

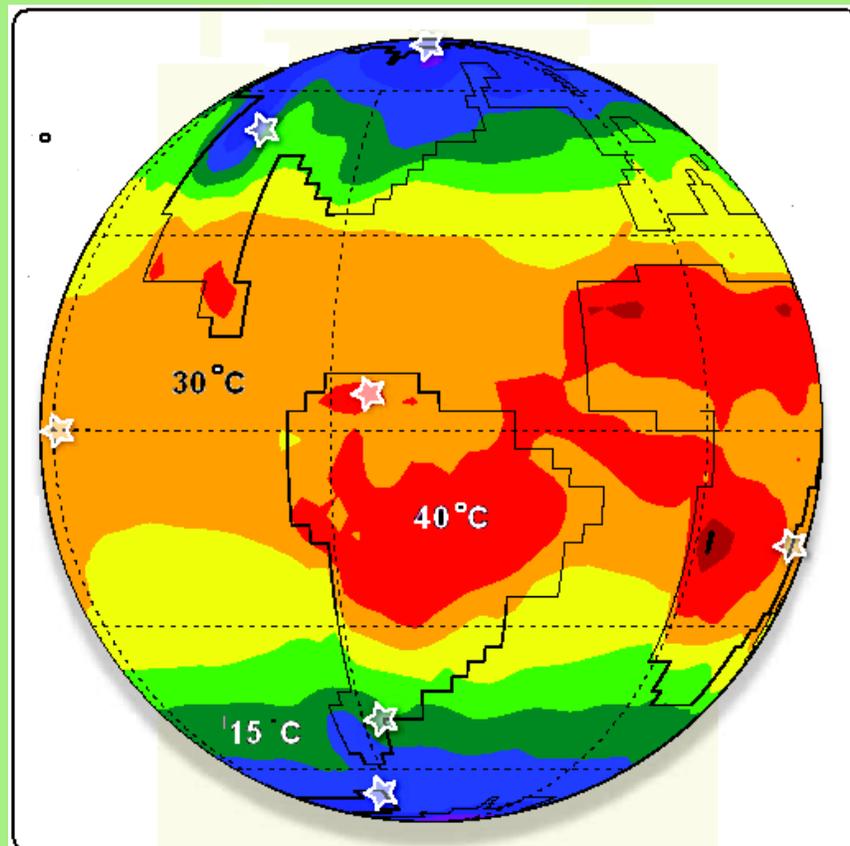
Global warming in cold blood

Reptile fossils are helping map prehistoric temperatures of the Amazon, says S.Ananthanarayanan.

To say that global warming has happened before but things were not catastrophic has become routine with armchair critics who pooh-pooh concerns about what our pace of carbon emission and power consumption is doing to the earth. And there is hence great curiosity to know how hot the earth did get during its past warm phases.

Evidence

There is ample evidence of temperatures during these past warm periods. In the form, for instance, of fossil remains of crocodiles and palm trees in the arctics and in Wyoming and Siberia, which show that these regions once knew much higher temperatures, similar to the regions where crocs and palms actually flourish. As the orbit and rotation of the earth was the same during these periods, the question is how hot were the tropics when the poles were, maybe, 30° C warmer than they are today.



Current thinking, formed from evidence of plant and animal life forms that flourished in the tropics during the periods of maximum warming of the planet, and other markers that reveal both

temperatures and antiquity, is that tropical temperatures were probably 5 to 6°C warmer than they are today. It is difficult to model the thermodynamic processes of circulation and global heat exchange which could maintain such a mild temperature gradient, of the poles being at almost the same temperature as the tropics during a period of greenhouse conditions. As we know, the seasons and temperature gradients are the result of asymmetric warming of different parts of the earth at different times, due to the tilt, rotation and movement of the earth around the sun. As these were unchanged during the so called 'hot phases' of the earth's history, how could the tropics keep from getting much warmer, when the conditions at the poles had become warm and balmy?

Reptile evidence

Prof Jason Head and a team of researchers in USA and Panama report in the journal, *Nature* that they have evidence of tropical temperatures having been a good 5-6° C higher than current estimates – a finding that may be more amenable to matching plausible global climate mechanisms. The finding is based on the discovery, in Colombia, which is practically on the equator and as tropical as one can get, of fossils of giant snakes, as large as 13 metres long and weighing over a ton. As snakes are in the category of so called 'cold blooded' animals, which stay nearly at the temperature of their surroundings, the presence of such large snakes in Columbia, during the warm ages about 58-60 million years ago indicates that the temperatures during those times must have been well over what has been estimated with the help of other evidence.

Poikilotherms.

