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LETTER

Linking stoichiometric homoeostasis with ecosystem structure, functioning and stability

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Abstract

Ecosystem structure, functioning and stability have been a focus of ecological and environmental sciences during the past two decades. The mechanisms underlying their relationship, however, are not well understood. Based on comprehensive studies in Inner Mongolia grassland, here we show that species-level stoichiometric homoeostasis was consistently positively correlated with dominance and stability on both 2-year and 27-year temporal scales and across a 1200-km spatial transect. At the community level, stoichiometric homoeostasis was also positively correlated with ecosystem function and stability in most cases. Thus, homoeostatic species tend to have high and stable biomass; and ecosystems dominated by more homoeostatic species have higher productivity and greater stability. By modulating organism responses to key environmental drivers, stoichiometric homoeostasis appears to be a major mechanism responsible for the structure, functioning and stability of grassland ecosystems.

Keywords

Biodiversity, ecological stoichiometry, ecosystem services, species traits.

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INTRODUCTION

The ecosystems upon which humans rely have been altered in unprecedented ways by human population expansion and industrialization. As a result, biodiversity is decreasing (Chapin *et al.* 2000), species invasions are expanding (Cohen & Carlton 1998) and major biogeochemical cycles are changing (Falkowski *et al.* 2000; Elser *et al.* 2009). These forces put ecosystems under considerable stress, making it critical to understand the mechanisms that underpin ecosystem structure, functioning and stability (McCann 2000; Loreau *et al.* 2001; Ives & Carpenter 2007). Many studies have shown that greater ecological diversity leads to greater ecosystem production and stability (Tilman & Downing 1994; Tilman *et al.* 1996, 2006; Naeem & Li 1997; Bai *et al.* 2004; Ptacnik *et al.* 2008) but the topic remains controversial (Wu & Loucks 1995; Chapin *et al.* 1997; McCann 2000; Loreau *et al.* 2001; Ives & Carpenter 2007). The diversity of species traits present, especially in nutrient use strategies, is likely to play a fundamental role in modulating the relationship between biodiversity and ecosystem structure, functioning and stability (Chapin *et al.* 1997; Knops *et al.* 2002) because these traits link organismal functioning to ecological dominance and to key environmental factors such as biogeochemical nutrient supplies.

Stoichiometric homoeostasis is the ability of an organism to maintain a given elemental composition despite variation in the elemental composition of its environment or diet (Sterner & Elser 2002) and reflects the net outcome of many underlying physiological and biochemical adjustments as organisms respond to their surroundings (Hessen *et al.*

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