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IN FOCUS
Natural history matters: how biological constraints shape diversified interactions in pollination networks

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Species-specific traits and life-history characteristics constrain the ways organisms interact in nature. For example, gape-limited predators are constrained in the sizes of prey they can handle and efficiently consume. When we consider the ubiquity of such constrains it is evident how hard it can be to be a generalist partner in ecological interactions: a free living animal or plant can't simply interact with every available partner it encounters. Some pairwise interactions among coexisting species simply do not occur; they are impossible to observe despite the fact that partners coexist in the same place. Sazatornil et al. explore the nature of such constraints in the mutualisms among hawkmoths and the plants they pollinate. In this iconic interacion, used by Darwin and Wallace to vividly illustrate the power of natural selection in shaping evolutionary change, both pollinators and plants are sharply constrained in their interaction modes and outcomes.

Keywords: Lorem ipsum, dolor sit amet, consectetuer, adipiscing, suspendisse

"There is a Madagascar Orchis–the Angræcum sesquipedale–with an immensely long and deep nectary. How did such an extraordinary organ come to be developed? Mr. Darwin's [[p. 475]] explanation is this. The pollen of this flower can only be removed by the proboscis of some very large moths trying to get at the nectar at the bottom of the vessel. The moths with the longest proboscis would do this most effectually; they would be rewarded for their long noses by getting the most nectar; whilst on the other hand, the flowers with the deepest nectaries would be the best fertilized by the largest moths preferring them. Consequently, the deepest nectaried Orchids and the longest nosed moths would each confer on the other a great advantage in the 'battle of life.' This would tend to their respective perpetuation and to the constant lengthening of nectar and noses."

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References

[1] Borrell, B. (2005) Long tongues and loose niches: Evolution of euglossine bees and their nectar flowers. Biotropica, 37, 664669.

[2] Moré, M., Amorim, F.W., Benitez-Vieyra, S., Medina, A.M., Sazima, M. & Cocucci, A.A. (2012) Armament imbalances: match and mismatch in plant-pollinator traits of highly specialized long-spurred orchids. PLoS ONE, 7, e41878.

[3] Cocucci, A.A., Moré, M. & Sérsic, A.N. (2009) Restricciones mecánicas en las interacciones planta-polinizador: estudio de casos en plantas polinizadas por esfíngidos. Interacciones planta—animal y la conservación de la biodiversidad (eds R. Medel, R. Zamora, M. Aizen & R. Dirzo), pp. 4359. CYTED, Madrid.

[4] Bascompte, J. & Jordano, P. (2014) Mutualistic Networks. Princeton University Press, Princeton, NJ.

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Figures

Fig. 1 Morphological mismatches set important biological constraints for size-limited foragers, including e.g., predators, pollinators, and frugivores. In plant-animal mutualisms, a morphological mismatch between partners sets size limits that filter out a range of phenotypes that otherwise could eventually interact. Other reasons for forbidden links include, e.g., phenological differences (4). Thus, a number of the potential interactions that could take place in a given mutualistic assemblage simply cannot occur because of biological reasons: these are forbidden interactions. Photo: Andrea Cocucci. An sphingid moth, *Agrius cingulata*, visiting a flower of *Bauhinia mollis* (Fabaceae), Las Yungas, Argentina.