Nutrient enrichment modifies temperature-biodiversity relationships in large-scale field experiments [#]

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Background

Spatial patterns of biodiversity are a core topic in ecology; however, the mechanisms driving these patterns remain unclear. Climate effects and human impacts, i.e., nutrient enrichment, simultaneously drive spatial biodiversity patterns. However, there is little consensus about their independent effects on biodiversity.

Here, we conducted comparative field experiments on two mountainsides — in Norway and China — to examine the independent effects of temperature and nutrient enrichment on aquatic bacterial species richness and community composition.

Results

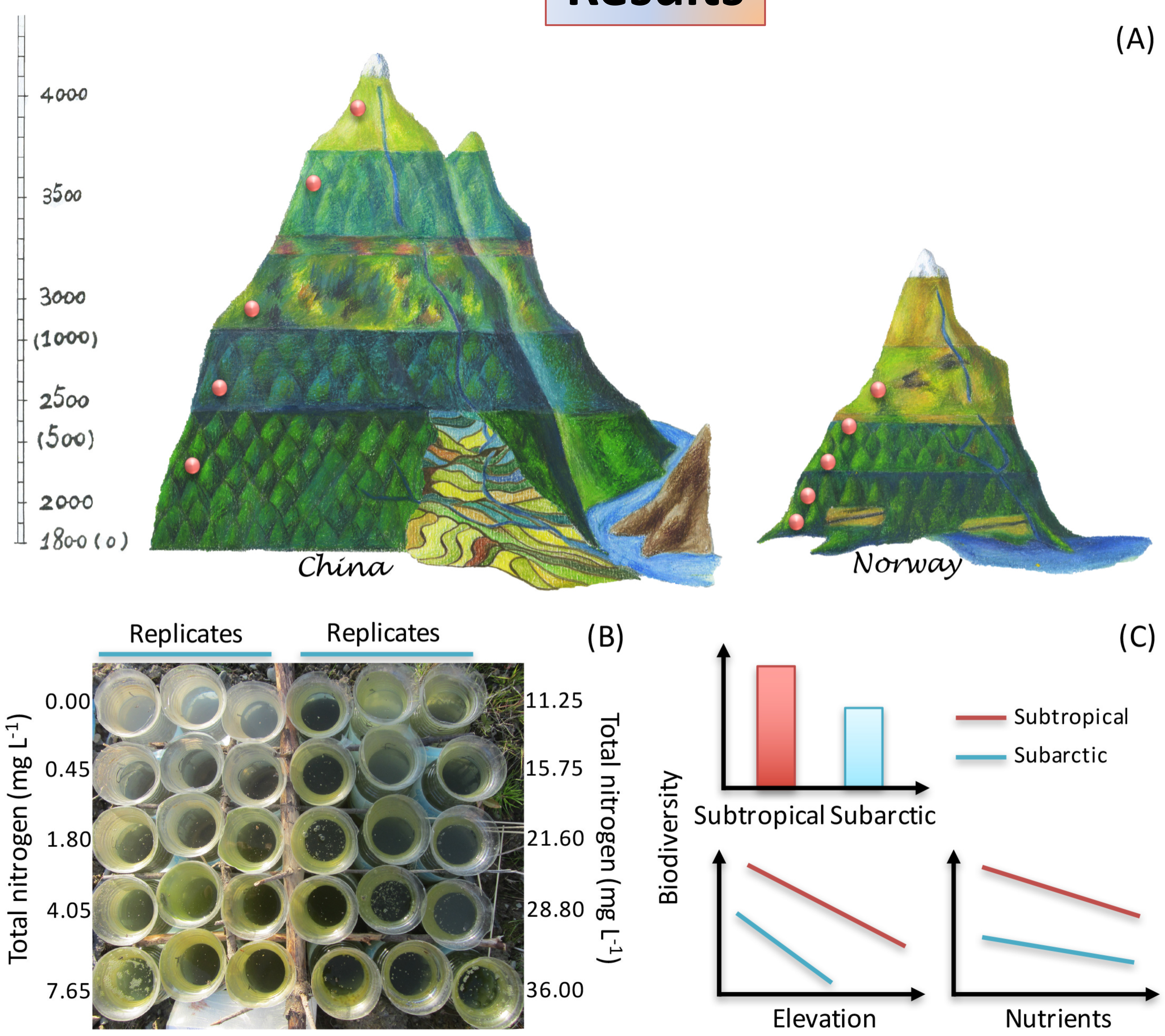

Figure 1 The manipulation of nutrient enrichment along elevational gradients. The experiments were conducted in parallel in the mountains of the subtropical (i.e., China, left panel) and subarctic (i.e., Norway, right panel) regions (A). Along each mountainside, sterile microcosms with ten nutrient levels and three replicates at each level (B, field photo) were set up at each of five elevations, indicated by the brown dots (A), and were left in the field for one month. The nutrient levels were indicated by nitrogen because the ratio between nitrogen and phosphorus was consistent (B).

