Interhemispheric comparison of scale-dependent spatial variation in the structure of intertidal rocky-shore communities

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Abstract. In rocky intertidal habitats, the pronounced increase in environmental stress with elevation, caused by tides, generates significant vertical variation in community structure. Along coastlines, environmental changes generate horizontal biological variation, which, when measured at large sampling intervals, generally surpasses vertical biological variation. It is unknown, however, how vertical biological variation compares with horizontal biological variation when the latter is measured in environmentally similar habitats. We tested the hypothesis that, for sites experiencing similar environmental conditions along the shore, horizontal biological variation does not surpass vertical biological variation even when horizontal variation is measured at large sampling intervals along the coast. We compared vertical and horizontal variation in intertidal communities by surveying habitats experiencing the same wave exposure on the NW Atlantic and SE Pacific coasts. We measured biological variation based on differences in species richness, occurrence, and abundance between quadrats from low and high elevations (vertical variation) and between quadrats at three horizontal scales of sampling interval on both coasts: local (tens of cm between quadrats), meso- (~100 km between quadrats), and regional (~200 km between quadrats). We measured biological variation for all species combined, separately for sessile and mobile species, and for the numerically dominant species. The data analyses indicated that horizontal biological variation was never higher than vertical biological variation, not even at the regional scale, providing support for our hypothesis. Overall, our findings suggest that studies comparing spatial scales of biological variation should consider the underlying environmental variation in addition to simply scale alone.

Key words: Bray–Curtis index; community structure; intertidal; Raup–Crick index; spatial scale; spatial variation; species richness.

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INTRODUCTION

Defining the spatial domain in which models provide explanatory power, i.e., their generality, is a major aim of ecology (Menge 1991, Beck 1997a, b, Kelaher et al. 2004). Spatial community patterns have often been investigated to infer model generality, but a large variability is typically present due to the context dependency of ecological processes (Underwood and Petraitis 1993, Menconi et al. 1999, Kelaher et al. 2004). Spatial community patterns depend on the scale of observation, so patterns that are evident at certain scales may be absent at others (Wiens 1989, Coleman 2002, Davies et al. 2005, Martins et al. 2008, Harris et al. 2015).
Intertidal habitats (those between the highest and lowest tides on marine shores) have been particularly convenient to investigate spatial variability in communities (Menconi et al. 1999, Díaz-Tapia et al. 2013). The nearly unidimensional nature of intertidal habitats, being much longer than wide when viewed along kilometers of coastline, facilitates comparisons of biological variation among “horizontal” scales of observation. Horizontal variation in community structure is generated by a combination of abiotic factors, biotic interactions, priority effects (i.e., competitive dominance given by early coloniza-
tion), and dispersal processes (Underwood and Chapman 1996, Benedetti-Cecchi et al. 1999, Chase and Leibold 2003, Leibold et al. 2004). All of these factors can generate patterns at different spatial scales (Leibold et al. 2004).

Despite intertidal habitats being relatively narrow, they also exhibit “vertical” biological variation. The daily alternation of high and low tides determines a sharp increase in abiotic stress related to changes in temperature, desiccation, irradiance, and osmotic potential from low to high elevations. Such environmental variation, directly or indirectly (through changes in interspecific interactions), ultimately causes vertical zonation patterns in which species replace one another across intertidal elevations (Menge and Branch 2001, Harley and Helmost 2003, Benedetti-Cecchi et al. 2006, Scrosati and Heaven 2007, Zwierschke et al. 2013).

As a step to categorize sources of variation in intertidal communities, it has recently become of interest to compare vertical and horizontal biological variation. For example, studies on marine rocky shores have found that vertical variation in community structure was higher than horizontal variation measured at local scales from tens of cm to a few m, but lower than horizontal variation measured at regional scales from tens to hundreds of km (Benedetti-Cecchi 2001, Valdivia et al. 2011). Those studies measured regional biological variation across sites differing in abiotic factors such as wave exposure and substrate type, which likely explains the observed increase in biological variation with distance. Thus, if sites with similar conditions in terms of these factors are compared, vertical biological variation could actually remain larger than, or at least similar to, biological variation measured horizontally at regional scales, provided enough time (e.g., even just a few decades) has passed for community homogenization along the coast. This scenario, however, might not occur if, for example, dispersal limitation (Nekola and White 1999, Heino et al. 2015, Soininen 2016) had the chance to influence horizontal biological variation along the shore. Overall, then, how vertical biological variation compares with horizontal biological variation at increasing alongshore distances across environmentally similar sites is not fully clear. To address this knowledge gap, we conducted a mensurative study to contrast vertical biological variation with horizontal biological variation measured from local to regional scales across environmentally similar sites. To determine whether patterns are generalizable to systems representing different species pools and environments (Fraschetti et al. 2005, Dal Bello 2016), we analyzed two datasets representing two oceans and both hemispheres, one dataset from the NW Atlantic coast and one from the SE Pacific coast.

