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Population dynamics of the Mongolian gerbils: Seasonal patterns and interactions among density, reproduction and climate

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Abstract

The Mongolian gerbil (*Meriones unguiculatus*) is one of key rodents widely distributed in semi-arid, typical steppes, and desert grasslands in Inner Mongolia, China. We studied population dynamics of Mongolian gerbils under semi-natural conditions using monthly live trapping from 2001 to 2004 in south-central Inner Mongolia. Mongolian gerbils displayed seasonal fluctuations of density and population growth rate. Reproduction and recruitment of gerbils occurred primarily from March–August with a breeding lull in autumn. Population growth rates of Mongolian gerbils were not related to population density but were negatively related to temperature and precipitation. Enhanced reproductive performance and success of females increased population growth of gerbils in our enclosure. We also found that increased temperature and precipitation during the plant growing season negatively affected recruitment and rate of pregnancy. Mongolian gerbils prefer habitats with short, sparse vegetation and dry, loose and sandy soil. Increases in temperature and rainfall enhance vegetation growth; consequently, tall, dense and moist vegetation might reduce the suitability of habitats and retard population growth of Mongolian gerbils. Pronounced seasonal climatic fluctuations in northern latitudes may be the main cause of seasonal population dynamics of Mongolian gerbils.

Keywords: Density independence; *Meriones unguiculatus*; Population growth rate; Recruitment; Reproductive performance; Seasonal dynamics

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1. Introduction

The Mongolian gerbil, *Meriones unguiculatus* (Milne-Edwards, 1867) is one of the key rodents widely distributed in semi-arid, typical steppes, and desert grasslands of the southeast of the Bakal area in Russia, Mongolia, and Northern China (Gromov et al., 1963; Mallon, 1985; Luo et al., 2000). Gerbils mainly select seeds of annual dicots and some foliage as food (Zhong et al., 1985; Wang and Zhong, 1998). Mongolian gerbils live in social groups of 2–17 males and females (Ågren et al., 1989a) year-round and hoard food communally before winter. Mongolian gerbils prefer open habitat with short, sparse vegetation and dry, loose, and sandy soil; they are the dominant rodent species in the heavily degraded and desertified grasslands in Inner Mongolia (Zhong et al., 1985; Wang and Zhong, 1998). Mongolian gerbils can modify vegetation, micro-topography, soil structure, and nutrient cycling of grassland ecosystems through various activities, such as burrowing, digging, foraging, and food hoarding (Weiner et al., 1982; Steinberger and Whitford, 1983; Zhong et al., 1985; Schauer, 1987). These activities also enrich environmental heterogeneity to provide suitable habitats or resources for other organisms (Zhong et al., 1985; Dickman, 1999). Understanding fluctuations in abundance of Mongolian gerbils is important for evaluating its role in ecosystem processes and maintenance of biodiversity of grasslands.

Rodent populations in arid and semi-arid regions often show pronounced seasonal variation in numbers and structure. It is generally accepted that precipitation is the main limiting factor directly determining the primary productivity of plants, and population dynamics of rodents in the semi-arid and arid environments follows rainfall fluctuations (Brown and Heske, 1990; Fox et al., 1993; Masters, 1993; Predavec, 1994; Meserve et al., 1995; Southgate and Masters, 1996; Dickman et al., 1999; Madsen and Shine, 1999; Shenbrot and Krasnov, 2001; Jaksic and Lima, 2003; Letnic and Dickman, 2005). Bottom-up trophic processes are believed to be the underlying mechanisms for the positive relationships; accordingly, reproduction of rodents is stimulated by enhanced growth and seed production of annual and perennial plants after rain events (Brown and Heske, 1990). Nevertheless, rodent–rain relationships are complex and cannot be adequately represented by a simple bottom-up trophic model (Brown and Ernest, 2002). It is unknown how Mongolian gerbils respond to seasonal variations in rainfall in Inner Mongolia.

Little information was available about the dynamics of wild Mongolian population of grasslands (Ågren et al., 1989a, b). Although Xia et al. (1982) described the population dynamics of Mongolian gerbils in agricultural fields in Inner Mongolia, data was obtained with the removal method using snap traps or the burrow entrance number index method. Moreover, Xia et al. (1982) trapped gerbils only three times a year. More frequent live-trapping data are necessary for analyzing the seasonal dynamics of wild Mongolian gerbil populations. In the current paper, we present population data from a 4-year live-trapping study of Mongolian gerbils in Inner Mongolia. We aimed to: (1) determine whether the population of Mongolian gerbils was affected by density-dependent feedbacks; (2) determine how gerbil population responded to seasonal weather changes (i.e. temperature and precipitation); and (3) assess the roles of the reproductive performance of males and females in the seasonal population dynamics of gerbils. We also examined the difference in the effects of the aforementioned factors between the breeding and nonbreeding seasons.