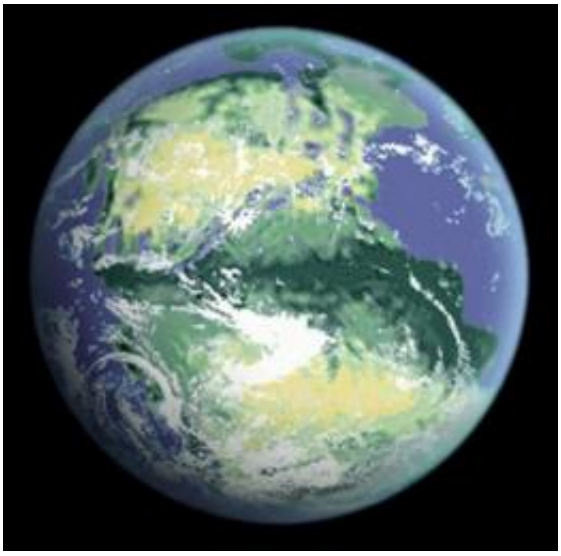
Latitude and rain dictated where species lived

May 12 2011



More than 200 million years ago, nearly all the land on Earth was part of Pangaea. Animals could roam freely, yet they appear to have sorted themselves into regions. Researchers at Brown are figuring out why. Credit: Jessica Whiteside, Brown University

Aggregating nearly the entire landmass of Earth, Pangaea was a continent the likes our planet has not seen for the last 200 million years. Its size meant there was a lot of space for animals to roam, for there were few geographical barriers, such as mountains or ice caps, to contain them.

Yet, strangely, animals confined themselves. Studying a transect of

Pangaea stretching from about three degrees south to 26 degrees north (a long swath in the center of the continent covering tropical and semiarid temperate zones), a team of scientists led by Jessica Whiteside at Brown University has determined that reptiles, represented by a species called procolophonids, lived in one area, while mammals, represented by a precursor species called traversodont cynodonts, lived in another. Though similar in many ways, their paths evidently did not cross.

"We're answering a question that goes back to Darwin's time," said Whiteside, assistant professor of geological sciences at Brown, who studies ancient climates. "What controls where organisms live? The two main constraints are geography and climate."

Turning to climate, the frequency of rainfall along lines of latitude directly influenced where animals lived, the scientists write in a paper published this week in the online early edition of the Proceedings of the National Academy of Sciences. In the tropical zone where the mammal-relative traversodont cynodonts lived, monsoon-like rains fell twice a year. But farther north on Pangaea, in the temperate regions where the procolophonids predominated, major rains occurred only once a year. It was the difference in the precipitation, the researchers conclude, that sorted the mammals' range from that of the reptiles.

The scientists focused on an important physiological difference between the two: how they excrete. Mammals lose water when they excrete and need to replenish what they lose. Reptiles (and birds) get rid of bodily waste in the form of uric acid in a solid or semisolid form that contains very little water.

The skull of the procolophonid Hypsognathus was found in Fundy basin, Nova Scotia, which was hotter and drier when it was part of Pangaea. Mammals, needing more water, chose to live elsewhere. Credit: Jessica Whiteside, Brown University

On Pangaea, the mammals needed a water-rich area, so the availability of water played a decisive role in determining where they lived. "It's interesting that something as basic as how the body deals with waste can restrict the movement of an entire group," Whiteside said.

In water-limited areas, "the reptiles had a competitive advantage over mammals," Whiteside said. She thinks the reptiles didn't migrate into the equatorial regions because they already had found their niche.

The researchers compiled a climate record for Pangaea during the late Triassic period, from 234 million years ago to 209 million years ago, using samples collected from lakes and ancient rift basins stretching from modern-day Georgia to Nova Scotia. Pangaea was a hothouse then: Temperatures were about 20 degrees Celsius hotter in the summer, and atmospheric carbon dioxide was five to 20 times greater than today. Yet there were regional differences, including rainfall amounts.

The researchers base the rainfall gap on variations in the Earth's

precession, or the wobble on its axis, coupled with the eccentricity cycle, based on the Earth's orbital position to the sun. Together, these Milankovitch cycles influence how much sunlight, or energy, reaches different areas of the planet. During the late Triassic, the equatorial regions received more sunlight, thus more energy to generate more frequent rainfall. The higher latitudes, with less total sunlight, experienced less rain.

The research is important because climate change projections shows areas that would receive less precipitation, which could put mammals there under stress.

"There is evidence that climate change over the last 100 years has already changed the distribution of mammal species," said Danielle Grogan, a graduate student in Whiteside's research group. "Our study can help us predict negative climate effects on mammals in the future."

Provided by Brown University