Spatial scale can be defined as sampling grain or resolution (area of each sampling unit), extent (total area surveyed by the study), or sampling interval (distance between sampling units; Palmer and White 1994, Legendre and Legendre 1998, Leponce et al. 2004). We measured horizontal biological variation in terms of sampling interval at local scale (variation between quadrats tens of cm apart), mesoscale (between quadrats ~100 km apart), and regional scale (between quadrats ~200 km apart). Biological variation should in principle be captured better by indices that are based on the abundance of species than those based on species presence/absence or just the number of species (richness). Thus, we used measures of variation that span a gradient of information: from differences in species richness, to those based on species occurrence, and to those based on species abundance. Both datasets describe the abundance of rocky intertidal seaweeds and invertebrates at two elevation zones measured along the shore from local to regional scale. For each of the two studied coasts, we ensured environmental similarity among sites by sampling sites with similar substrate type and wave exposure, as these factors have a large influence on intertidal community structure (Menge and Branch 2001, Heaven and Scrosati 2008).
MATERIALS AND METHODS

We compared vertical and horizontal biological variation for two temperate coasts: the NW Atlantic coast (NWA, hereafter) and the SE Pacific coast (SEP, hereafter). The data on seaweed and invertebrate abundance for NWA were measured in May 2008 and have been published by Watt and Scrosati (2014). The data for SEP were measured between June and August 2012 and have been published by Catalán and Valdivia (2019).

For NWA, we surveyed Taylor Head (44°49’ N, 62°34’ W), an unnamed site near Tor Bay Provincial Park (45°11’ N, 61°21’ W), and Godie Point (45°37’ N, 60°49’ W), on the Atlantic coast of Nova Scotia, Canada. We only sampled wave-sheltered habitats, which are protected from direct oceanic swell by rocky structures such as islets. Along the studied coastal range, wave-sheltered habitats are consistently characterized by the marked predominance of the canopy-forming seaweed *Ascophyllum nodosum*, making these habitats easy to identify (Watt and Scrosati 2013a, b). Moreover, in situ measurements done in these wave-sheltered habitats using dynamometers (see design in Bell and Denny 1994) have indicated that values of daily maximum water velocity (an indication of wave exposure) are between 3 and 6 m/s (Scrosati and Heaven 2007), consistently lower than the values of up to 12 m/s measured in wave-exposed habitats that face the open ocean directly in Nova Scotia (Hunt and Scheibling 2001). The studied habitats are pristine, without any evident signs of anthropogenic influences (Watt and Scrosati 2014), and have a similar substrate rugosity and slope.

For SEP, we surveyed Cheuque (39°24’ S, 73°13’ W), Calfuco (39°47’ S, 73°23’ W), and Pucatrihue (40°32’ S, 73°42’ W), on the Pacific coast in Chile. We only surveyed wave-exposed habitats, which are characterized by all of them facing the open waters of the Pacific Ocean directly, without any physical obstructions (Tejada-Martínez et al. 2016). While we deployed dynamometers in the study sites, most were lost due to strong waves or vandalism. Nevertheless, the upper intertidal zone of wave-exposed habitats in this region is consistently characterized by the dominance of the chthamalid barnacle *Fehlius cirratus* (Moreno 2001), which is also observed along northern areas of the Chilean coast (Broitman et al. 2001, Valdivia et al. 2015). The studied habitats are subjected to a comparable degree of harvesting (Moreno 2001) and exhibit a similar rugosity and slope of the substrate.

