

Article

## Forms and genesis of species abundance distributions

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### Abstract

Species abundance distribution (SAD) is one of the most important metrics in community ecology. SAD curves take a hollow or hyperbolic shape in a histogram plot with many rare species and only a few common species. In general, the shape of SAD is largely log-normally distributed, although the mechanism behind this particular SAD shape still remains elusive. Here, we aim to review four major parametric forms of SAD and three contending mechanisms that could potentially explain this highly skewed form of SAD. The parametric forms reviewed here include log series, negative binomial, lognormal and geometric distributions. The mechanisms reviewed here include the maximum entropy theory of ecology, neutral theory and the theory of proportionate effect.

**Keywords** maximum entropy; lognormal; neutral theory; proportionate effect; biodiversity.

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### 1 Introduction

Ecology studies the abundance and distributions of living organisms, as well as their relationships and feedbacks with the environment (Odum and Barrett, 1953). Species are not alone in an ecosystem; as such, ecological community is often considered a confined unit of interest, and how community patterns and functions emerge from species interactions has become the overarching question in ecology (Zhang et al., 2011; Hui et al., 2013; Minoarivelo et al., 2014; Nuwagaba et al., 2015). In particular, the number of individuals of species constituting a given ecological community is not evenly distributed, often with many rare species but only a few common ones (Bowler and Kelly, 2010; Hui et al., 2009, 2011), as also observed in fine scale occupancy frequency distributions (Hui and McGeoch, 2007a, 2007b, 2008, 2014). Factors affecting population size of a given species in a community and thus the frequency distribution of species abundance have become a focal point of discussion in ecology (Harte, 2011).

Species abundance distribution (SAD) can be an indicator of commonness and rarity in a community (Harte, 2011); it is a community-level metric, denoted by  $\Phi(n)$  hereafter, that represents the number of species with  $n$