# Pushing antiquity further back

**Evidence proves that Stone Age-type culture thrived in southern Africa as long as 44,000 years ago, says** s ananthanarayanan

THE earliest Stone Age settlements known were not of more than 20,000 years ago, in southern Africa. A group of scientists, including those from the University of Witwatersrand, Johannesburg, has firmly dated evidence of a similar culture that thrived as long as 44,000 years ago. The finding, just reported in the *Proceedings of the National Academy of Sciences*, is a result of an analysis of objects, including well-preserved organic remains, found in archaeological layers in the Border Cave in South Africa.

The Border Cave is a rock shelter in the mountain range that runs across South Africa's border with Swaziland. It was discovered in the 1940s and found to have a well preserved timeline of signs of human activity. A detailed study in the 1970s revealed skeletons of humans and other animals and thousands of articles of varying antiquity. The most notable and earliest of these is a piece of baboon bone that bears 29 notches and may have been used as a calendar, in the manner of other ancient communities in southern Africa. The current study, by an international team, has pushed the antiquity further back. "The dating and analysis of archaeological material discovered at Border Cave in South Africa has allowed us to demonstrate that many elements of material culture that characterise the lifestyle of San hunter-gatherers in southern Africa were part of the culture and technology of the inhabitants of this site 44,000 years ago," says Lucinda Backwell, senior researcher in palaeoanthropology at Witwatersrand University.

**Hunter-gatherers**

The earliest human communities known so far have been the ancestors of the hunter-gatherer people — ancestral population clusters — that still exist in southern Africa. Hunter-gatherer is considered to have been the subsistence mode of humans till 10,000 years ago. The characteristic is the reliance on food from wild plants and free-running animals, as distinct from cultivated plants and domesticated or reared animals. It was with agriculture that a nomadic subsistence lifestyle was replaced with settlement and large populations — and there is evidence that the change, also called the *Neolithic Revolution*, started in different locations some 10,000-8,000 years ago.

Remnants of these ancient people are found to this day in the hunter-gatherer communities in southern Africa. Generally referred to as the *San people*, these communities appear to have remained at Stone Age practices and, particularly, do not practice agriculture. The women gather wild-growing fruit, berries, tubers, bush onions and other plant materials for use as food. Ostrich eggs are gathered and the empty shells serve as water containers. Many species of insects, including grasshoppers, beetles, caterpillars, moths, butterflies and termites, form an important part of their diet, particularly during the dry season when animal meat is difficult to come by. Hunting, in any case, was with poisoned arrows and spears and was laborious and meat was necessarily not a major component of their diet. These indigenous people have proved to be valuable resources for genetic and anthropological research and their lifestyle has been identified with archaeological findings that date from 10,000-20,000 years ago.

Lucinda Backwell

The significance of the Border Cave discoveries is that the place pushes the date of such living practices back to 44,000 years ago. An examination of stone tools that were found in the same archaeological layers as the organic remains, and from older deposits, reveals the path of evolution in stone tool technology. Organic artifacts that are clearly similar to the material culture of the San communities appear relatively abruptly. "This finding supports the view that what we perceive today as 'modern behaviour' is the result of non-linear trajectories that may be better understood when documented at a regional scale," says a press note released by Witwatersrand University.

**Vegetable poisons**

An interesting part of the discoveries is a wooden stick decorated with incisions, used to hold and carry a poison that was used on arrowheads. "They fashioned fine bone points for use as awls and poisoned arrowheads. One point is decorated with a spiral groove filled with red ochre, which closely parallels similar marks that the San make to identify their arrowheads when hunting," says Backwell. The purpose of poison in the arrowheads was for bringing down more hardy animals that were hunted. The arrow itself could break off, but the head would remain and weaken the animal over days or weeks. The hunters would painstakingly follow the prey till it collapsed!

The poison used was found to be derived from *ricinoleic acid*, which is found in castor seeds. Castor seeds contain *ricin*, a poisonous protein. The heat used in extracting castor oil denatures and inactivates the protein and castor oil has many uses and commands a good price. But gathering raw castor seeds, during harvest and before processing, is hazardous. Compounds found on the plant surface can cause permanent nerve damage and farm workers in India, Brazil and China are affected. Pure, extracted *ricin*, the protein, is highly toxic and a small dose can kill an adult human.

