

Net Nitrogen Mineralization and Nitrification in Three Subtropical Forests of Southwestern China

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ABSTRACT

Nitrogen is a limiting nutrient for plant growth in many forest ecosystems; however, information on N mineralization and nitrification in subtropical forests is generally lacking. To determine the effect of forest site on N mineralization and nitrification and the key contributing factors under subtropical climate, we studied the seasonal patterns of soil N mineralization and nitrification with closed *in situ* core incubation method in a mixed evergreen broadleaf forest, a pure Chinese fir (*Cunninghamia lanceolata* (Lamb.) Hook) forest, and a pure Zhennan (*Phoebe zhennan* S. Lee et F. N. Wei) forest in Dujiangyan, Sichuan province, southwestern China. Our results indicated that the rates and the seasonal patterns of net N mineralization and nitrification were similar among the three forest sites. The rates of both net N mineralization and nitrification were the highest in the winter season (December 2000 to April 2001), and negligible in spring and summer. The variability in net N mineralization and nitrification and the specific environmental contributing factors, however, varied in different forest sites. The overall similarity in N mineralization and nitrification rates suggests that regional climate condition is the most dominant controlling factor on N mineralization and nitrification. At local scales, however, biodiversity may play an important role in patterns of N mineralization and nitrification; higher biodiversity could lead to higher and more stable N mineralization and nitrification.

Keywords: net N mineralization, nitrification, Sichuan province, soil temperature, soil water content, subtropical forest, throughfall

INTRODUCTION

Nitrogen (N) is a limiting nutrient for plant growth in many forest ecosystems (Aber *et al.* 1989) and N supply is expected to limit the ecosystem-level carbon uptake and storage in many systems (Rastetter *et al.* 1997; Luo *et al.* 2006; Reich *et al.* 2006). Soil N availability is influenced by many transformation processes, such as N mineralization, nitrification, immobilization, volatilization, and denitrification, the first two being likely most important in terrestrial ecosystems. In N mineralization the organic N is transformed into inorganic N, whereas in nitrification NH_4^+ is oxidized into NO_3^- . The pool of ammonium and nitrate in terrestrial ecosystems is small, but there is a large annual flux through these pools (Schlesinger 1997).

As two fundamental processes of N cycling in terrestrial ecosystems, N mineralization and nitrification are still poorly understood in some forest ecosystems, including the broad-leaved forests and mixed forests (Nilsson *et al.* 1995). Moreover, information is generally lacking on the N mineralization and nitrification in subtropical forest ecosystems (Maithani *et al.* 1998; Upadhaya *et al.* 2005) and the data are extremely limited in subtropical China (e.g., Wang *et al.* 2007). There are reported short term soil N spatial variations (two months) in a mixed evergreen broadleaf forest in subtropical China (Wang *et al.* 2007), but the knowledge of a longer term mineralization dynamics in more diverse forest types is still unknown. In addition, although there is rich literature documenting the significant role of forest type on N cycling (Gower and Son 1992; Reich *et al.* 1997; Lovett and Rueth 1999), very few examined the effect of forest type by differentiating the contribution of microclimatic (e.g., temperature and soil moisture) and biotic factors (e.g. biodiversity).

The subtropical forests in southwestern China have been subjected to fragmentation by deforestation and over-

exploitation, which resulted from regional socio-economic developments (Chen 2000a). Study on the N transformation dynamics and their controlling factors in this region will not only provide insights into N cycling in these ecosystems, but also provide valuable information for natural ecosystem restoration and forest management at a local level. In this study, we investigated N mineralization and nitrification dynamics in three subtropical forest ecosystems, i.e., a mixed evergreen broadleaf forest, a pure Zhennan (*Phoebe zhennan* S. Lee et F. N. Wei) forest plantation, and a pure Chinese fir (*Cunninghamia lanceolata* (Lamb.) Hook) forest plantation using the closed *in situ* core incubation method. The evergreen broadleaf forest and Zhennan forest plantation are under similar local climate conditions but differ in plant biodiversity; the Zhennan and Chinese fir forest plantation are similar in plant biodiversity but under different local climate conditions. We also measured the soil organic carbon (SOC) and total N content changes during the same period. Environmental factors such as soil water content, soil temperature and throughfall were also measured.

The objectives of this study were 1) to determine the seasonal N mineralization and nitrification patterns of the three different forest sites under subtropical climate conditions, and 2) to determine the major controlling factors on N mineralization and nitrification in this region. We expect that 1) the N mineralization and nitrification in the three forest sites have similar seasonal patterns; 2) the rates of N mineralization and nitrification are different among the three forest sites; and 3) biodiversity may play an important role in rates and variability of the N mineralization and nitrification at the local scale. Due to human disturbances and over-exploitation, it is not very easy to find the true replicates for all three forest types; this non-replicated situation may limit the generalization of our findings.