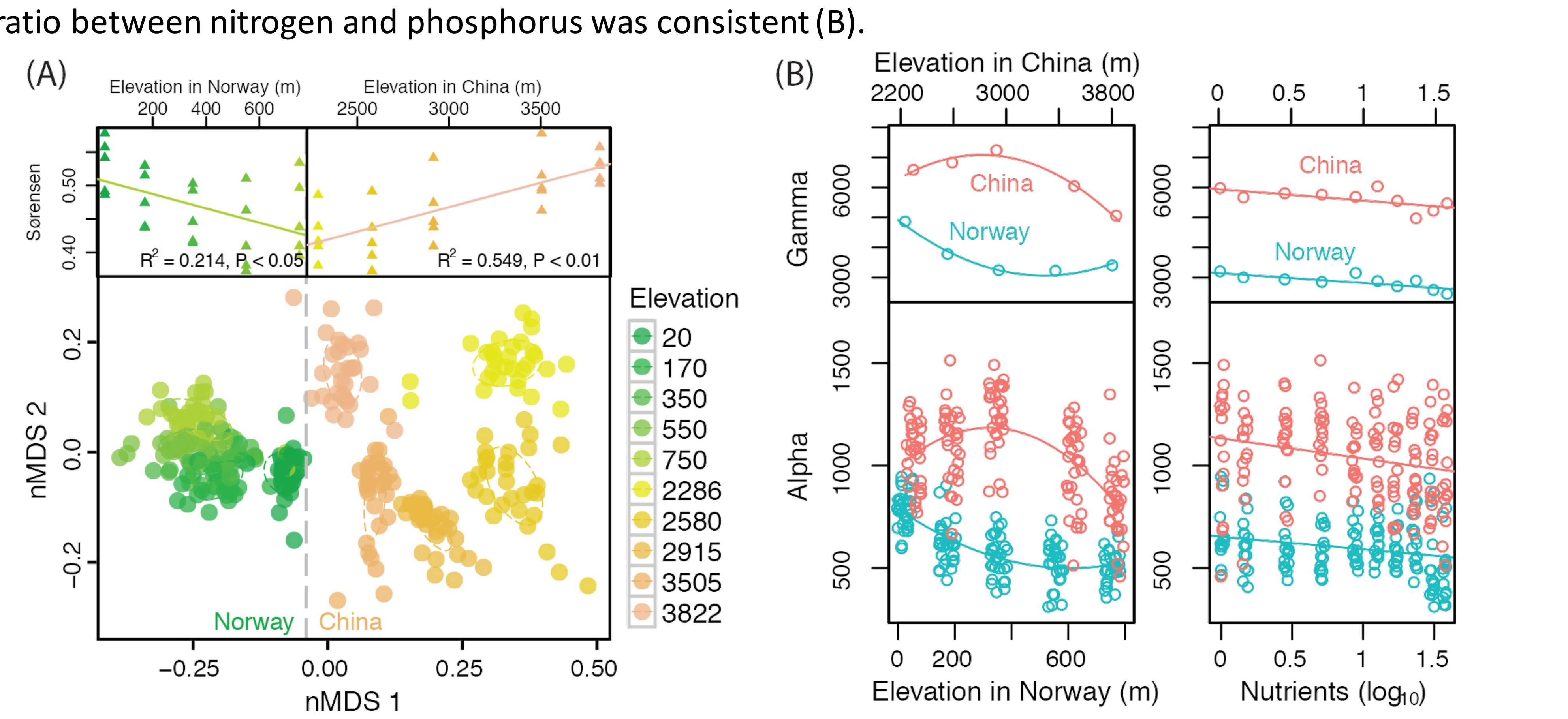

Figure 2 Responses of community composition and diversity to elevation and nutrients.

