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The puzzling history of South American mammals

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ABSTRACT

After millions of years of isolation, the emergence of the Isthmus of Panama connected South America with North America, allowing the interchange of two previously separated faunas. The interchange was not balanced because more mammals from North America are recorded in South America than vice versa. Could this be caused by extinctions that left fewer South American mammals to move northward?

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When the Isthmus of Panama formed, it connected North and South America, allowing the interchange of the previously separated faunas from two continents. A puzzling aspect of this interchange is that North American mammals seem to be more successful. The fossil record shows more mammals with North American origin in South America than vice versa. Clarifying the reasons and mechanisms behind this asymmetry is important for understanding the legacy of the interchange in the distribution of biodiversity of mammals today.

South America was separated from other continents for most of the Cenozoic era (last 66 million years until present), and during this time a very characteristic fauna evolved, including animals such as ground sloths, glyptodonts and monkeys, among many others. Then, the Isthmus of Panama created a land bridge linking it with North America, resulting in a major natural experiment in earth history: the interchange of the previously separated faunas from South and North America. The fossil record shows that the interchange was balanced at first, but during the Pleistocene epoch (between 2.6 million and 12000 years ago) about 50%of the mammals in South America were of North American origin. In contrast, only about 10%of the mammals in North America had originated in the southern continent. Together with colleagues, we addressed the long-standing question of why the end result of the interchange was asymmetrical.

Four hypotheses could explain the imbalance of the interchange: 1) it could result from a higher rate of movement of mammals from North to South America; 2) there was a similar rate of movement, but the North American mammals evolved more into new species after moving to South America; 3) the South American mammals had more extinctions; 4) the rate of movement was similar, but

there were more mammals in North America to move south. Or maybe the imbalance resulted from some combination of these scenarios. To test the four hypotheses, we compiled the fossil records of mammals from the two continents and classified them according to their geographical location and their continent of origin. Then, we used mathematical models to estimate the origination, extinction and movement of mammals across the two continents during the last 23 million years.

We found that the main reason for the asymmetric result of the interchange is that South American mammals had proportionally more extinctions. Because of the relative higher extinctions, the South American mammals' diversity decreased, causing fewer southern mammals to move northwards.

It is still unclear what could have caused the extinctions of South American mammals. Since most of the fossils come from the southern part of the continent, in particular the Pampas in Argentina, most of the extinctions likely occurred there. During the period with high extinctions, the global climate was becoming cooler and in southern South America drier, accelerating the expansion of grasslands that characterize the Pampas landscape today. These environmental changes could have affected the fauna. Additionally, the differences between the predators on each continent could have also played a role in the extinctions. Compared with other North American mammals, the carnivores (e.g., dogs, cats, bears) did particularly well in the interchange, and they are very abundant in South America today. Before the interchange, the main predators in South America were sparassodonts, a group of meat-eating marsupials. When North American carnivores arrived in South America, the sparassodonts were already in decline. Carnivores appear to be more efficient predators than sparassodonts, with larger brains and specialized teeth. Many South American mammals could not survive the arrival of more efficient predators. Yet another possible reason for the extinctions, could be that the North American mammals brought new parasites and diseases that negatively affected South American mammals.

In conclusion, our study shows that the asymmetric result of the interchange between South and North America is due to the proportionally higher extinction of South American mammals. As a result, the extinctions left fewer mammals that could move northwards, and that is why there are more mammals of North American origin in South America than vice versa. Understanding what happened long ago during this faunal interchange is very important for gaining knowledge about how life evolved in the Americas. We showed that the reason for the asymmetric result is that extinctions left fewer South American mammals to move north, but why the South American mammals disappeared remains an exciting and open question.