This is the poison that was found in the arrowheads discovered in the Border Cave. The castor seed poison, along with poisonous plant resin, was mixed with bees' wax and wrapped in fibres made from the inner bark of a woody plant. Regarding the use of bees' wax, Backwell also notes, "This complex compound used for hafting arrowheads or tools, directly dated to 40,000 years ago, is the oldest known evidence of the use of bees' wax."

Such knowledge of plant-based poisons is in keeping with the tradition among the San people of the use of plant materials for medicinal purposes. In fact, they are one of the first indigenous peoples to receive royalties for the use of some of their traditional knowledge by drug companies. *Hoodia gordonii*, a juicy plant used by the San bushmen to suppress the appetite during long hunting missions, was patented by the South African Council for Scientific and Industrial Research in 1998 for the same appetite-suppressing quality. A licence was granted to a pharmaceutical concern for development of the active ingredient in the *Hoodia* plant, to be used as a drug for dieting. When the patent came to the attention of the San, a benefit-sharing agreement was reached between them and the Council in 2003. The San were represented by a regional organisation formed under San leadership, the Working group of Indigenous Minorities in Southern Africa.

Border Cave in South Africa was occupied by humans for tens of thousands of years.

Tools and beads found at Border Cave date back as far as 44,000 years. Image courtesy of Francesco d'Errico and Lucinda Backwell.

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# The beginning of a new chapter

**The discovery of the Higgs boson calls for a celebration of what the human species has accomplished, writes** saswato r das

THE recent announcement by scientists at Cern, the large European particle accelerator outside Geneva, that they had detected the long-sought Higgs boson particle, is the fulfillment of one of the longest quests in modern physics. It is also a real triumph for Cern – it is its most momentous discovery so far – and justifies the billions of dollars spent on creating a state-of-the-art laboratory. More than anything else, however, the finding of the Higgs boson is a tribute to the power of the human mind, which can conjure up equations that predict exactly how nature behaves.

In this, the detection of the Higgs boson falls right in line behind a long list of physics milestones, from the understanding of the law of gravity by Isaac Newton in the 18th century to the unification of electromagnetism by James Clerk Maxwell in the 19th century to Einstein's explanation of the equivalence of mass and energy (his famous equation $E=mc2$) in the 20th century.

British physicist Peter Knight described the discovery of the Higgs boson as significant to physics as the discovery of DNA structure was to understanding life. Why was finding the Higgs boson so important for physicists? The answer has to do with something they call the Standard Model. Proposed in the 1960s, it is the best theory so far that explains the existence of subatomic particles and unifies strong, weak and electromagnetic forces. (Together with gravity, they are the four fundamental forces of nature. Gravity, however, has resisted unification; it is explained by Einstein's general theory of relativity.) The Standard Model explains everything, from the physics of electricity produced in generators to radioactivity to nuclear fusion that powers the sun.

The moment when Cern director Rolf Heuer confirmed the Higgs results.

In 1964, Peter Higgs and five other lesser known scientists suggested a mechanism that explained how most fundamental particles obtained mass. (There are two fundamental particles that are massless — one is the photon of light and the other an esoteric particle called a gluon.) The subatomic particle that endows other subatomic particles with mass — in other words, the key to all mass in the universe — has come to be known as the Higgs boson (bosons themselves are named after the great Indian physicist Satyendra Nath Bose, whose contributions to physics resulted in Bose-Einstein statistics).

Without mass, atoms would disintegrate; the universe as we know it would not exist. As such, the Higgs boson is central to the Standard Model.

However, the Higgs boson remained elusive. For four decades, it was the only particle predicted by the Standard Model that was not seen. It became an obsession for particle physicists. Some said existing particle accelerators were not powerful enough, and bigger ones needed to be built. (Physicists smash particles to produces whiffs of pure energy, which produce fundamental particles, some extremely short lived, that are then detected.) Other physicists wondered that if the Higgs was not to be found, could it be that the Standard Model was wrong.

The Large Hadron Collider at Cern — the biggest, most complicated and most powerful atom smasher in the world, which can accelerate protons to 99.9999 per cent of the speed of light — was built at a cost of approximately $6 billion, largely to detect the Higgs boson. And it hit pay dirt. After millions of manhours and billions of dollars, physicists had their quarry.

