附录3　本研究功能α和β多样性指数的计算公式

Appendix 3　The formulas of the functional α and β diversity indices calculated in this study

多样性类型 Diversity type	多样性指标 Diversity index	计算公式 Calculation formula	参考文献 Reference
功能α多样性 Functional α diversity	功能丰富度 (*FRic*)	$FRic = \frac{SF_{ic}}{R_c}$	Mason et al, 2005; Villéger et al, 2008
	功能均匀度 (*FEve*)	$EW_l = \frac{dist(i,j)}{w_i + w_j}$ $PEW_l = \frac{EW_l}{\sum_{l=1}^{s-1} EW_l}$ $FE_{ve} = \frac{\sum min(PEW_l, \frac{1}{S-1}) - \frac{1}{S-1}}{1 - \frac{1}{S-1}}$	
	功能离散度 (*FDiv*)	$g_k = \frac{1}{S} \cdot \sum_{i=1}^{s} x_{ik}$ $dG_i = \sqrt{\sum_{k=1}^{T} (x_{ik} - g_k)^2}$ $\overline{dG} = \frac{1}{S} \sum_{i=1}^{s} dG_i$ $\Delta d = \sum_{i=1}^{s} W_i$ $\Delta \lvert d \rvert = \sum_{i=1}^{s} W_i \times \lvert dG_i - \overline{dG} \rvert$ $FD_{iv} = \frac{\Delta d + \overline{dG}}{\Delta \lvert d \rvert + \overline{dG}}$	
功能β多样性 Functional β diversity	βsør	$\beta sør = \frac{V(C1) + V(C2) - 2 * V(C1 \cap C2)}{V(C1) + V(C2) - V(C1 \cap C2)}$	
	βnes	$\beta nes = \frac{\lvert V(C1) - V(C2) \rvert}{V(C1) + V(C2) - V(C1 \cap C2)} * \frac{V(C1 \cap C2)}{2 * \min(V(C1), V(C2)) - V(C1 \cap C2)}$	Villéger et al, 2013
	βtur	$\beta tur = \frac{2 * \min(V(C1), V(C2)) - 2 * V(C1 \cap C2)}{2 * \min(V(C1), V(C2)) - V(C1 \cap C2)}$	

SF_{ic}指群落中物种所占据的生态位; R_c指特征值的绝对值; $dist(i, j)$为物种和的欧氏距离; S为物种数; w_i为物种i的相对丰富度; l为分支长; PEW_l为分支长权重; x_{ik}为物种i性状k的重心; g_k 为性状k的重心; dG_i为到重心的欧氏距离; $\overline{dG}$为物种到重心的平均距离; Δd为丰度加权偏加的总和;

$\Delta|d|$为物种i与重心的平均距离。

C1 和 *C2* 代表两个群落, *V(C1)*和 *V(C2)*分别代表这两个群落中物种功能特征所占空间体积; $V(C1 \cap C2)$代表两个群落功能空间相交部分的体积。

SF_{ic} is the niche space filled by the species within the community; R_c is the absolute range of the character; $dist(i, j)$ is the Euclidean distance between species i and j; S is species numbers; w_i is the relative abundance of species i; l is the length of the branch; PEW_l is weight of branch length; x_{ik} is the coordinate of species i on trait k; g_k is the center of gravity of trait k; dG_i is the Euclidean distance to this center of gravity; $\overline{dG}$ is the mean distance of the S species to the center of gravity; Δd is the sum of abundance-weighted deviances; $\Delta|d|$ is the absolute abundance-weighted deviances for distances from the center of gravity.

C1 and *C2* represent two communities, and V(*C1*) and V(*C2*) is the spatial volume occupied by the functional traits of species in these two communities respectively. $V(C1 \cap C2)$ is the volume of the intersection part of the functional space of two communities.

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