Honey bee colony losses: What's happening in South America?

by FABRICE REQUIER[1,*], NANCY GARCIA[2], GEORG ANDERSSON[1], FACUNDO ODDI[1], LUCAS A. GARIBALDI[1]

SUMMARY

The concerns for the effects of honey bee declines have spurred several large-scale surveys of honey bee health around the world to evaluate potential drivers of colony losses. United States and Europe already have well developed honey bee surveys, however, no large-scale survey has yet been developed in South America. In this paper, we present such an initiative of a national survey of honey bee health in Argentina, which hosts the largest population of managed honey bee colonies in South America. It is also one of the top honey-producing countries in the world. We developed a volunteer-based survey using a standardized questionnaire and distributed it to a national network of beekeepers. The rapid mobilization and support from beekeepers shows an interest in and a need for this type of national survey. We call for help from the readers of *American Bee Journal* to improve the dissemination of the questionnaire among potential interested parties in Argentina. We provide methods and recommendations to help the development of national surveys of honey bee health and also encourage such initiatives in other South American countries.

Key-words: *Apis mellifera*, beekeeping, honey bee health, standardized questionnaire, volunteer-based survey

Currently, a third to a half of managed honey bee colonies is lost every winter in Europe (Potts et al. 2010a) and North America (Seitz et al., 2016). This decline in managed honey bees threatens honey production and crop pollination service in many countries (Potts et al. 2016), leading to concerns for negative social, economic and ecological effects (Potts et al. 2010b). Unable to identify the mechanism of the decline, studies suggest that the colony failure comes from interactions between environmental changes, pressure from pest and pathogens and beekeeping management (Potts et al. 2010b, Goulson et al. 2015, Simone-Finstrom et al. 2016). Traditional experimental approaches, i.e. laboratory and field works, have failed to assess multiple interactions, potentially imposed by time limitations (Goulson et al. 2015). To improve and complement these studies, large-scale surveys of honey bee health have emerged around the world.

The surveys of honey bee health around the world

Large-scale surveys of honey bee health are often volunteer-based, created with standardized methods in the form of questionnaires, and diffused to beekeepers (Van der Zee et al. 2013). The aim is to help understanding the current overall decline of honey bees by recording the distribution of colony losses, pests and pathogens. The collected data can be used to assess correlations between colony losses and potential explanatory factors including beekeeping management and the occurrence of pests and pathogens.

North America (vanEngelsdorp et al. 2008, Currie et al. 2010, Seitz et al., 2016), Europe (Chauzat et al. 2016), China, Israël, Turkey (van der Zee et al. 2012) and the Republic of South Africa (Pirk et al. 2013) already have these kinds of honey bee surveys in place. The common trait of all the successful surveys comes from inter-institutional coalitions to build large-scale networks of beekeepers. Such coalitions gave birth to consortiums and partnerships at national and international levels, such as the Bee Informed Partnership in United States (vanEngelsdorp et al. 2008, Seitz et al., 2016), the EPILOBEE consortium in Europe (Chauzat et al. 2016), and the COLOSS Network on a more global scale (van der Zee et al. 2012). South America often lacks strong connections between institutions and networks of organizations, which makes it more difficult to work at national and international levels (Maggi et al. 2016). This continent is consequently one of the few continents where large-scale surveys of honey bee health are lacking (but see Jaffé et al. 2015 for the Brazilian stingless bees survey).

Toward large-scale surveys of honey bee health in South America

South America should be a high priority area for this kind of research, since it encompasses a large gradient of climates, environmental conditions, and beekeeping management, three potential drivers of honey bee decline (Potts et al. 2010b, Goulson et al. 2015). Furthermore, beekeeping provides social as well as economic and ecological benefits, and the decline of honey bees are therefore of great concerns, especially since South America hosts 6.8 million colonies of managed honey bees in Argentina, Brazil, Chile, Uru-

[1]Instituto de Investigaciones en RecursosNaturales, Agroecología y Desarrollo Rural (IRNAD), SedeAndina, Universidad Nacional de Río Negro (UNRN) and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Mitre 630, CP 8400, San Carlos de Bariloche, Río Negro, Argentina
[2]Centro PymeAdeneu, Agencia de desarrolloeconómico del Neuquen, Neuquen, Argentina
[*]Corresponding author: Fabrice Requier, frequier@unrn.edu.ar

guay, and Venezuela (Maggi et al. 2016), and contributes to a large part of the honey production and exportation worldwide (FAOSTAT 2016).

We here present an initiative of the first large-scale survey of honey bee health in South America, based in Argentina, which is the largest contributor of both managed honey bee colonies (Maggi et al. 2013), and honey production and exportation (FAOSTAT 2016) in South America. With this new initiative we aim to record the distribution of colony losses, the occurrence of pests and pathogens, as well as beekeeping practices and associated socio-economical values of beekeeping, for the season 2015-2016. This information will be used to model the effects of the different potential drivers of colony losses and map distribution of pests and pathogens in Argentina.

An initiative of volunteers-based survey in Argentina

Our survey is based on international standardized methods (Van der Zee et al. 2013), for which a volunteer-based survey was developed, including a national network of beekeepers, a standardized questionnaire, and various dissemination strategies. To build a network of beekeepers, as well as to have a strong foundation for the initiative, we first started a coalition across extension workers and governmental agencies (Centro Pyme Adeneu[1], and INTA[2]), beekeeping associations (e.g. SADA[3]) and research institutes (e.g. IRNAD[4], and INIBIOMA[5]). The draft survey questionnaire was designed with 35 anonym questions divided in three topics; (*1*) beekeeping practices (e.g. number of colonies and apiaries, types of honey harvests, genetic of bees), (*2*) the occurrence of bee-aggressors (e.g. symptoms of pathologies, and the identifications of pathologies), and (*3*) the rate of colony losses (the summer and winter colony losses). We diffused the questionnaire with five general strategies. First, it is available directly online in a web-based survey (**https://goo.gl/nmhvcd**), which is also diffused by email invitations, by the beekeeping social networks (e.g. the SADA Facebook), by the press (e.g. university newsletters, radio interviews, and popular journals), and by national beekeeping journals (e.g. Requier et al. 2016a, Requier et al. 2016b). Furthermore, to include Argentinean beekeepers without access to Internet, and to avoid creating a biased representation of the national beekeeping situation in Argentina, we also provided a paper version associated with "face-to-face" interviews.

