An extended framework for the general dynamic theory of biogeography

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Abstract

The General Dynamic Model of biodiversity (GDM) explains patterns of species richness on volcanic hotspot archipelagos with respect to island age (T) and area (A) by adjoining a hump-shaped function of T to the species area relationship (SAR). There are three main GDM models: 1) the semi-log ATTˆ2 model, which is an extension of a semi-log SAR, 2) the Power ATTˆ2 model which is a linear combination of a quadratic expression of island age and power law SAR and 3) the LogATTˆ2 model, where a power law in A is scaled by a lognormal function of T. We assess the relative performance of these models and compare their performance to other models including A or T or both. In light of our findings and the mathematical properties of the best performing models, we propose an extended framework for species richness models within the GDM. Species richness data was gathered from databases and published sources, resulting in 30 datasets for various taxa. We used the Akaike Information Criterion corrected for small sample size (AICc) to compare the relative performance of all models tested. Of the GDM models the LogATTˆ2model performed best in all cases. However, in almost 3/4 of the cases the best model overall was one that contained A or T only. For the Canary Islands area was not a significant predictor for any taxa which was probably due to the two old, low lying, but still relatively large islands of Fuerteventura and Lanzarote. The mathematical properties of the Log ATTˆ2 can be leveraged to derive an extended framework within the GDM which both connects it logically to other models and incorporates the cases where models containing only A or T were the best models. It also allows one to formulate a criterion for the consistent inclusion of predictors other than A and T i.e., that a substituted variable (say, elevation or a habitat diversity measure substituted for area) or an adjusted variable (say, area adjusted by an aridity index) have an approximately lognormal profile in T.

Keywords: general dynamic model, species area relationships, species richness, island ontogeny, choros model

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