Just as the discovery of DNA by John Watson and Francis Crick made it possible to understand genetics and created the field of molecular biology, the discovery of the Higgs boson will be the beginning of a new chapter in science. Some physicists plan to build on the Standard Model to create a more beautiful theory called Super Symmetry. Others hope that finding the Higgs boson will lead to an explanation for dark matter, the mysterious substance that makes up most of the matter in the universe.

Though it may sound esoteric and arcane, modern physics has also influenced our lives to a great extent. For one, it has led to tremendous leaps in technology. The entire electronics industry — in other words, our cell phones, computers, television sets and so on — could not have been possible without modern physics. Cern even created the World Wide Web. Accelerator science has led to many improvements in medical imaging, which routinely saves lives. (Of course, it has not been all good — the atom bombs that destroyed Hiroshima and Nagasaki were also the result of modern physics.)

It still seems amazing that, by asking proper questions, humans can figure out mathematical equations that describe how the universe works, and extrapolate. Newton wondered what kept the moon in its orbit and was able to figure out the law of gravity. He then used it to explain the orbits of the planets. Similarly, Peter Higgs and colleagues wondered what endowed particles with mass, and were able to predict the Higgs boson.

At the end of the day, this calls for a celebration of what the human species has accomplished.

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# A decisive significance

**The infectious process reveals itself in the unity of biological and social factors. Incidence, severity of the clinical course and death rate depend closely on the activity of the main economic laws of social formations, writes** tapan kumar maitra

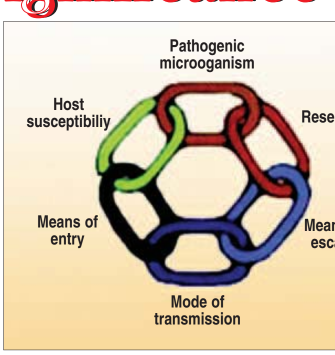
THE origin of an infectious disease depends on the reactivity of the human body, the quality and quantity of the causative agent, the influence of the external environment and social conditions. Depending on the relationship of these factors, the infectious process may terminate in the death of the causative agent, the death of the host or the establishment of mutual adaptation between the host and the parasite.

The penetration of the causative agent into the body does not always entail disease but in many cases it is limited by a short-term infection without any manifestation of the disease or by a comparatively long carrying state (streptococci, adenoviruses, enteroviruses, herpes virus, malarial *Plasmodium*, *Entamoeba histolytica*).

The reactivity of the human body, with its immunobiological readiness to render the pathogenic micro-organism harmless, is closely related with the environment, with conditions of life, the nature of work and nutrition, hygienic and general cultural levels and many other factors. The condition of the macro-organism and its resistance have a decisive significance in the origin, course and outcome of an infectious disease. Susceptibility depends to a certain extent on age and sex due to certain physiological peculiarities. For example, during menstruation, pregnancy and labour, the female organism becomes more sensitive, particularly to streptococcal diseases. Children are more susceptible to some infectious diseases and less susceptible to others than adults. Resistance to many infectious diseases in children up to the age of six months is associated with a poorly developed central nervous system and also with the presence of maternal immunity.

Besides, it has been established that in relation to some diseases (dysentery, staphylococcal and streptococcal diseases, colienteritis and infections caused by the *Coxsackie* virus) children are more susceptible than adults. The varied age resistance to infectious diseases depends on the nature of metabolism, the function of the organs of internal secretion and on peculiarities of immunity.

Vitamin deficiencies have a great influence on the susceptibility to infectious diseases. A deficiency of vitamin A provides for the appearance of catarrhs of the mucous membranes of the eye and leads to *xerophthalmia*, enhances the development of skin affections, broncho-pneumonia, influenza and acute catarrhs of the upper respiratory tract. A deficiency of vitamin Bn causes an increased susceptibility to leprosy and to a number of pathogenic and conditionally pathogenic microbes. Vitamin C deficiency causes a decline in the resistance to tuberculosis, diphtheria, streptococcus, staphylococcus, pneumococcus and other diseases.




Quite important is the fact that during many infectious diseases, as a result of the lethal action of drugs on the normal intestinal microflora which supply the organism with vitamins of the B group, vitamin deficiencies develop.

