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Title: Towards holistic environmental risk assessment to protect bees, pollination and biodiversity

Short Title: Bee systems ERA

Abstract: The systems approach to honey bee pesticide risk assessment recently proposed by the European Food Safety Authority (EFSA) is a long-awaited paradigm shift for environmental risk assessment. This should be fully supported by rigorous and rapid development of the necessary systems tools. However, the initial focus on honey bees alone is not enough to protect the bulk of pollinators, nor help significantly with the plight of biodiversity. Therefore, we suggest that the method is extended to species better representing wild bees and other non-target organisms. This, together with detailed environmental and toxicological context models, will provide the potential for huge steps forward in environmental risk assessment and protection of biodiversity.

Main Text:

We support EFSA's ambition to improve the quality and realism of honey bee (*Apis mellifera*) environmental risk assessment (ERA)¹ which will include bee-environment interactions. It will require a concerted scientific endeavour within a robust multi-stressor framework, including sub-lethal effects, that is currently lacking in any ERA. This systems approach could assess environmental risk in combination with real world validation, allowing for iterative testing and improvement of the modelling tools and flexible adaptation to global environmental changes.

Yet the effort required to achieve this goal means that model species should be chosen, and models implemented, carefully. Although there are many socio-political, historical, and practical advantages for honey bees as a model, this bee species is an exceptional case in the bee world. Honey bee colonies are superorganisms whose social organization provides a highly resilient buffer against environmental stressors that solitary and weakly social bees lack. They are nurtured by beekeepers, who provide shelter, supplementary food and disease control. Honey bees are simply not representative for most wild bee species, which provide the bulk of pollination service. We believe that the bee-environment interaction would be better represented by extending the EFSA approach to more vulnerable species.

Systems models for *Bombus terrestris* and *Osmia bicornis* are already under development, as semi-social and solitary alternatives to eusocial honey bees. It should be a priority to establish whether these species are good analogues for modelling other, more vulnerable, bee species. If not, then knowledge should be gathered to adapt the models to other bee species, and ideally to other non-target organisms. The environmental and toxicological context similarly need to be modelled and monitored accurately to provide high quality inputs to the species models. These steps would support a much more rigorous ERA and would enhance this already long-awaited and necessary paradigm shift².

1 <https://www.efsa.europa.eu/en/consultations/call/public-consultation-draft-efsa-scientific-committee-opinion-1>

2 Topping, C. J., A. Aldrich, and P. Berny. 2020. 'Overhaul environmental risk assessment for pesticides', *Science*, 367: 360-63.