At each of the three study sites on each coast, we surveyed 20 × 20 cm (NWA) and 50 × 50 cm (SEP) quadrats located at the high and low intertidal zones. At each zone, locations for quadrats were haphazardly selected, ensuring that quadrats were spaced at least a few tens of cm from one another along a transect following the shoreline (Fig. 1). For each coast, the low zone was the lower third of the intertidal range, while the high zone was the upper third of the intertidal range. We considered the intertidal range to be the vertical distance between 0 m (chart datum: lowest normal tide in Canada and mean lower low water in Chile) and an upper boundary determined using ecological indicators. For NWA, the upper boundary was at 1.5 m of elevation above chart datum, which was the upper distribution limit of fucoid seaweed canopies (Watt and Scrosati 2013a). For SEP, the upper boundary was at 4 m of elevation, which was the upper distribution limit of the barnacle *Fehlius cirratus*. Therefore, the low intertidal zone ranged between 0 and 0.5 m of elevation at NWA and 0–1.3 m at SEP, while the high zone ranged between 1 and 1.5 m at NWA and 2.6–4 m at SEP. We used a total of 550 quadrats at NWA (275 at each of the high and low intertidal zones) and 118 at SEP (59 at each of the high and low intertidal zones). For each quadrat, species abundance was quantified as percent cover for sessile and mobile taxa in NWA and as percent cover for sessile taxa and density for mobile taxa in SEP, following Dethier et al. (1993) and Scrosati and Heaven (2007). All macrobenthic (>1 mm) organisms were identified at the lowest possible taxonomic level, usually species. Nevertheless, some taxonomic identities were identified at genera and family level.

For NWA and SEP, we determined vertical and horizontal variation (at local, meso-, and regional scales) in community structure by separately calculating three indices. Each index measures biological variation between two quadrats. The simplest index was the coefficient of variation for species richness (CV), richness calculated for each quadrat as the number of species found...
therein. Thus, CV considers neither difference in species identity nor in species abundance between the two quadrats. Coefficient of variation for species richness is 0 when both quadrats have the same richness and positive when richness differences exist. The second index was the Raup–Crick dissimilarity index (RC), which calculates variation based on differences in species occurrence (presence/absence) between two quadrats (Legendre and Legendre 1998, Chase et al. 2011). Thus, RC considers differences in species identity but not in species abundance (just presence vs. absence) between the two quadrats. Raup–Crick dissimilarity index ranges between 0 (when both quadrats have the same species) and 1 (when both quadrats do not share any species). The third index was the Bray–Curtis dissimilarity index (BC), which calculates variation based on differences in species abundance between two quadrats. Bray–Curtis dissimilarity index ranges between 0 (when both quadrats have the same species with equal abundances) and 1 (when both quadrats do not share any species; Stevens 2009). These three indices of variation represent a gradient of increasing information from CV to RC to BC.

For both coasts, we determined vertical biological variation by calculating CV, RC, and BC for pairs of quadrats (randomly selected from each site) with one quadrat from the high intertidal zone and the other from the low zone. We determined horizontal variation at local, meso-, and regional scales separately for the high and low zones. For the local scale, we calculated the above three indices for random pairs of quadrats from the same site, the two quadrats in each pair being tens of cm apart. For the mesoscale, the pairs included one random quadrat from one site and one from the next site along the coast (thus, the two quadrats in each pair were ~100 km apart). In this case, the estimate of mesoscale variability also includes the within-site (local) variation. For the regional scale, the pairs of quadrats included one random quadrat from each of the two most distant sites (so the two quadrats in each pair were ~200 km apart). Such variability also includes the local and mesoscale variation. To use independent measures of vertical and horizontal variation, each surveyed quadrat was used only in one pair of quadrats (Underwood and Chapman 1998, Benedetti-Cecchi 2001, Valdivia et al. 2011). For the NWA coast, we used 45 replicate pairs for the vertical scale and, at each of the high and low zones, 24 replicate pairs for the
local scale, 46 for the mesoscale, and 45 for the regional scale. For the SEP coast, we used nine replicate pairs for the vertical scale and, at each of the high and low zones, nine replicate pairs for the local scale, and eight for the meso- and regional scales.

