the pressure at which blood flow is delivered to the eye. If, in a glaucomatous eye, ocular perfusion pressure is low as well then the blood has a hard time getting inside the eye, leading to a lowered supply of oxygen and important nutrients, and delayed removal of waste products. That is not all — patients on anti-hypertensive medication or hypotensive individuals are also at significant risk for decreased ocular perfusion pressure.

Usually the compensatory mechanism of the circulatory system in the body adapts to low blood pressure, especially for the vital organs like the brain or the eyes. But for some people this might not be true, which could lead to some serious damage to the eye. Several large studies provide overwhelming evidence that low ocular perfusion pressure is an important risk factor for glaucoma. Considering this ailment is the second leading cause of irreversible blindness in the world and almost 90 per cent of the cases go undetected, there is an urgent need for educating the general public about this disease and its associated risks.

So, what must be done? Decreased ocular perfusion pressure can be corrected by either decreasing eye pressure or increasing systemic blood pressure. While there is enough research available on the former, the latter remains an enigma. Moreover, increasing blood pressure could have detrimental effects on other vital organs. Calculating ocular perfusion pressure could be of some help in patients who do not respond to standard anti-glaucoma therapies, which aim at lowering eye pressure. If a patient is on maximum ocular medication but is still progressing, and on blood pressure medication, it is reasonable to ask the cardiologist or primary care physician to reduce the dose or change the timing of anti-hypertensive medication. Since blood pressure dips at night when intra ocular pressure rises, it would be better to avoid using beta blockers, which also lower blood pressure. Fluid volume at bedtime is another way to help keep blood pressure from bottoming out during sleep. A glass of fresh lime with a little salt may help.

The statistics are shocking. There are at least 12 million people in India affected with glaucoma, 1.5 million of whom are blind from the disease. The design for glaucoma screening needs to include a wider spectrum of factors other than simply eye pressure, owing to the complexity involved. Ocular perfusion pressure actually provides a ray of hope by being another modifiable risk factor. Hopefully, more research will be carried out to tackle this menace.

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