Opinion Paper

RESPONSE TO PYKE AND REN: HOW TO STUDY INTERACTIONS

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Text—We published a paper in *Biology Letters* earlier this year that asks a straightforward question: might flowers with sodium-enriched nectar receive higher visitation rates from a more diverse suite of pollinators? The answer was unequivocally yes (Finkelstein et al. 2022). Pyke and Ren wrote an opinion piece (Pyke & Ren 2022) taking issue with our experiment, calling it 'irrelevant.' Here, we briefly respond to their criticisms.

First, Pyke and Ren take issue with our recipe for artificial nectar claiming it was 'unrealistic.' Nowhere in the manuscript did we claim that the nectar mimicked realistic nectar. Instead, it was an experiment to ascertain whether pollinators can detect and preferentially respond to plants with more sodium in their nectar. Control flowers and experimental flowers were the same in every way, except experimental flowers had more sodium. And we are certainly aware of Heibert & Calder's (1983) work, which we cite and which inspired our experiment. We also note that it is common practice for experimental ecologists to push a system to ask a question. Warming experiments often increase air temperatures many degrees above ambient conditions, perhaps beyond what is 'realistic.' Similarly, other experimental ecologists completely remove some keystone species from some patches of rocky intertidal ecosystems but not other patches, a situation which is also often unrealistic. This is common practice in ecology.

Second, Pyke and Ren argue that increased visitation to flowers with sodium-enriched nectar 'probably reflects efficient foraging rather than visitor attraction.' That could well be the case, but the result stands – flowers with more sodium were visited more frequently. Pyke and Ren think it "also unlikely that flower visitors can detect sodium levels in floral nectar at a distance, and before visiting and probing a flower, and so this kind of attraction is also unlikely." No evidence is provided for this claim, and it remains an open and, as far as we can tell, un-tested claim. All we know from our results is that when we spiked flowers with sodium, some pollinators must have been able to detect that sodium, and those flowers with more sodium were visited more often and by a more diverse set of pollinators.

Third, Pyke and Ren seem to disagree with our suggestion that natural selection could operate in the wild to shape plant-pollinator interactions. We wrote (emphasis added): "***Future studies should examine*** the effectiveness of the pollinators that were attracted to the plants with Na-enriched nectar and ***ask whether Na-enriched nectar increases plant fitness***. Our work ***suggests*** that if

plants can increase Na concentrations in nectar, they ***may be able*** to better attract Na-limited pollinators, which ***should*** ultimately benefit those individuals. ***Whether sodium-enriched nectar leads to increased fitness of both partners is an open, but testable hypothesis***."

Pyke and Ren spend several sentences describing how they think natural selection operates in the wild to shape nectar evolution, ending with "this would result in the plants with favourable nectar receiving and transmitting more pollen, and thus having higher potential reproductive fitness than plants with less favourable nectar." That is exactly the point we raised. If plants have favourable nectar (i.e., more sodium), they might have higher potential reproductive fitness than plants with less favourable nectar (i.e., less sodium).

In sum, we conducted a manipulative experiment and found, as predicted, that sodium can act as a lure to pollinators, and speculated about the results. We hope others will follow up, using the variety of methods discussed in this exchange (or some new ones).

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