Detecting, gauging and managing foraging competition between domesticated bees and wild bees: a case study from France

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As modern farming practices make agroecosystems less suitable environments for sustainable honey production, professional beekeepers now commonly migrate their bees. They periodically move large apiaries to natural areas, either to exploit temporary mass-flowering resources or to escape chemical hazards and seasonal food shortages. But in recent years, conservation biologists have raised awareness about the risks of ecological interference between massively introduced managed honey bees and the native wild bee fauna in protected natural areas.

The hypothesis of foraging competition between the domesticated honey bee and wild bees, and other pollinators, has been coined into the bee research literature decades ago (Roubik, 1978; Schaffer et al., 1983, 1979), as some field studies were carried out on the foraging pattern of honey bees in the new world, i.e. away from its native range. It is only in the early 2000's that the bee competition issue has gained momentum in the scientific literature (Mallinger et al., 2017), eventually assembling a consistent corpus of studies including reviews and syntheses (Geslin et al., 2017; Mallinger et al., 2017; Wojcik et al., 2018), opinion papers (Alaux et al., 2019; Geldmann and González-Varo, 2018; González-Varo and Geldmann, 2018; Kleijn et al., 2018; Saunders et al., 2018) and emerging guidelines for applied bee conservation (Henry and Rodet, 2020; Rasmussen et al., 2021; Sørensen et al., 2020). As a byproduct, debates and controversies emerged among protected land managers, conservation biologists and the beekeeping industry about how to manage honey bees in natural areas.

Here, we offer an overview of the situation in France, starting from a case study in a protected natural area with high-density beekeeping (Henry and Rodet, 2020, 2018). We will describe (i) how competition was evidenced in the field, (ii) which recommendations came out from field surveys, and (iii) how local stakeholders actually applied recommendations and how it has shaken things up at the national scale.

A case study: the rosemary honey flow in southern France

Our original study (Henry and Rodet, 2018) was carried out in a protected Mediterranean rosemary scrubland covering 5700 ha. During the spring rosemary bloom, professional beekeepers migrate numerous colonies into the area (up to 14 colonies/km^2) for rosemary honey production. We sampled foraging wild bees and honey bees in 60 locations with different conditions of apiary density and proximity and during two consecutive study years. At each location, we collected data on honey bee and wild bee occurrence, as well as their nectar and pollen foraging success using standardized surveys.

We found that high-density beekeeping triggers foraging competition which depresses not only the occurrence (−55%) and nectar foraging success (−50%) of local wild bees but also nectar (−44%) and pollen (−36%) harvesting by the honey bees themselves. The latter intraspecific competition among honey bees has practical implications for beekeepers. It shows that the local carrying capacity has been exceeded and raises concerns for honey yields and colony sustainability.

Defining an apiary influence range for managing the cohabitation of honey bees and wild bee communities

Overall, those competition effects spanned distances of 600–1.100 m around apiaries, i.e. covering 1.1–3.8km^2 areas also called "Apiary Influence Ranges" (AIR). Regardless the considered competition criterion, setting distance thresholds among apiaries appeared more tractable than setting colony density thresholds for beekeeping regulation (Henry and Rodet, 2020). This property was subsequently proposed as a paradigm for providing land managers with concrete recommendations when it comes to alleviate beekeeping pressure in a protected area.

The recommended distance among neighboring apiaries will depend on three main parameters: (i) the focus ecological metric chosen to reveal competition and its corresponding AIR, (ii) the desired land protection goal (i.e. the percent land cover managers are willing to allocate to beekeeping) and (iii) the proximity of priority conservation areas that need be fully protected against possible competition effects, for instance due to the presence of pollinator species with unfavorable conservation status (*sensu* Rasmussen et al., 2021). For instance, considering an average 900m Apiary Influence Range, and targeting a balanced 50% land protection goal in favor of wild pollinator conservation (against 50% land cover dedicated to productive beekeeping), the AIR concept would return a recommendation of 2.5-km spacing among neighboring apiaries.

Perspectives from science to regulation: precautionary principle in natural protected areas

Although specific to a peculiar ecosystem and applicable only during a rather short period of the season, the rosemary case study has motivated a variety of initiatives more widely across France to regulate beekeeping in natural areas.

In 2019, the French coastal protection agency (Conservatoire National du Littoral, CdL), which is also the owner of the rosemary study area, has decided to adopt a precautionary policy for all their dependencies. The agency currently manages 750 protection areas, each covering few tens to several thousands of hectares. Although managers will preserve apiaries already allowed by long term contracts, apiary locations in larger areas (>500 ha) will be modified so as to achieve a balanced 50% protection goal in favor of wild pollinators. Furthermore, new applications to host an apiary will not be granted in smaller areas (100 to 500 ha) as well as in small islands.

