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**FIGURE 1** Models of vertical fine root distribution in each species across different soil rock fragment content (0%, 25%, 50%, and 75%) and years of growth. The curve of each rock fragment content was derived from the *β* parameter (*P* < 0.05 for all cases and did not show). *β* was estimated by 3 repetitions as the following function: *Y* = 1-*β*d, where the cumulative root fraction of fine root (*Y*) from the surface to any depth (d). Larger values of *β* indicate deeper rooting profiles.

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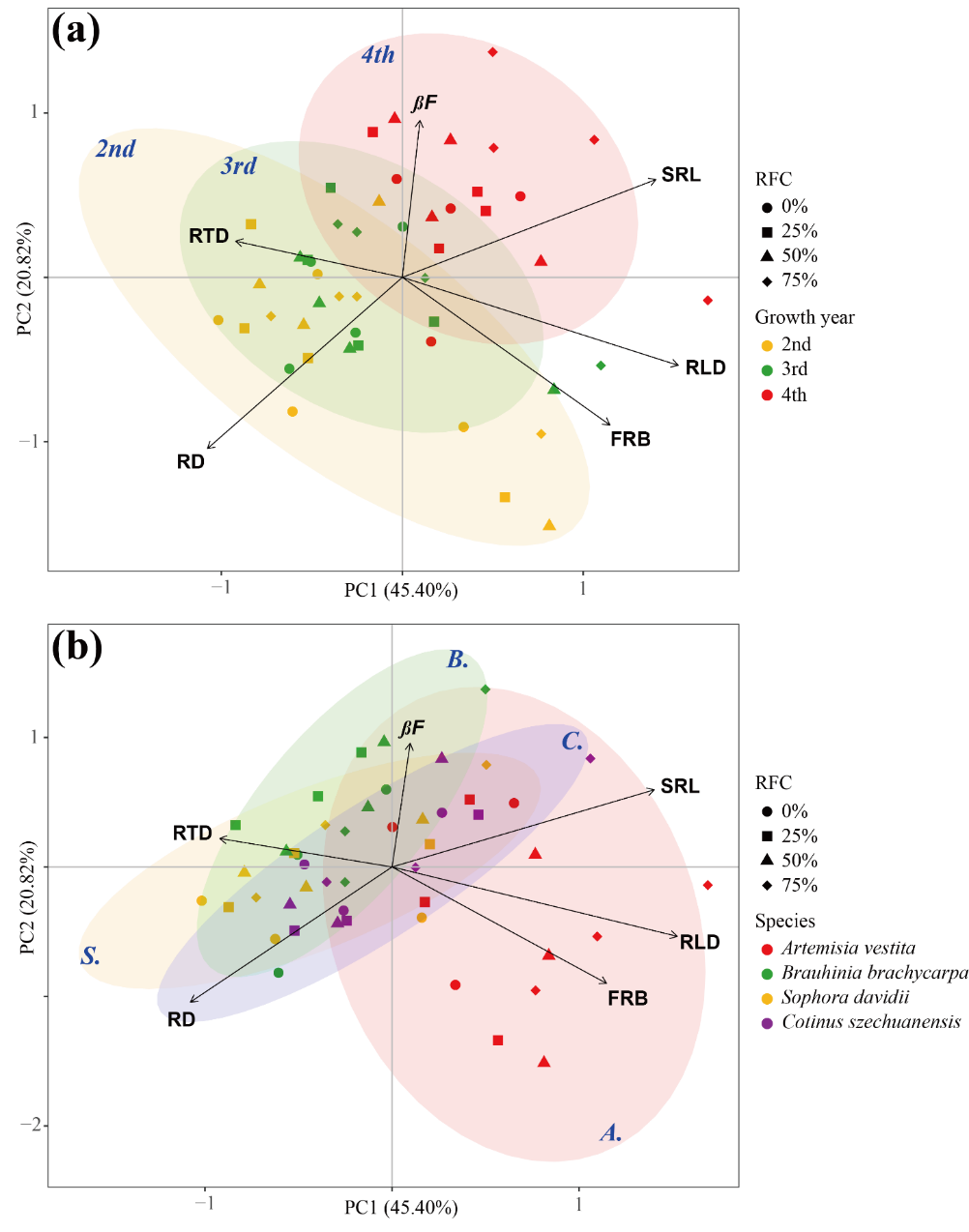
**FIGURE 2** Variation range in *β*, biomass, and morphology traits of fine root in each species between different levels of soil rock fragment content (indicated by line). Point indicated variation percentage from 0% to 25%, 50%, and 75% RFCs. Fine root traits were mean value of whole soil depth in each growth year.

