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Do Geomagnetic Variations Affect the Foliar Spiral Direction of Coconut Palms?

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In coconut palms, leaves are attached to the stem in either an ascending clockwise (left-handed or L) or counter-clockwise (right-handed or R) spiral (1). Foliar spiral direction (FSD) is a classic case of morphological antisymmetry, in which dextral and sinistral forms are not inherited and are equally common within a species (2). FSD would seem a simple stochastic process unworthy of further study if not for the observation, based on data collected from 71,640 coconut palms in 42 locations around the world, that the FSD of coconut palms varies with latitude: R-trees predominate in the N Hemisphere and L-trees predominate in the S Hemisphere (3). A re-analysis of this data indicated that hemispheric asymmetries in FSD were significantly better correlated with magnetic latitude than with geographic or geomagnetic latitude, suggesting that latitudinal asymmetries in FSD might be associated with the temporally varying component of Earth's magnetic field (4). Here, we present two new lines of evidence that geomagnetic variations may underlie asymmetries in palm FSD. First, we show that asymmetries occur in the FSD of palm populations on opposite sides of islands, and second, that asymmetries in FSD vary with the 11-year solar cycle.

The prediction that asymmetries in coconut palm FSD should exist on opposite sides of islands arises from the fact that because seawater is more electrically conductive than land, induced earth currents divide and stream past an island more strongly in one particular direction. The "geomagnetic island effect" is characterized by a complete reversal of the vertical Z component of short-period geomagnetic field anomalies at observation points on opposite sides of islands (5). To examine whether FSD varied around the circumferences of islands, we collected data on 6 islands (Puerto Rico, n = 4850; Antigua, n = 2038; Hawaii, n = 3552; Maui, n = 2175; Tahiti, n = 1635; Moorea, n = 2116). For each population, the degree of asymmetry was determined by calculating an "asymmetry quotient" (AQ) based on the formula:

AQ = (L - R)/Total

Asymmetries in FSD were evident on opposite sides of all 6 islands studied. It is of interest to consider whether the “palm island effect” described here bears any relation to the “geomagnetic island effect.” The most detailed map of the “geomagnetic island effect” for a tropical island exists for Tahiti (5). In this map, P_z is a scaled parameter representing the Z component of the anomalous geomagnetic field that arises from the distortion of electric current flowing in the ocean around Tahiti. We found a close correlation ($r = 0.87$; $p<0.001$) between P_z and the AQs of coconut palm populations on Tahiti.

Using data provided in (6), we also examined whether asymmetry in FSD varies with the solar cycle. Of 384 trees, 375 fell into one of 9 cohorts of 20 trees or more. A strong correlation ($r = 0.85$; $p<0.001$) was found between the AQs of the 9 cohorts and the total average monthly sunspot numbers during the 4 years prior to planting. Our data suggest that maximum AQ is achieved circa 1.5 years before sunspot minimum, a time in the solar cycle typically characterized by the highest frequency of recurrent geomagnetic storms. We propose that earth currents during geomagnetic storms may bias the diffusion of morphogens in coconut palm embryos, thereby giving rise to asymmetries in FSD.

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