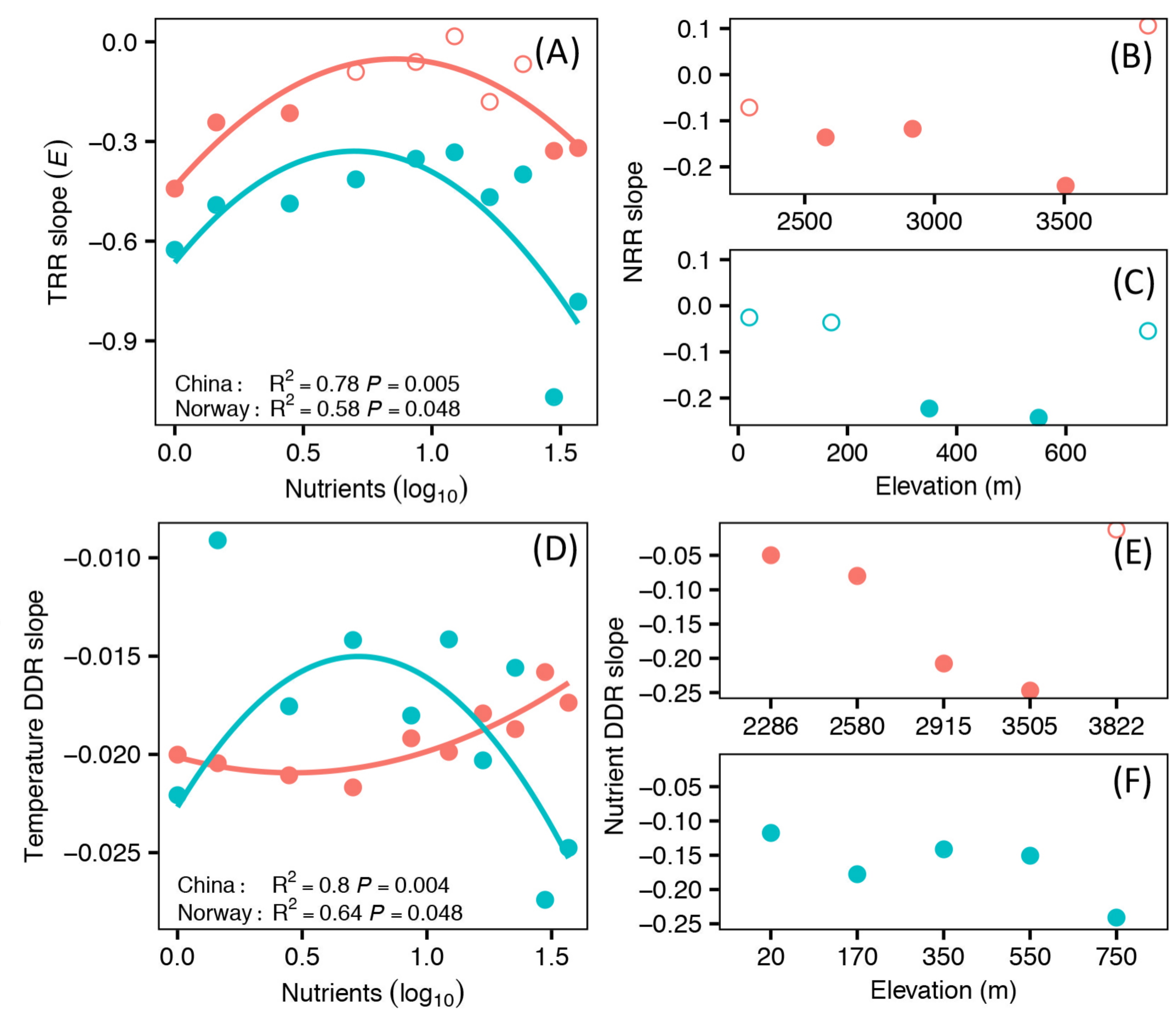

Figure 3. The variation of the temperature or nutrient dependence of biodiversity. Species richness plots (A-C): The slopes of the temperature-richness relationship (TRR) and nutrient-richness relationship (NRR) along nutrient enrichment (A) and elevation gradients (B, C), respectively. Community similarity plots (D-F): The slopes of the temperature distance-decay relationship (DDR) and nutrient DDR along nutrient enrichment (D) and elevation gradients (E, F), respectively.

