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Soil available nitrogen, dissolved organic carbon and microbial biomass content along altitudinal gradient of the eastern slope of Gongga Mountain

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ABSTRACT

Gongga Mountain is a unique mountain in western China which has not only modern low-latitude glaciers, but also an integrated vertical vegetation distribution from subtropical forests to tundra. Our study aimed to understand the soil fertility status of subalpine and alpine ecosystems in this region through measuring the soil available nitrogen (SAN), dissolved organic carbon (DOC) and soil microbial biomass (SMB) along the eastern slope of Gongga Mountain. We found that the SAN, DOC and SMB varied along the altitudinal gradient, and decreased from the soil surface to subsurface, probably due to the different return plant residue, decomposition rate, as well as temperature and moisture in different elevations. The range of NH_4^+–N content was from 1.7 mg kg^{-1} to 134.2 mg kg^{-1}; NO_3^- + NO_2^-–N was from 2.6 mg kg^{-1} to 202.0 mg kg^{-1}; DOC was from 30.6 mg kg^{-1} to 610.2 mg kg^{-1}; soil microbial biomass carbon (SMBC) was from 41.4 mg kg^{-1} to 2538.5 mg kg^{-1}; and soil microbial biomass nitrogen (SMBN) was from 0.6 mg kg^{-1} to 410.7 mg kg^{-1}. SAN, DOC and SMB were all significantly related to each other, indicating that all these three indexes are dependent on soil organic matter. At last, the ratio of SMBC to SMBN ranged from 2.4 to 65.3, mostly less than 6.0, which meant the bacteria dominated the soil microbial community in our study sites.

1. Introduction

Soil available nitrogen (SAN) is the nitrogen form which can be uptaken and utilized directly by vegetation [1], mainly including ammonium nitrogen (NH_4^+–N), nitrate and nitrite nitrogen (NO_3^- + NO_2^-–N). SAN also is the essential nutrient for plant growth [2], and it's content level can significantly affect terrestrial ecosystem productivity, and has feedback relationship with species diversity, community succession and sustainability of forestry ecosystem [3].

Dissolved organic carbon (DOC), soil microbial biomass carbon (SMBC) and soil microbial biomass nitrogen (SMBN) are the small part of soil organic carbon pool, but the most important and active parts in soil ecosystem [4]. They participate in soil C and N biogeochemical cycle and play a critical role in nutrient retention and soil fertility in terrestrial ecosystems [5].

The Gongga Mountain of eastern Qinghai–Tibetan Plateau is a typical alpine region with high peaks, deep valleys, transitional climate and integrated vertical vegetative zone. It is a glacier succession slash with a integrated natural vertical band of plants from subtropical to frigid zone [6], with complicated geology, different landforms, rich natural resources and obvious transitional climate. At different latitudes of the mountain, soil temperature, precipitation, plant and soil animal diversity vary greatly.

Previous studies on Gongga Mountain mainly focused on plant floristics [6], soil development [7], calicioid lichens and fungi [8,9], greenhouse gas fluxes [10], soil organic matter dynamics [11], succession features of subalpine forest [12], mountain ecosystem [13], geoecology [14], glacier [15,16] and climate [17], with little attention given to the natural spatial distribution of SAN, DOC, SMBC and SMBN along an altitudinal gradient of the Gongga Mountain. The present study aimed to ascertain the changes, concentrations and the relationship among SAN, DOC, SMBC and SMBN under vertical vegetation zones along the elevation of Gongga Mountain. The results are expected to fill up the gap of knowledge about the soil C, N cycle and soil fertility status of Gongga Mountain, and to provide reference for further studies.

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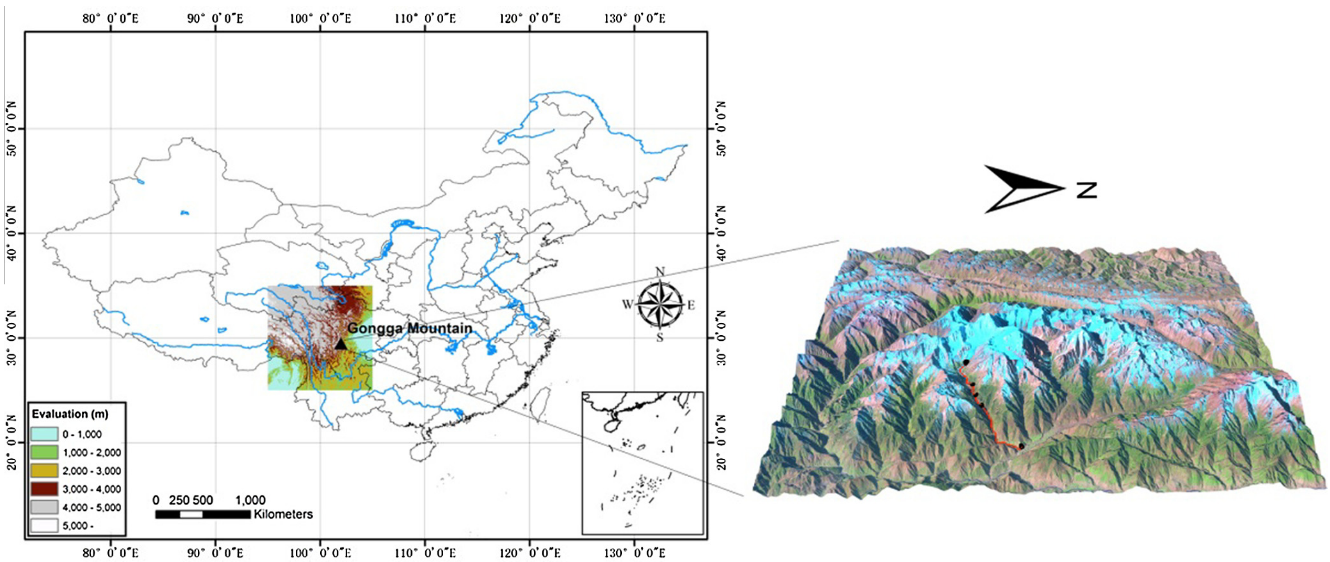

