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TOWARDS A CAUSAL UNDERSTANDING OF POLLINATION SUCCESS: EVALUATING A PATH ANALYSIS APPROACH TO COMPLEMENT THE POLLEN LIMITATION INDEX AND OTHER RATIO VARIABLES IN POLLINATION ECOLOGY

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ABSTRACT

Pollination success is an outcome of plant traits in combination with biotic and abiotic factors. However, the relative importance of these drivers has been obscured by the lack of an appropriate causal framework to relate drivers to each other and to pollination outcomes. This is because plant traits and pollination outcomes are quantified by a suite of ratio variables (indices) which normalise for maximum potential seed production, to allow comparison between species and populations. However, these indices are calculated from common ratio-elements, resulting in spurious correlations and thus precluding inclusion of multiple indices in a common causal framework. For example, the extent to which plant reproduction is limited by pollen receipt (pollen limitation) depends on the extent to which plants rely on pollen from other genetic individuals to make seed (self-incompatibility). The index of pollen limitation (PL) is often calculated using seed production following hand cross-pollination, which is also used to calculate the index of auto-fertility (AF). This prevents us from using AF as an explanatory variable in a comparative analysis of PL. We review the contributions of ratio variables to pollination biology and evaluate a path-analysis approach to relate plant traits and environmental variables to pollination success. Using this approach, we assess to what extent the lower proportion fruit set in trees relative to other growth forms can be attributed to differences in resource constraints versus auto-fertility versus pollen receipt from pollinators. This approach, which we have used in a multi-species study, is also promising for investigating causes of variation in reproductive success among populations within species.