Spatial Variation of Fine Root Biomass in a Lowland Dipterocarp Forest, Peninsular Malaysia

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ABSTRACT

Distribution of fine root biomass is studied at a mature, lowland dipterocarp forest. To clarify the variability of fine root biomass in surface soils we established quadrats of 1m x 1m, 2m x 2m and 4m x 4m each in area in the Pasoh Forest Reserve, Peninsular Malaysia. We systematically collected 16 soil cores with 25cm^2 x 10cm in size at each quadrat. We extracted fine root with a diameter thinner than 5 mm and separated the fine root into three diameter classes, 0 to 1 mm, 1 to 2 mm and 2 to 5 mm. Fine root biomass with a diameter of 0 to 5 mm was estimated as 3.0 to 5.0 mg cm^{-3} at the top 10 cm soil. The coefficient of variation (CV) was higher in the 2-to-5 mm class than in thinner classes showing that the distribution of thicker fine root was more heterogeneous than thinner classes. The CV of fine root biomass with a diameter of 2 to 5 mm ranged 63 to 98%. On the other hand, the CV of fine root with a diameter of 0 to 2 mm ranged 27 to 47%. That the total fine root biomass significantly correlated with the 2-to-5 mm class, not with thinner classes, suggests that the biomass of thinner fine root shows relatively homogeneous distribution and that the variation of total fine root biomass is mainly dependent on that of the 2-to-5 mm class.

KETWORDS: carbon storage, diameter class, Pasoh Forest Reserve, surface soil, tropical forest

1. INTRODUCTION

Forest ecosystems are expected to sequester carbon (C) in their biomass and soils to mitigate carbon dioxide concentration in the atmosphere. Since tropical rain forests have huge biomass and high biological activity, they have been a crucial C reservoir in terrestrial ecosystems. In order to accurately assess the C storage in forest ecosystems, we need to evaluate the belowground part of forest biomass. Fine root, which should be the most dynamic part of belowground biomass, has central effects on changes in C storage in soils. Here we tried to determine the fine root biomass and its spatial variability in the surface soil of tropical rain forest in Malaysia.

2. MATERIALS AND METHODS

2.1. Study Site

This study was conducted at a lowland dipterocarp forest in the Pasoh Forest Reserve, Peninsular Malaysia (lat. 2˚58'N, long. 102˚19'E). Soil type around the study site was Acrisols with partial occupation by Ferralsols. Mean annual temperature is 25 ˚C and mean annual precipitation is 2000 mm in the Pasoh region. We established two 1m x 1m quadrats, one 2m x 2m quadrat and one 4m x 4m quadrat in the core area of the Pasoh Forest Reserve. Additional larger quadrats, one with 20m x 20m in area and the other with 40m x 40m in area, were also established nearby the smaller quadrats.

2.2. Fire Root Biomass Measurement

We systematically divided each quadrat to 16 subquadrats and collected one soil core with 25 cm^2 x 10 cm in size each from subquadrats. We defined the fine roots as roots with diameter of 5 mm or thinner. We extracted fine roots from soil cores by washing in tap water and sieving. Extracted roots were dried and separated into three diameter (d) classes: 0 mm < d ≤ 1 mm, 1 mm < d ≤ 2 mm, 2 mm < d ≤ 5 mm.

3. RESULTS AND DISCUSSION

Fine root biomass was estimated as 4.1 to 7.0 mg cm^{-3} for the top 5 cm soil, 1.9 to 3.8 mg cm^{-3} for the subsequent 5 cm soil and 3.0 to 5.0 mg cm^{-3} at a depth of 0 to 10 cm. Fine root biomass at the subsoil weakly correlated with that at the topsoil (r=0.4549).

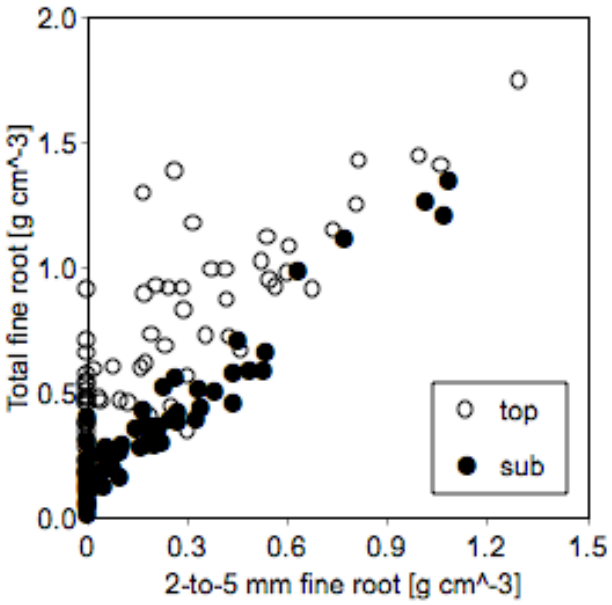

Figure 1. Total fine root mass in relation to 2-to-5 mm diameter class.

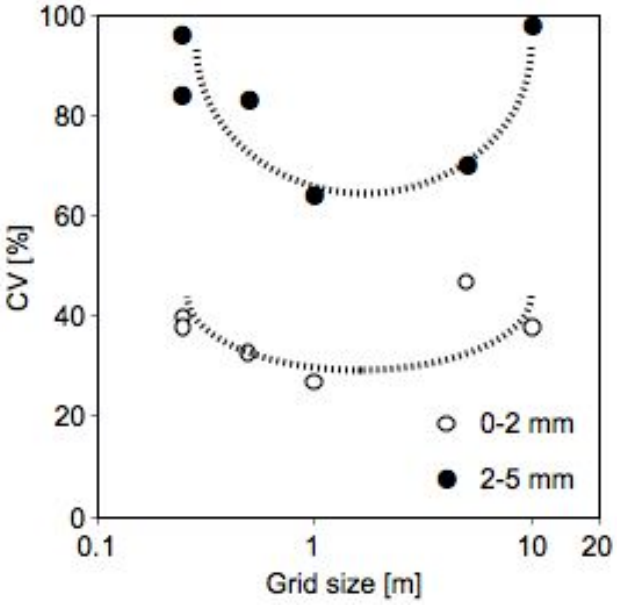

Figure 2. CV of fine root biomass (0 to 10 cm) measured at various grid sizes.

The topsoil had more 0-to-1 mm root than thicker root. While the subsoil had more 2-to-5 mm root than thinner root. Figure 1 shows that total fine root biomass highly correlated with biomass of 2-to-5 mm diameter class (r=0.8239 for top soil and r=0.9629 for sub soil). This is reflecting the fact that thicker fine root has greater biomass for shorter length or smaller number.

The coefficient of variation (CV) represents the variability of spatial distribution of fine root biomass. Fine root biomass of the 2-to-5 mm diameter class had as high as 100% of CV (Fig. 2). In contrast, thinner fine root had much smaller CV. This shows thinner fine root distributed in more homogeneous manner than thicker fine roots. Fine root with a diameter of 0 to 1 mm appeared at every soil cores. On the other hand, no thicker fine roots were found at some soil cores, e.g., 56% of soil cores were empty of 2-to-5 mm diameter class at one of 1m x 1m sites. Absence from some soil cores and existence of one piece of thicker fine root in other soil cores might cause greater variability in total fine root biomass. When the quadrats were divided into four quarter-quadrats, which contained four soil cores each, no significant difference was found among the quarter-quadrats. This suggests that fine roots distributed so sporadically even in the relatively narrow area that no statistical difference was detected.