We compared vertical and horizontal biological variation primarily using the data of all species considered together. These data allowed us to calculate CV and RC for both NWA and SEP, but BC could only be calculated for NWA because the abundance of sessile and mobile

![Intertidal height](image)

Fig. 2. Vertical biological variation and horizontal biological variation (mean ± standard error) measured at local, meso-, and regional scales at the low and high intertidal zones on the NW Atlantic and SE Pacific coasts based on data for sessile and mobile species combined. Variation was calculated based on the coefficient of variation for species richness (A–B), on the Raup–Crick dissimilarity index (C–D), and on the Bray–Curtis dissimilarity index (E). Asterisks above the bars describing horizontal variation indicate statistically significant differences relative to vertical variation.
species was calculated differently for SEP. Because mobile species change places frequently while sessile species cannot, we also compared vertical and horizontal variation separately for sessile and mobile species. As abundance was measured in the same way for species within each of those two functional groups, we were able to calculate BC (in addition to CV and RC) for NWA as well as SEP for both groups. Finally, we also calculated CV for dominant species: *Ascophyllum nodosum* (seaweed) and *Perumytilus purpuratus* (mussel), which were the most abundant species for NWA and SEP, respectively. Those species are autogenic ecosystem engineers (Jones et al. 1994), so they can influence patterns of variation for entire communities.

Separately for NWA and SEP, for CV, RC, and BC, and for all species combined, sessile species only, mobile species only, and dominant species, we compared vertical variation with horizontal variation at the three studied scales by running Dunnett’s pairwise tests (Quinn and Keough 2002), considering vertical variation as the reference. To maintain the groupwise type 1 error rate at 0.05, Dunnett’s test adjusts the per-comparison error rate according to the number of comparisons done for a group, which was six for all cases in this study (three comparisons done for each of both elevation zones). We conducted these analyses using R version 3.5.1 (R Core Team 2018).

### RESULTS

Regardless of the used metric (CV, RC, or BC) or sampled coast (NWA or SEP), horizontal biological variation was never higher than vertical

Table 1. Summary information for Dunnett’s pairwise tests.

| Index | Local scale | Mesoscale | Regional scale |
|-------|-------------|-----------|----------------|
|       | Low | High | Low | High | Low | High | Low | High |
| NW Atlantic coast Community | | | | | | | | |
| C.V. Richness | −7.8 | <0.01 | −6.3 | <0.01 | −9.1 | <0.01 | −5.9 | <0.01 | −8.8 | <0.01 | −6.2 | <0.01 |
| Raup–Crick | −1.7 | 0.3 | −2.6 | <0.05 | −2.6 | <0.05 | −3.5 | <0.01 | −2.3 | <0.05 | −2.4 | <0.05 |
| Bray–Curtis | −1.6 | 0.4 | −2.1 | 0.2 | −1.7 | 0.4 | 0.6 | 1.0 | −1.4 | 0.5 | −1.3 | 0.07 |
| Sessile | | | | | | | | |
| C.V. Richness | −6.7 | <0.01 | −6.1 | <0.01 | −6.6 | <0.01 | −4.5 | <0.01 | −6.1 | <0.01 | −5.6 | <0.01 |
| Raup–Crick | −1.1 | 0.8 | −0.6 | 1.0 | −1.6 | 0.4 | −1.6 | 0.4 | −0.7 | 1.0 | −2.0 | 0.2 |
| Bray–Curtis | −1.5 | 0.5 | −1.9 | 0.3 | −1.5 | 0.5 | 0.7 | 1.0 | −1.3 | 0.7 | −1.1 | 0.8 |
| Mobile | | | | | | | | |
| C.V. Richness | −3.5 | <0.05 | −3.0 | <0.05 | −4.2 | <0.01 | −3.9 | <0.01 | −5.1 | <0.01 | −1.1 | 0.8 |
| Raup–Crick | −2.7 | <0.05 | −3.1 | <0.05 | −3.4 | <0.05 | −2.7 | <0.05 | −4.0 | <0.01 | 0.3 | 1.0 |
| Bray–Curtis | −2.8 | <0.05 | −5.0 | <0.01 | −3.1 | <0.05 | −3.7 | <0.01 | −3.8 | <0.01 | −0.9 | 0.9 |
| Ascophyllum nodosum | | | | | | | | |
| C.V. abundance | −0.9 | 0.9 | −1.5 | 0.5 | −0.1 | 1.0 | 0.6 | 1.0 | −1.3 | 0.7 | −0.5 | 0.9 |
| SE Pacific coast Community | | | | | | | | |
| C.V. Richness | −2.2 | 0.2 | −1.8 | 0.3 | −1.1 | 0.8 | −2.9 | <0.05 | −1.6 | 0.4 | −1.9 | 0.3 |
| Raup–Crick | −2.1 | 0.2 | −4.5 | <0.01 | −3.0 | <0.05 | −4.4 | <0.01 | −2.7 | <0.05 | −4.4 | <0.01 |
| Sessile | | | | | | | | |
| C.V. Richness | −1.0 | 0.8 | −2.4 | 0.1 | −0.2 | 1.0 | −2.6 | 0.1 | −0.7 | 0.9 | −1.8 | 0.3 |
| Raup–Crick | −2.7 | <0.05 | −5.5 | <0.01 | −2.7 | <0.05 | −5.3 | <0.01 | −2.6 | <0.05 | −5.3 | <0.01 |
| Bray–Curtis | −1.7 | 0.4 | −0.8 | 0.9 | −2.3 | 0.1 | −0.4 | 1.0 | −1.8 | 0.3 | 0.6 | 1.0 |
| Mobile | | | | | | | | |
| C.V. Richness | −1.4 | 0.5 | −1.1 | 0.8 | −1.2 | 0.7 | −1.3 | 0.6 | −1.9 | 0.3 | −1.4 | 0.6 |
| Raup–Crick | −0.4 | 1.0 | −2.3 | 0.1 | −0.7 | 1.0 | −2.2 | 0.1 | −1.3 | 0.6 | −2.2 | 0.1 |
| Bray–Curtis | −0.6 | 1.0 | −0.6 | 1.0 | −1.3 | 0.6 | −0.4 | 1.0 | −1.1 | 0.7 | 1.4 | 0.5 |
| Perumytilus purpuratus | | | | | | | | |
| C.V. abundance | −3.6 | <0.01 | −2.4 | 0.09 | −3.4 | <0.01 | −1.8 | 0.3 | −3.9 | <0.01 | −1.8 | 0.3 |