Fig. 1. Map of the Gongga Mountain and sample line in our study.

2. Materials and methods

2.1. Study site

Gongga Mountain is located in the junction (29°20′–30°20′N, 101°30′–102°15′E) of four counties in Sichuan Province, Luding, Kangding, Jiulong and Shimian counties (Fig. 1). It is a famous alpine region of Hengduan Mountain with an area of 955876.8 hm^2 and a highest peak of 7556 m. Geomorphologically, Gongga Mountain is an alpine valley landscape situated in transitional zone of the Qinghai–Tibetan Plateau (4000 m) and Sichuan Basin (500 m). Gongga Mountain is also on the transitional zone of warm moist subtropical monsoon climate in eastern china and temperate sub-humid climate in Eastern Qinghai–Tibetan plateau (Fig. 2). Along the eastern slope of Gongga Mountain, it has integrated vertical vegetative zone from subtropical zone to frigid zone along the altitudinal gradient from 1000 m to 5000 m [12]. The vertical vegetation zones can be divided into the evergreen broad-leaved forest (1000–2200 m), coniferous broad-leaved mixed forest (2200–2500 m), subalpine coniferous forest (2500–3600 m), alpine bush meadow (3600–4600 m) and alpine gravel vegetation zone (4600–5000 m) [47]. Our five research sites (Fig. 3) were set along the altitudinal gradient, with detailed information of each site listed in Table 1.

2.2. Sample collection and analyses

Soil samples (0–5 cm, 5–10 cm, 10–20 cm) were collected in November 2011 from three random sampling quadrats (10 m × 10 m) at each altitudinal site described above.

In each of sampling plots, the soil at different sampling depth was collected from three sites randomly after clearing the litter layer on the ground and, and then mixed into a composite samples. Because of big snow and high elevation, we did not collect 10–20 cm soil sample of the highest elevation (alpine shrub meadows). Therefore, we collected 14 mixed soil samples in all. All soil

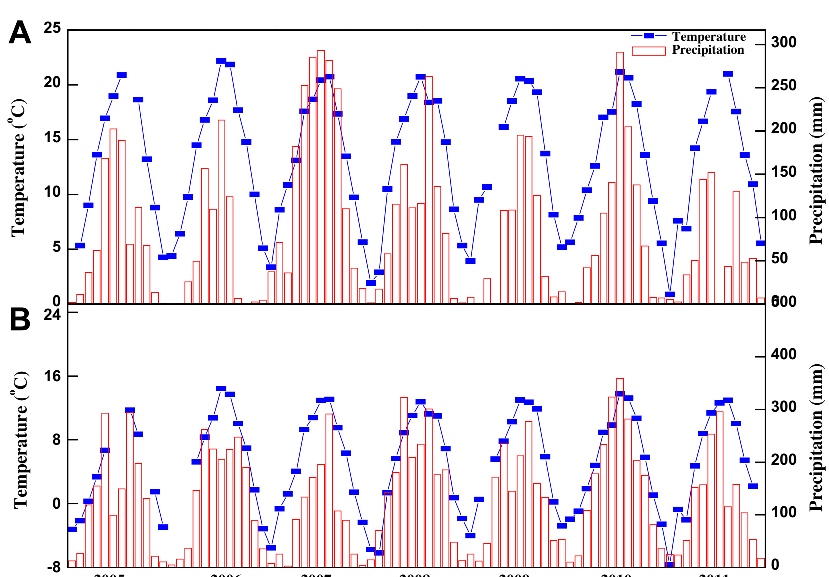

Fig. 2. The temperature and precipitation of each month in recent 7 years. The top A figure stands for the temperature (curve) and precipitation (column) of 1600 m, and the bottom B is 3000 m. The data are from Gongga Mountain ecological system observation station of Chinese Academy of Science.