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SHORT NOTE

Are Orchid Bees (Apidae: Euglossini) Good Indicators of the State of Conservation of Neotropical Forests?

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Abstract

This work discusses the criteria proposed to consider wild bees as bioindicators, and specifically applied to orchid bees in neotropical forests. Some of the issues are: 1) the deficiencies of the sampling methods, which makes it difficult to accurately assess species inventories. 2) missing knowledge about the biology of many species. 3) spatial or temporal distribution of most species remains unknown, which may mislead the results of short-term studies. 4) It is not clear whether orchid bees are affected by climate change as seen in other bees, which weakens their predictive potential. 5) A measure of the economic benefits provided by orchid bees is needed to better appraise them and their conservation. Finally, future studies should develop predictive models for conservation, accounting for evolutionary aspects like phylogeny or distributions; together with studies of the effect of disturbance on the physiology of the bees.

As proposed by Reyes-Novelo et al., 2009, seven criteria have to be met by wild bees to be considered as bioindicators and in this work we highlight issues for each criteria when working specifically with orchid bees as bioindicators in the Neotropics.

'The taxonomy of the group must be well known and stable so that the species can be identified reliably': Although there are five well-defined genera (Kimsey, 1987; Roubik & Hanson, 2004), a major issue is the lack of taxonomic identification of females for most species.

'Biology and lifestyle must be well known': Studies such as Dressler (1982) or Roubik and Hanson (2004) provide general aspects of their biology. However, other basic knowledge remains unknown for most species. For instance, the impossibility to collect and identify females prevents the estimation of sex-ratios in a population, which could be used for conservation purposes (Murray et al., 2009). Seasonal cycles, dynamics with natural enemies and other ecological factors could mislead studies that are based on indexes of diversity. In addition, the heterogeneity across sampled ecosystems, sharing the same species, makes the inference of the above aspects difficult.

'The group should be composed of well-defined and rich trophic guild that should be important in the structure and functioning of ecosystems': Although the role of orchid bees to preserve plant diversity through pollination is undeniable (Ackerman, 1986), information on the network of host plants remain unknown for most species. Moreover, the fact that orchid bees can thrive in the absence of its orchid mutualists (Pemberton & Wheeler, 2006) is an example of the difficulty to make predictions about forest conservation based on the presence of certain species.

'Organisms should be easily captured, manipulated and observed; the study of the group should not jeopardize its conservation': Orchid bees males collect fragrances in nature, which facilitates their collection by means of chemical fragrances placed as baits (Parra-H et al., 2016) and collections are done manually with nets, which is prone to bias caused by the skills of the collector. Fixed traps are also prone to bias since some species are never caught by these traps (Prado et al., 2017) and their efficiency can be influenced by their design (Sydney & Gonçalves, 2015).

Another bias is the innate variation across species in the preference for certain fragrances, while some are not attracted by any fragrance and others are attracted by specific fragrances (Dodson & Dressler, 1969; Nemésio & Silveira, 2004). Protocols that perform samplings twice a month often do not account for the uneven spatial and temporal distribution throughout the year, an issue in areas with strong seasonality (Nemésio, 2012). Overall, it has been difficult to establish systematic sampling methods (Prado et al., 2017).

'The geographical distribution of the group should be broad, including different habitats, allowing the use of a variety of experimental designs and comparisons'

Orchid bees inhabit lowlands from sea level to more than 2000 meters above sea level, from Mexico to northern Argentina (Kimsey, 1987; Roubik & Hanson, 2004). Parra-H et al. (2016) suggest that their distribution is much more complex than currently documented or that specific events in the ecosystems generate population structuring, making it more dynamic in terms of displacement and occupation. Again, many species are not attracted to chemical baits and some species are able to fly long distances to reach the baits, moving across different habitats, making it impossible to determine accurately their distribution ranges.

'Species should tend to specialize in a particular habitat, so that they are sensitive to habitat degradation and regeneration'

In a 20-year monitoring in Panama, Roubik (2001) observed that there was no aggregate trend in abundance, and richness was overall stable for most species. This contrasts with some theoretical predictive models for orchid bees (Faleiro et al., 2018) and bee declines in other parts of the world as a result of climate change and other factors (Goulson et al., 2015; Rykken et al., 2014). Many of the reported disappearances in short-term studies are in fact due to demographically rare species and not caused by local extinctions; thus, short-term studies may not provide reliable numbers (Rasmussen, 2009; Reyes-Novelo et al., 2009; Roubik, 2001). Other studies showed that abundance and richness are not affected by habitat fragmentation and disturbance (Botsch et al., 2017) or they respond positively to disturbances (Brosi, 2009; Otero & Sandino, 2003). In agroecosystems, using orchid bees abundances to show differences between different types of monocultures may be influenced by plantation size, spatial distribution (Hedström et al., 2006a) and seasonality (Hedstöm et al., 2006b). Moreover, species composition may not be a good indicator when comparing monocultures under different conditions (Hedström et al., 2006a). An explanation is that orchid bees can fly up to 2 – 50km,exploiting a wide spectrum of resources across different habitats (Elizondo, 2015; Pokorny et al., 2015). Then, individuals sampled in a disturbed environment may be flying in from another place, making them poor indicators of forest conservation. Then again, orchid bees can exploit habitats that lack their orchid mutualists which points at our lack of knowledge about habitat specialization (Pemberton & Wheeler, 2006).

'The group must have species with potential economic importance'

Orchid bees are important pollinators of plant species in the forest (Rocha-Filho et al., 2012) and few of those are of economic importance (Dressler, 1982). Still, an economic measure of how much agroecosystems and forests benefit from them is missing, a credit often given to honeybees and other native bees (Kremen et al., 2002; Losey & Vaughan, 2006). Neither there is data on how honeybees interact with orchid bees, which generally is a negative relationship in which honeybees outcompete native bees (Cane & Tepedino, 2017).

In the light of our considerations, we conclude that the use of orchid bees as bioindicators should be reevaluated. Their use seem to be based on precarious concepts due to the lack of research. Importantly, we are not aware of any study that investigated the effects of pollution on orchid bees (e.g. mortality, residues accumulation); another element to evaluate the state of conservation of habitats using orchid bees (Celli & Maccagnani, 2003). Future studies should implement orchid bees phylogeny (Ramírez et al., 2010) together with geographical distributions and the IUCN conservation status to make predictions on the evolutionary diversity of the group, as an approach to conservation efforts (Forest et al., 2015).

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