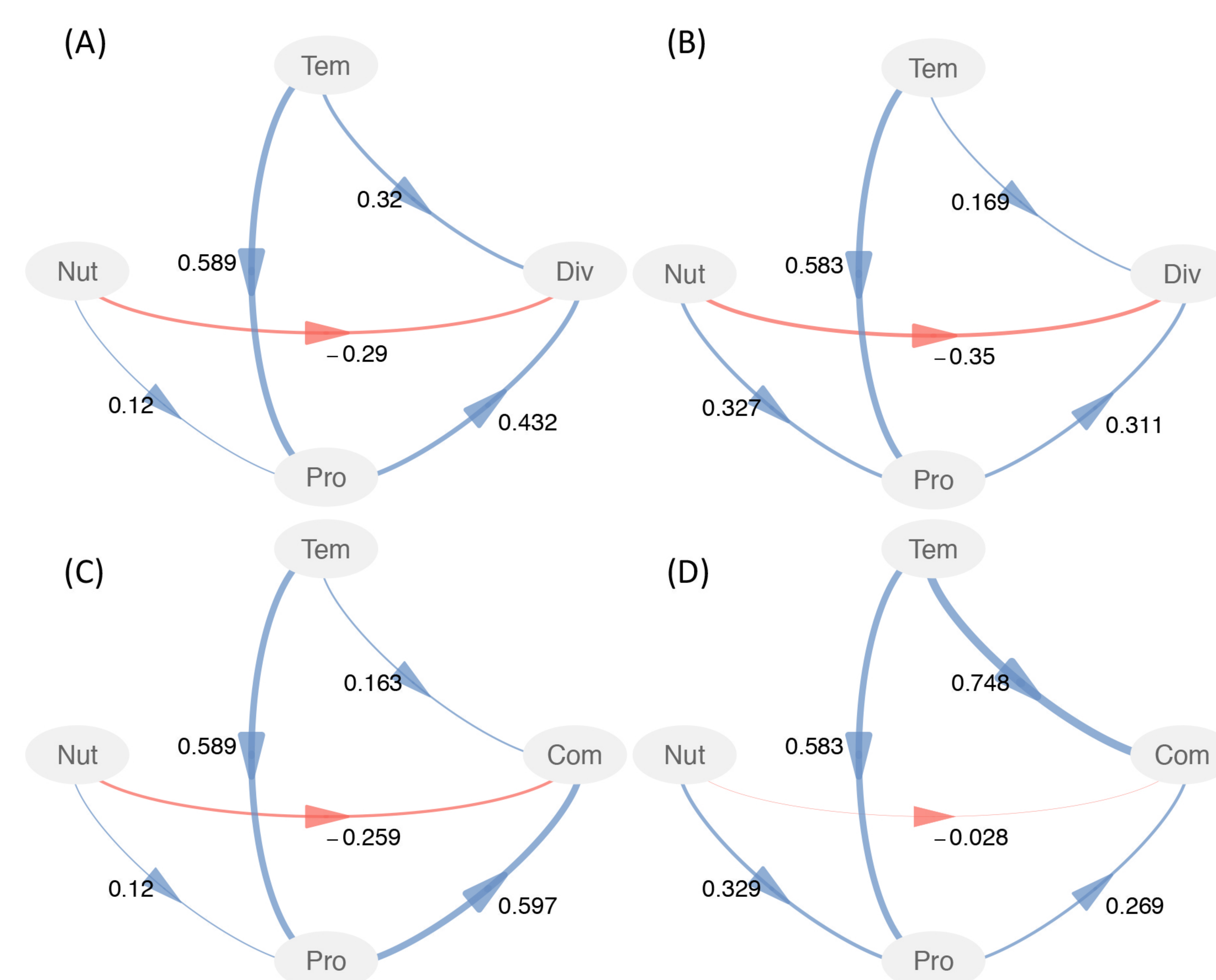

Figure 4. The direct and indirect effects of temperature and nutrients on biodiversity. The effects of temperature (Tem), nutrient enrichment (Nut) and primary productivity (Pro) on bacterial diversity (Div) and community composition (Com) for Norway (A, C) and China (B, D), explored with partial least squares path model.

Conclusions

- Clear segregation of bacterial species along temperature gradients, and decreasing alpha and gamma diversity towards higher nutrients.
- The temperature dependence of species richness is greatest at extreme nutrient levels, whereas the nutrient dependence of species richness is strongest at intermediate temperatures.
- For species turnover rates, temperature effects are strongest at intermediate and two extreme ends of nutrient gradients in subtropical and subarctic regions, respectively. Species turnover rates caused by nutrients do not increase toward higher temperatures.
- We documented the direct effects of temperature and nutrient enrichment on biodiversity, and also showed that both factors indirectly affected communities through primary productivity.

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