Reply to Rehm: Why rates of upslope shifts in tropical species vary is an open question

Global warming is causing a great many species to shift their distributions poleward and upslope around the world (1), whereas others appear unaffected. Reasons for this variation in response remain murky. One source of variation may be geographic: tropical species, adapted to relatively stable thermal environments, may be more sensitive to temperature increases than species inhabiting seasonal temperate zones (2). We recently tested this hypothesis using climate change resurveys conducted across a variety of taxa. We found stronger upslope shifts in tropical species compared with temperate zone species, suggesting that the former are disproportionately sensitive to temperature increases (3).

Rehm (4) argues that our summary of basic patterns of range shifts masks an important distinction between responses by plants and animals. In particular, Rehm points out that life history and dispersal ability influence species' distributional responses to climate change and suggests dispersal constraints are likely to slow distributional shifts in plants (4). Rehm assesses his hypothesis by adding a recent study (5) to the two resurveys of tropical plants in our database and comparing shift rates of tropical plants ($n = 3$) to temperate plants ($n = 6$). Rehm finds no difference between shift rates of temperate and tropical plants within this sample and concludes that, although tropical animals may be moving more quickly than their temperate counterparts, tropical plants are not (4).

We agree that species' distributional responses to climate change are influenced by life history traits and dispersal ability, among other factors. We also agree that our analysis represents a preliminary effort to compare shift rates of tropical and temperate zone species and reiterate that our results must be interpreted with caution "given that tropical resurveys are still few and diverse in taxa studied" (3). Thus, we view Rehm's suggestions as an extension of our work and not a correction.

We share Rehm's concern about drawing broad conclusions from small sample sizes. Rehm (4) uses three tropical studies to argue that shift rates in tropical and temperate plants are equivalent. However, the additional study included by Rehm is not a resurvey—Feeley et al. (5) estimated distributional responses to climate change in Costa Rican plants by comparing current elevational distributions along an elevational transect with older data from herbarium specimens collected over a broad geographic region. Thus, with only two resurveys of tropical plants published to date, resurvey data are not sufficient at this time to support Rehm's (4) conclusion that "tropical plants are not shifting their ranges faster than temperate [plants]."

We agree that knowledge of species-specific responses to climate change remains extremely limited, especially in the hyperdiverse but understudied tropics. The largest barrier to understanding how life history traits influence tropical species' responses to climate change is the paucity of data. We therefore applaud recent efforts to census plant and animal populations along tropical elevational gradients (6). In time, these efforts should yield the data necessary to understand why some tropical species are "strong responders" to climate change, whereas others are not.

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The authors declare no conflict of interest.

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