**Notes:** We compared vertical variation with horizontal variation at the three studied scales (local, meso, and regional) at two intertidal elevations (low and high). Significant differences between vertical and horizontal variation are indicated in bold.
biological variation considering all species together (Fig. 2, Table 1). Based on CV data, horizontal variation was always lower than vertical variation for NWA, but similar to vertical variation in all but one case for SEP (mesoscale at high elevations, for which it was lower). Based on RC data, horizontal variation was lower than vertical variation for both NWA and SEP in all but the same case (local scale at low elevations, for which it was similar). Based on BC data, horizontal variation was always similar to vertical variation for NWA.

Considering only sessile species, horizontal biological variation was also never higher than vertical variation (Fig. 3, Table 1). Based on CV data, horizontal variation was always lower than

![Intertidal height graph](image_url)

Fig. 3. Vertical biological variation and horizontal biological variation (mean ± standard error) measured at local, meso-, and regional scales at the low and high intertidal zones on the NW Atlantic and SE Pacific coasts based on data only for sessile species. Variation was calculated based on the coefficient of variation for species richness (A–B), on the Raup–Crick dissimilarity index (C–D), and on the Bray–Curtis dissimilarity index (E–F). Asterisks above the bars describing horizontal variation indicate statistically significant differences relative to vertical variation.
vertical variation for NWA and always similar to vertical variation for SEP. Based on RC data, horizontal variation was always similar to vertical variation for NWA and lower than vertical variation in all cases but one for SEP (regional scale at low elevations, for which it was similar). Based on BC data, horizontal variation was always similar to vertical variation for both NWA and SEP.

Considering only mobile species, horizontal biological variation was, again, never higher than vertical variation (Fig. 4, Table 1). Regardless of the used metric (CV, RC, or BC), horizontal variation was lower than vertical variation in all but one case for NWA (regional scale at high elevations, for which it was similar). At SEP, horizontal variation was always similar to vertical variation.