Later on, in 2020 and 2021, the French National Forest Office (Office National des Forêts, ONF) as well as the network of French National and Regional Natural Reserves (Réserves Naturelles de France, RNF) have both launched internal consultancies and ordered external expertise to envision regulating beekeeping in and around their numerous dependencies. However, the national beekeeping unions have pointed out the absence of sound scientific basis for supporting such decision, in particular regarding floral resource availability. This intensifying conflict shows how *top-down* injunctions are likely to fail.

In the meanwhile, an action of dialogue between stakeholders is underway in the French Cévennes National Park, aiming to build local operational solutions for floral resource sharing based on collective intelligence. Such *bottom-up* initiatives could pave the way for new, more consensual management approaches. All in all, much progress remains to be done about the definition and quantification of floral resources for honey bees and wild pollinators, as well as about the field detection and population monitoring of pollinator species with unfavorable conservation status.

Literature cited

Alaux, C., Le Conte, Y., Decourtye, A., 2019. Pitting wild bees against managed honey bees in their native range, a losing strategy for the conservation of honey bee biodiversity. Front. Ecol. Evol. 7. https://doi.org/10.3389/fevo.2019.00060

Geldmann, J., González-Varo, J.P., 2018. Conserving honey bees does not help wildlife. Science 359, 392–393. https://doi.org/10.1126/science.aar2269

Geslin, B., Gauzens, B., Baude, M., Dajoz, I., Fontaine, C., Henry, M., Ropars, L., Rollin, O., Thébault, E., Vereecken, N.J., 2017. Massively introduced managed species and their consequences for plant–pollinator interactions. Adv. Ecol. Res. 57, 147–199. https://doi.org/10.1016/bs.aecr.2016.10.007

González-Varo, J.P., Geldmann, J., 2018. Response—"Bee conservation: key role of managed bees" and "Bee conservation: inclusive solutions." Science 360, 390–390. https://doi.org/10.1126/science.aat3746

Henry, M., Rodet, G., 2020. The apiary influence range: A new paradigm for managing the cohabitation of honey bees and wild bee communities. Acta Oecologica 105, 103555. https://doi.org/10.1016/j.actao.2020.103555

Henry, M., Rodet, G., 2018. Controlling the impact of the managed honeybee on wild bees in protected areas. Sci. Rep. 8, 9308. https://doi.org/10.1038/s41598-018-27591-y

Kleijn, D., Biesmeijer, K., Dupont, Y.L., Nielsen, A., Potts, S.G., Settele, J., 2018. Bee conservation: inclusive solutions. Science 360, 389–390. https://doi.org/10.1126/science.aat2054

Mallinger, R.E., Gaines-Day, H.R., Gratton, C., 2017. Do managed bees have negative effects on wild bees?: A systematic review of the literature. PLOS ONE 12, e0189268. https://doi.org/10.1371/journal.pone.0189268

Rasmussen, C., Dupont, Y.L., Madsen, H.B., Bogusch, P., Goulson, D., Herbertsson, L., Maia, K.P., Nielsen, A., Olesen, J.M., Potts, S.G., Roberts, S.P.M., Sydenham, M.A.K., Kryger, P., 2021. Evaluating competition for forage plants between honey bees and wild bees in Denmark. PLOS ONE 16, e0250056. https://doi.org/10.1371/journal.pone.0250056

Roubik, D.W., 1978. Competitive interactions between neotropical pollinators and africanized honey bees. Science, New Series 201, 1030–1032.

Saunders, M.E., Smith, T.J., Rader, R., 2018. Bee conservation: key role of managed bees. Science 360, 389–389. https://doi.org/10.1126/science.aat1535

Schaffer, W.M., Jensen, D.B., Hobbs, D.E., Gurevitch, J., Todd, J.R., Schaffer, M.V., 1979. Competition, foraging energetics, and the cost of sociality in three species of bees. Ecology 60, 976–987. https://doi.org/10.2307/1936866

Schaffer, W.M., Zeh, D.W., Buchmann, S.L., Kleinhans, S., Schaffer, M.V., Antrim, J., 1983. Competition for nectar between introduced honey bees and native North American bees and ants. Ecology 564–577.

Sørensen, P.B., Strandberg, B., Bruus, M., Kjær, C., Larsen, S., Hansen, R.R., Damgaard, C.F., Strandberg, M., 2020. Modelling risk of competitive effects from honeybees on wild bees. Ecol. Indic. 118, 106749. https://doi.org/10.1016/j.ecolind.2020.106749

Wojcik, V.A., Morandin, L.A., Davies Adams, L., Rourke, K.E., 2018. Floral resource competition between Honey Bees and wild bees: is there clear evidence and can we guide management and conservation? Environ. Entomol. 47. https://doi.org/10.1093/ee/nvy077