This word literally means 'varied temperature' and was formerly the term for the so called 'cold blooded' animals, which were thought to have no means of controlling body temperature. We now understand more of how body temperatures are regulated and prefer the term 'ectotherm', or animals that receive heat from outside, rather than generate heat from within

Cold blooded animals thus have a very frugal energy economy, but need to seek out places of optimum temperature to maintain their metabolism. We may all have seen lizards sunning themselves on a rock and it is known that fish seek out the depths of water where the temperature is the most suitable. Insects are known to warm the muscles that are used in flight by rapid vibration. And cold blooded animals generally tone down their level of activity, like in hibernation, when temperatures are low.

They are thus more dependent on the environment and in challenging conditions, are likely to be driven to extinction by more adapted, warm blooded species. But, relieved of the need to maintain body temperature by metabolism, they need only 10 % of nutrition of warm blooded animals and can drive the latter out where the conditions are right, like in tropical rain forests.

Size and temperature

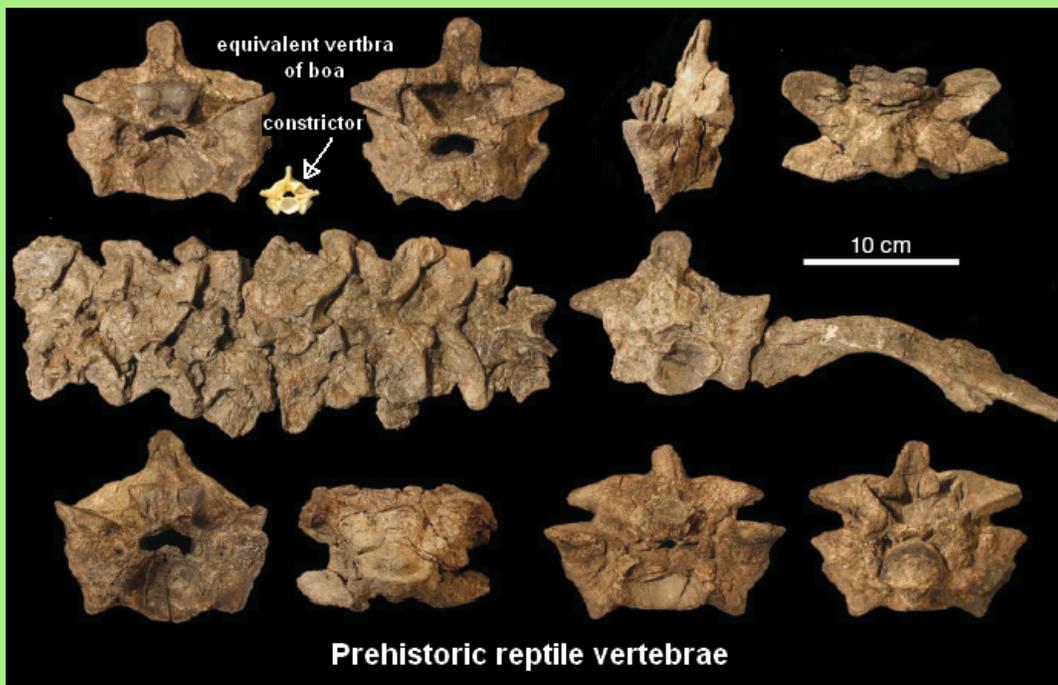
While cold blooded animals are able to adapt metabolic rates according to available heat and even store energy for basic metabolism, there are different optimum conditions for animals of

different sizes. Large ectotherms, like sea turtles, by virtue of their large body weight, compared to their surface area, are able to store heat for long periods. These animals can then take in heat at the surface of the sea and then make long dives into cooler, deep waters where the hunting is good. Conversely, the large body mass needs more energy for basic metabolism and large ectotherms cannot exist at all unless there is a minimum high temperature source of heat.

This dependence of large ectotherms on higher temperatures is borne out by the fact that larger snakes on the earth today are always found in warmer climates and cold countries are host only to smaller ectotherms. In fact, it is possible to link the size of cold blooded animals found in a region with the mean temperature and then to use evidence of animals in an unknown area to conjecture what the temperature may be.

Giant snake fossils

Prof Jason Head and colleagues used this relationship to derive from the snake fossils discovered in Columbia what the temperature may have at the time the snakes were alive. The fossils date to 58-60 million years ago, which is in the heart of the last period of great warming of the earth. The temperatures that Head et al derive turns out to be 5-6° C higher than what other evidence has indicated.



This discovery, then, that the tropics did warm substantially, is a body blow to the theory that the tropics, which account for 50% of the surface of the earth, are a great thermostat which keeps the earth's temperature from getting extreme.

These estimates of geological temperature variations have little to do, of course, with the present crisis of rapid, single century temperature rise that human activity has brought about. But they do question the belief that the earth has been able to contain temperature within safe limits.