**Fig. 4.** Vertical biological variation and horizontal biological variation (mean ± standard error) measured at local, meso-, and regional scales at the low and high intertidal zones on the NW Atlantic and SE Pacific coasts based on data only for mobile species. Variation was calculated based on the coefficient of variation for species richness (A–B), on the Raup–Crick dissimilarity index (C–D), and on the Bray–Curtis dissimilarity index (E–F). Asterisks above the bars describing horizontal variation indicate statistically significant differences relative to vertical variation.
Considering only the dominant species, horizontal variation was also never higher than vertical variation (Fig. 5, Table 1). Based on CV data, horizontal variation was always similar to vertical variation for *A. nodosum* (Fig. 5A, Table 1). The same pattern was observed for *P. purpuratus* at the high intertidal zone while, at the low intertidal zone, horizontal variation was lower than vertical variation (Fig. 5B, Table 1).

**DISCUSSION**

This study compared vertical biological variation with horizontal biological variation measured in environmentally similar intertidal habitats along two coasts. The analyses consistently revealed that horizontal variation in terms of species richness, occurrence, and composition measured from local to regional scales never surpassed vertical biological variation. Similar results were obtained when sessile and mobile species were considered separately and when we considered only the numerically dominant species. Thus, this study contrasts those that found regional-scale horizontal biological variation surpassing vertical biological variation when surveying environmentally different sites along the coast (Benedetti-Cecchi 2001, Valdivia et al. 2011). Although factors such as dispersal limitation, demographic stochasticity, and historical contingencies (Nekola and White 1999, Ricklefs 2004, Wootton 2005, Chase and Myers 2011, Vellden 2014, Mori et al. 2018) could have added biological variation at regional scales, our study shows that abiotic consistency was a major factor determining the structure of intertidal communities. Even large sampling intervals could not generate a higher biological variation than that caused by the strong vertical stress gradient (Menge and Branch 2001, Harley and Helmuth 2003, Benedetti-Cecchi et al. 2006) when environmentally similar sites were surveyed along the shore.

The generality of our results is supported by the fact that we studied two coasts representing two oceans and both hemispheres, each coast having a completely different species pool (Appendix S1). This pattern is thus likely to occur on other coasts if a similar sampling protocol is employed. Overall, this pattern is likely most prevalent within biogeographic regions, as crossing biogeographic boundaries (e.g., from temperate to subtropical) would dramatically increase horizontal biological variation.

Our results, again, indicate that the vertical intertidal stress gradient can generate biological variation as large as, and even larger than, biological variation at regional scales spanning environmentally similar habitats along the coast. Explaining the differences between vertical and horizontal biological variation is an important task for future research.

**Fig. 5.** Vertical biological variation and horizontal biological variation (mean ± standard error) measured at local, meso-, and regional scales at the low and high intertidal zones on the NW Atlantic and SE Pacific coasts based on the abundance of dominant species: *Ascophyllum nodosum* (A) and *Perumytilus purpuratus* (B) for NW Atlantic coast and SE Pacific coast, respectively. Asterisks above the bars describing horizontal variation indicate statistically significant differences relative to vertical variation.
scale-dependent horizontal variation observed for each case in our study, however, cannot be done at present. Intertidal community structure is determined by complex abiotic influences on species performance and by direct and indirect interspecific interactions (Menge 1995, Menge and Branch 2001). Field experiments will thus be needed to unravel the mechanistic basis of the case-by-case differences encountered in our study.

Species richness, community composition, and structure exhibited similar patterns of variation across horizontal spatial scales in both hemispheres. Our sampling design, in which sites sharing similar coastal geomorphology and wave exposure were selected, allowed us to minimize the intra- and between-site environmental variation. Then, it was not surprising to find similar patterns of ecological variability across horizontal scales, which supported our use of biological indicators, such as macroalgae and barnacles, for wave exposure. Similarly, previous studies have showed scale invariance in the spatial distribution of marine communities (Dal Bello et al. 2015, Dal Bello 2016)—the authors interpret those patterns as the result of the superimposition of several biotic and abiotic processes acting at multiple spatial scales. Our results suggest that the absence of variation in environmental conditions could produce similar ecological variation across horizontal scales.

In conclusion, by using data from two coasts representing two oceans and both hemispheres, we identified a limited role for distance as a driver of horizontal biological variation when environmentally similar sites along the coast are surveyed. Recently, McCallen et al. (2019) did a comprehensive literature review of ecological studies and found that scale has been one of the most commonly occurring themes in ecology in the last 40 yr. Spatial scale is often fundamental to the design of ecological surveys and experiments (Chave 2013). Our study suggests that understanding spatial scales of biological variation should consider the underlying environmental variation besides simply scale alone.

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