Direct measurement of heterotrophic decomposition respiration from root litter in warm-temperate secondary deciduous forest in Japan

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ABSTRACT

We developed the measurement of heterotrophic respiration rate from root (*Quercus serrata*) litter (R_{rl}) using direct measurement method in natural forest condition. R_{rl} increased with increasing temperature and with decreasing root diameter. We found that R_{rl} using our direct measurement method was influenced by temperature and root diameter. These results imply that the R_{rl} is important indicator to clarify real root decomposition process in root turnover in natural forest condition.
KEYWORDS: heterotrophic respiration, root litter, *Quercus serrata*, temperature, root diameter

1. INTRODUCTION

Root turnover, which is a sequential process consisted of root production, death and decomposition, plays an important role in carbon cycling in forest ecosystems. Root turnover usually has been evaluated using minirhizotron or ingrowth core method. However, these methods have defined the death and decomposition as visual inspection and disappearance from image. Therefore, we still have less information from death to decomposition process of root. In addition, to estimate the truth of NEP in warm temperate forest, we need to clarify the relationships between the decomposition process and heterotrophic respiration rates (Kominami et al., 2008). Therefore, we attempted to measure heterotrophic respiration rate from root litter (R_{rl}) which had been buried directly in natural soil condition and evaluated change of R_{rl} in environmental factor and in morphological factor.

2. MATERIAL AND METHOD

This study was conducted in a warm-temperate secondary forest (Yamashiro Experimental Forest) in southern Kyoto prefecture, Japan (34°47'N, 135°51'E). The forest consists of deciduous broad-leaved tree species (mainly *Quercus serrata*). The forest soil is immature and sandy, which is derived from weathered granite, and has thin organic layer.

We excavated root litter samples < 5.0 mm in diameter of *Q. serrata* from upper 10 cm of soil on 14 September 2008. Each root sample was carefully isolated from soil and organic matter. Then these samples were immediately divided into three classes in diameter (0-1mm, 1-2mm, 2-5mm: total 83 samples), labeled and buried in soil surface layer in the field. Assuming that these samples were root litter, every week from 24 September to 18 December in 2008, we resampled three or four samples in each root diameter class. We had measured R_{rl} from these samples using an infrared gas analyzer (IRGA, GMP343, Vaisala, Finland) attached to a small chamber following Makita et al. (2009). After measurements, these samples were dried at 60 °C over 48 hours for calculation of water contents of samples. We also measured mean root diameter of samples with WinRHIZO Pro 2007a (Regent Instruments, Quebec, Canada), which is an image analysis system specifically designed for root measurement.

3. RESULT AND DISCUSSION

The range of heterotrophic respiration rate from root litter (R_{rl}), temperature in chamber and mean root diameter of the 83 root samples were 81.3-577.3 mg CO_2 kg^{-1} h^{-1}, 12.1-26.4 °C and 0.26-4.55 mm, respectively. Our value of mean R_{rl} (234.4 mg CO_2 kg^{-1} h^{-1}) was much higher than mean respiration rate from coarse woody debris (18.2 mg CO_2 kg^{-1} h^{-1}; Jomura et al. 2007). On the other hand, our value was lower than that from living fine root (828.4 mg CO_2 kg^{-1} h^{-1}; Makita et al. 2009) of *Q. serrata*, which were measured at same site.

There was a clear relationship between seasonal temperature and the R_{rl} in direct measurements in the field. The responses of R_{rl} were more sensitive to temperature for smaller root litters (0-1mm in diameter) than larger root litters(1-2 mm, 2-5 mm), which could be estimated by an exponential function (Fig. 1). The R_{rl} at 22 °C in the temperature increased with decreasing mean root diameter, which could be described by a power function (Fig. 2). In addition, there was larger variation of R_{rl} on smaller roots.

We found that R_{rl} using our direct measurement method was influenced by temperature and root diameter. These results imply that the R_{rl} based on temperature and root diameter is important indicator to clarify real root decomposition process in natural forest condition. Thus, heterotrophic respiration rate from root litter in our new method might enable us to do better understanding decomposition process in root turnover.

4. FIGURES

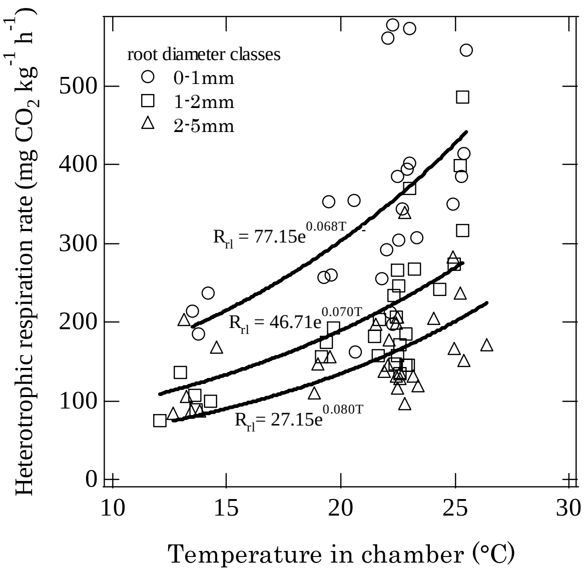

Figure 1. Relationship between heterotrophic respiration rate from the root litter (R_{rl}) and temperature in chamber (T)

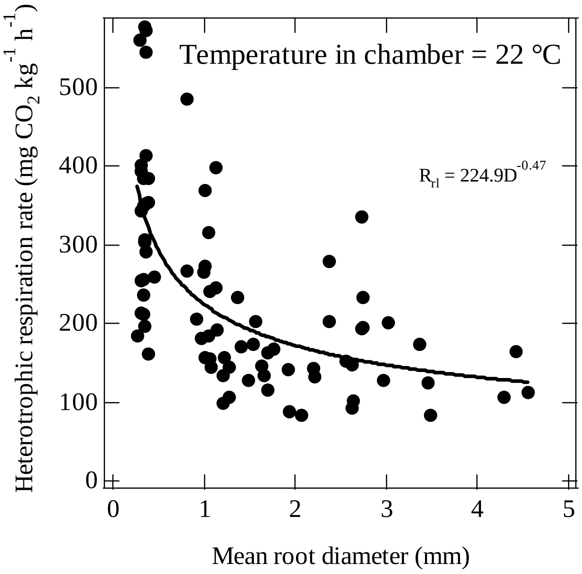

Figure 2. Relationship between heterotrophic respiration rate from the root litter (R_{rl}) and mean root diameter (D).

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