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**FIGURE 3** Fine root biomass of each species at different soil depths along four soil rock fragment content (0%, 25%, 50%, and 75%) and three years of growth. Bars represent means ± SE; n = 3. Different lowercase letters indicate significant differences between rock fragment content levels, \*, \*\*, and \*\*\* designate differences at *P* < 0.1, *P* < 0.05, and *P* < 0.01, respectively.

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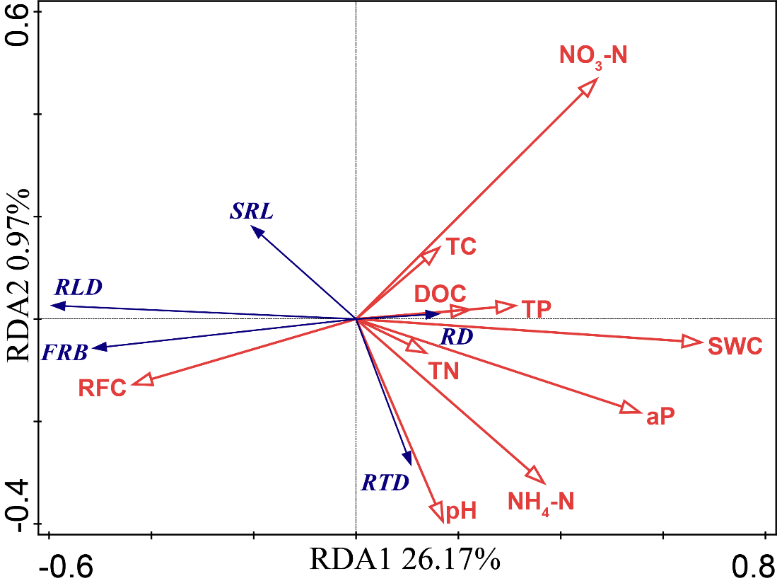
**FIGURE 4** Variation range in *β*, biomass, and morphology traits of fine root in each species between three years of growth (indicated by line). Point indicated variation percentage from the second, third, and fourth year. Fine root traits were mean value of whole soil depth in each growth year.

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**FIGURE 5** Principal component analysis of fine root traits (means of total soil layers) of the four species along rock fragment content gradient and years of growth. The proportion explained of Axis 1 and Axis 2 are 45.40% and 20.82%, respectively. Solid black lines indicate six fine root functional traits. The confidence circle represents the 95% confidence interval between growth years (a), yellow is 2nd, the green is3rd and the red is 4rd. The confidence circle represents the 95% confidence interval between species (b), the red is *A.* (*Artemisia vestita*), the green is *B.* (*Bauhinia brachycarpa*), the yellow is *S.* (*Sophora davidii*) and the blue is *C.* (*Cotinus szechuanensis*). Abbreviations for root traits are as follow: *βF*, *β* of fine root; FRB, fine root biomass; RLD, fine root length density; SRL, specific fine root length; RD, root diameter; RTD, fine root tissue density.

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**FIGURE 6** Relationships between fine root traits and soil properties in soil profile across years of growth and along rock fragment content gradient.

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**FIGURE 7** Redundancy analysis of fine root traits and soil properties along rock fragment content gradient in second and third year. The proportion explained of Axis 1 and Axis 2 are 26.17% and 0.97%, respectively. Solid blue lines indicate fine root traits in each soil depth. Solid red lines indicate soil properties in each soil depth. Abbreviations for root traits are as follow: FRB, fine root biomass; RLD, fine root length density; SRL, specific fine root length; RD, fine root diameter; RTD, fine root tissue density; RFC, rock fragment content; SWC, soil water content; TC, total soil carbon; TN, total soil nitrogen; TP, total soil phosphorus; DOC, soil soluble carbon; NH4-N, soil ammonium nitrogen; NO3-N, soil nitrate nitrogen; aP, soil available phosphorus.