MAKING THE PAPER

Jan van Dam

Fossils and astronomy provide clues to why species come and go.

EOMEDIA/UTRECHT UNIV.

For years, scientists have debated what determines the development of new species and the extinction of others. Are external factors such as extreme changes in climate responsible, or does survival depend on a species' intrinsic ability to compete against others? Jan van Dam at Utrecht University in The Netherlands is betting on the first possibility.

Work by van Dam's group suggests that mammals can live through long periods of gradual climate change until the changes reach a certain threshold (page 687). "The ends of the turnover cycles probably represent extreme climate conditions that animals cannot cope with," says van Dam.

Previous work examining the timing of species turnover dealt with either 'short' or 'coarse' time periods. Short periods — which usually encompass less than 10 million years — contain detailed information from within a particular timeframe. Coarse periods involve discrete chunks of information separated by wide intervals and distributed over a longer timespan. Four years ago, in an effort to put an end this distinction, van Dam urged colleagues who had been collecting and studying rodent fossils from three regions in Spain to pool their data. This generated a continuous and detailed record of rodent lineages spanning more than 22 million years. "Different people specialized in different types of rodent or time interval," he recalls. "I brought them together to share their knowledge for a new application."

The initial data consisted of 80,000 tooth fossils collected from the sediments of ancient lakesides and small streams. "In the best sections, we could use these beds in the same way as tree rings," van Dam explains. The researchers knew that a new bed is deposited every 20,000 years. So by counting the number of beds, they were able to precisely date the fossils. They then looked for correlations between the existence of different lineages and major changes in Earth's climate, as detailed by geological and astronomical records.

Statistical analysis revealed that during the 22-million-year span there had been spurts of species extinction and origination. These occurred in cycles lasting either 1 million years or between 2.4 million and 2.5 million years. These turnover cycles coincided with episodes of ice-sheet expansion and climate cooling, caused by unusual juxtapositions of Earth, the Sun and Mars that would have affected regional precipitation. These data contradict models in which species appear or disappear primarily because they are in competition with one another. "Competition would have had a minor effect compared with that of the climate," says van Dam.

For rodents, at least, the debate about what triggers species turnover is settled, according to van Dam. And he doesn't think the results will be any different when similar studies are done for larger mammals. The challenge will be to find an adequate number of large-mammal fossils to generate a record with the same temporal resolution as that established for rodents. Van Dam's group's findings also put into perspective the significance of human-induced extinctions that have occurred in more recent times — rates that have exceeded those caused by either competition among other species or planetary-driven climate cooling. "What we have done in the last few thousands years normally occurs once every million years or so," van Dam says. ■

KEY COLLABORATIONS

A group of physicists has discounted a possible avenue for investigating subatomic particles and the early Universe.

Quantum-chromodynamics theory posits that subatomic particles — such as quarks — are bound together by 'strong interactions'. It is these interactions that explain most of the mass of the visible Universe. According to the theory, the interactions weaken at extremely high temperatures, giving way to what is known as a quark plasma phase.

Through a series of complex mathematical calculations and a sophisticated computer program, Sandor Katz and his colleagues at the Institute for Theoretical Physics at Eötvös University in Budapest, Hungary, and the University of Wuppertal in Germany, elucidated a key facet of this theory (page 675).

They wanted to know whether the transition between phases was smooth and continuous, or abrupt, and found it to be the former. So, when the Universe formed, a continuous transition occurred from the plasma phase to the strong interactions phase.

If the transition had been more abrupt, particle physicists might have been able to use it to investigate the formation of the Universe or relics of the transition. But, says Katz, "it's not a big surprise for them. This was already expected, but it hadn't been proved." ■