Biodiversity of Migratory Species Following Geomagnetic Reversals

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Introduction (1000 character limit)

Earth's magnetic field is an essential barrier that contains the atmosphere and protects the Earth from cosmic rays from the sun. Variations to the geomagnetic field can cause disruption to electronic communications, power distribution, and is the source of solar weather and the polar auroras (Constable and Korte 2006). It is unknown how life on Earth would be affected if the geomagnetic field were to severely weaken or disappear. Migratory species like birds, elk, deer, and bees all rely on the geomagnetic field to navigate during migration. These species contain small amounts of biogenic magnetite in the brainstem which senses the field and uses it similar to how we use a GPS. My objective is to test whether biodiversity in migrating species changes due to variance in the geomagnetic field. My hypothesis is that the biodiversity of migratory species will decrease directly following a geomagnetic reversal, but remain fairly constant for non-migratory species.

Justification (2500 character limit)

When Earth's magnetic field begins to reverse, it does not happen all at once, rather it slowly weakens for hundreds to thousands of years (Gubbins 2008). Rock records provide a detailed account of when these reversals occurred in time. Disturbances to the geomagnetic field cause phenomenon such as space weather and the polar auroras, but little is known about the implications to life on Earth. Research done by Heyers et al. and Kirschwink and Kirschwink show that migratory species, such as the European Robin and honey bees, respond to changes in the geomagnetic field, and use this as a source of navigation during migration (Heyers et al. 2010; Kirschwink and Kirschwink 1991). These species contain biogenic magnetite in the brainstem that interacts with Earth's geomagnetic field, much like our own satellite GPS systems (Heyers et al. 2010). If the geomagnetic field were to show signs of reversing and begins to weaken, it is unknown how migratory species that rely on the geomagnetic field will react. It is possible that with a weakened field, these species will be unable to navigate when migrating. Confusion in the migratory system could lead disruptions in many different ecosystems around the world. For example, birds migrate to areas with an excess of resources, and if the birds are unable to find their way back to their preferred areas, it is likely that their total population would decrease (Somveille et al. 2015). The world's bee population is facing an epidemic and we are already seeing the effects of decreased pollination globally (Montero-Castaño and Vilà 2012). This research will allow us to understand the importance of Earth's geomagnetic field in relation to the navigation of migratory species and how variations in the geomagnetic field affect their populations.

Research Plan (2500 character limit)

I will use the Paleobiology Database to find the number of occurrences of the class aves and the class reptilia before and after paleogeomagnetic reversals in the Pliocene and Pleistocene, when both taxon were prominent in terrestrial environments. The reptilia will serve as the control group, so see if non-migratory species are also affected by variations in the geomagnetic field. The data will be processed using R software computing, and cleaned to remove any occurrences of nonsignificant value. The data will be analyzed using the vegan package and the biodiversity function, by taking the number of occurrences and abundances in order to calculate Shannon's Entropy both before and after geomagnetic reversals. A null hypothesis analysis will then be performed to ascertain if the changes in biodiversity is significant. In this way, we will be able to tell if there is a substantial decrease in biodiversity of migratory and non-migratory species after a geomagnetic reversal. We will use research done by William Lowrie in his paper *Geomagnetic Reversal History* to find the specific time periods of paleogeomagnetic reversals in the Pliocene and Pleistocene, and use these as time constraints in our data processing.

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