Over the years, great heed has been paid to the problems of the study of mineral metabolism. A deficiency of iron, calcium, magnesium, copper, zinc, iodine, manganese, boron, cobalt and molybdenum leads to a disturbance in metabolism, a decrease in the resistance of the organism and an increase in the susceptibility to infectious diseases. Small amounts of trace elements are capable of increasing the defence mechanisms of the macro-organism, in particular, the phagocytic activity of leucocytes. They restore the previously impaired biochemical functions. Physical and mental overstrain associated with an irregular organisation of working hours and a disturbance of conditions causes a weakening of the defence mechanisms to many infectious diseases.

Cooling lowers the resistance of the organism in relation to pathogenic and conditionally pathogenic microbes, enhances the development of pneumonia, catarrhs of the upper respiratory tract and other diseases. Louis Pasteur proved that cooling in chickens caused a disturbance of specific immunity to anthrax. When environmental temperature increases, penguins die from auto-infections caused by *aspergilli*. Cooling as well as overheating of animals' bodies leads to disturbances in biocatalytic reactions, a weakening of the organism and lowering of immunity to infectious diseases.

It is known, for example, that acute catarrhs are observed in the autumn-winter period, while colienteritis and infections caused by *Coxsackie* and *Echo* viruses develop in the summer. The effect of ultraviolet rays and sunlight on the organism depends on the wavelength, intensity and duration of application. Observations have shown that sunlight has a favourable effect on the organism and to a certain degree increases resistance to infectious diseases. However, in a number of cases, lengthy and intense irradiation is accompanied by a decrease in the resistance of the human organism to a number of pathogenic microbes. For example, spring relapses of malaria are observed in people infected by plasmodia and exposed to intense solar radiation. Of great theoretical and practical importance is the action of ionising radiation. As has been established, small doses of X-rays increase the resistance of animals to various diseases while increased doses lower it and enhance the activity of normal microflora and the development of bacteraemia and septicaemia. At the same time the permeability of mucous membranes is disturbed, their barrier capacity is reduced and the function of the reticuloendothelial system and defence properties of the blood are sharply lowered.

Especially dangerous to humans are increasing doses of ionising radiation as a result of the testing of nuclear weapons. Radioactive *strontium* accumulates in the atmosphere. It causes deep changes in the haemopoietic function of bone marrow, the formation of tumours and impairs reproductive ability. Poor hygienic conditions have an unfavourable effect on the human body. Despite the fact that there are 2.5 million tons of air per person, due to pollution in large cities and industrial centres, the incidence of respiratory diseases among people is growing of late. This results in the spread of chronic diseases (cancer of the lungs, emphysema, asthma, etc). Polluted air has a detrimental effect on animals and vegetation. A deficiency of oxygen, excess of carbon dioxide and other harmful gases cause chronic toxicosis and lead to the development of tuberculosis.

The hypophysis-adrenal system is of great importance in maintaining stability of the internal medium of the organism. This system is stimulated by the action of different stimulants — mechanical traumas, cold, heat, ultraviolet and ionising radiation, micro-organisms, etc. As a result of an excess deficiency or abnormal combination of hormones such as *somatotrophic* hormone, *adrenocorticotrophic* hormone, various disturbances in the functions of the organism may occur. For example, cortisone inhibits the inflammatory reaction and, therefore, enhances the development of the infectious process. The *somatotrophic* hormone, on the other hand, activates the inflammatory process and causes an anti-infectious action.

Disturbances of the normal activity of the central nervous system deserve special attention. As is known, the causative agents of infectious diseases are extraordinary biological stimulants. With experimental infections, principally by neurotropic stimulants, it had been observed long ago that the injection of the infected material into the brain is accompanied by the greatest number of deaths. Mental disturbances also lower the regulating function of the central nervous system. Mental patients in psychiatric hospitals more often contract infectious diseases.

Under the influence of various national disasters (famines, wars, earthquakes, floods) infectious diseases attain mass distribution and are accompanied by a high death rate and disability. Thus, the infectious process reveals itself in the unity of biological and social factors. The disease incidence, severity of the clinical course and death rate depend closely on the activity of the main economic laws of social formations.

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