A promising start-up of participation

Six weeks after the initiative, 39 beekeepers had answered the questionnaire, representing 163 apiaries and 8,311 colonies. The volunteer participants were both hobbyist and professional beekeepers. Responses were received from 12 of 23 Argentina's Provinces, with the highest participation rate in the provinces of Santa Fe, Buenos Aires and Neuquen (figure 1). No response has yet come from the provinces of Jujuy, Formosa, Catamarca, Tucuman, Santiago del Estero, La Rioja, Entre Rios, Mendoza, San Luis, La Pampa, and Tierra de Fuego (figure 1). The response rate for different questions was generally high, i.e. from 74.4 to 100%, but differed somewhat between the types of questions. Volunteers seem to be more prone to answer questions about beekeeping practices (i.e. number of colonies and apiaries, honey types harvested, bee genetics), but more hesitant to answer questions about colony losses and bee-aggressors (i.e. symptoms and identification of pathologies, see figure 2). Even though the fast response and mobilization of beekeepers is very positive, the participation as of today is not enough to enable an accurate description of the current situation of honey bee health in Argentina. Consequently, we don't provide any results of the surveys here, and we encourage beekeepers' continued participation to improve the spatial resolution of the data, as well as to increase the sampling size per province. We call for Argentinean beekeepers to continue to participate in the Argentinean survey of honey bee health, and we also ask for help from the readers of *American Bee Journal* to improve the spread the questionnaire (**https://goo.gl/nmhvcd**) among the colleagues they know in Argentina.

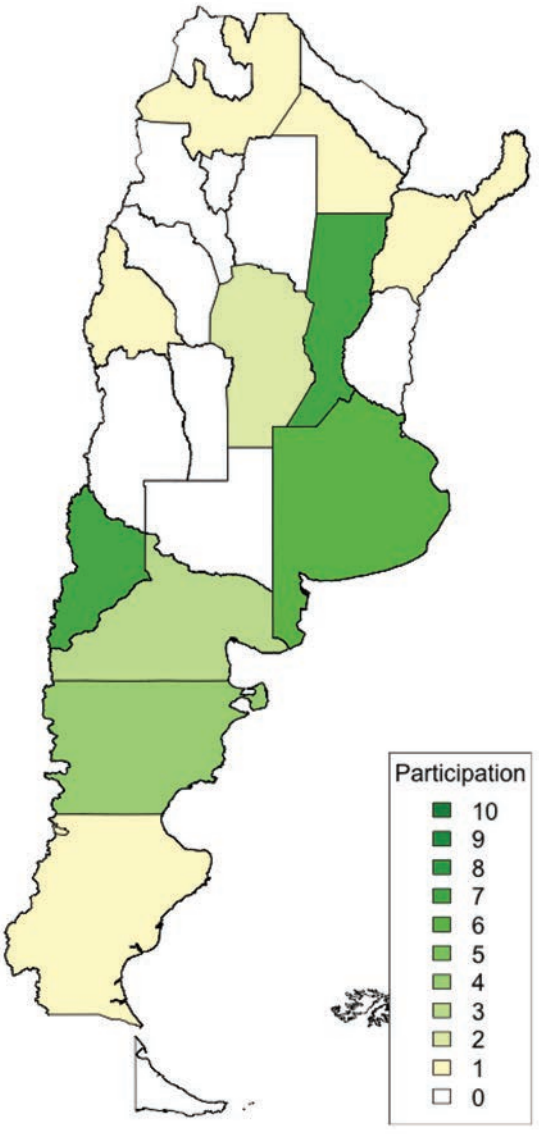

Figure 1. Spatial distribution of beekeepers' participation in Argentinian provinces for the 6 first weeks in the national survey of honey bee health in Argentina.

A template for the development of surveys in South America

The promising start of this initiative encourages similar initiatives in other South of American countries, where the social, economic and ecologic concerns about honey bee decline are quite similar to the Argentinean situation (Maggi et al. 2016). Consequently, we encourage researchers of other South American countries to carry out similar national volunteer-based surveys of honey bee health, with a special recommendation to follow a step-by-step methodology as presented here in order to be able to make results comparable among South American countries, and with other continents; creating (*1*) a national network of beekeepers through a inter-institutional coalition, (*2*) a standardized questionnaire, and (*3*) various dissemination strategies.

Our questionnaire was relatively short, i.e. 35 questions, however, there was a lower response rate for the last questions suggesting that beekeepers stopped filling out the questionnaire before the end. A variation in response rates (i.e. 74.4 to 100%) is common in surveys, where participants may get progressively tired of finishing the questionnaire (Burchell & Marsh 1992). The length of questionnaires is known to have a consistently negative effect on response rates,

[1] **Agencia de desarrolloeconómico del Neuquen**
[2] **Instituto National de TecnologiaAgropecuaria**
[3] **Sociedad Argentina de Apicultores**
[4] **Instituto de Investigaciones en RecursosNaturales, Agroecología y Desarrollo Rural**
[5] **Instituto de Investigaciones en Biodiversidad y Medioambiente**

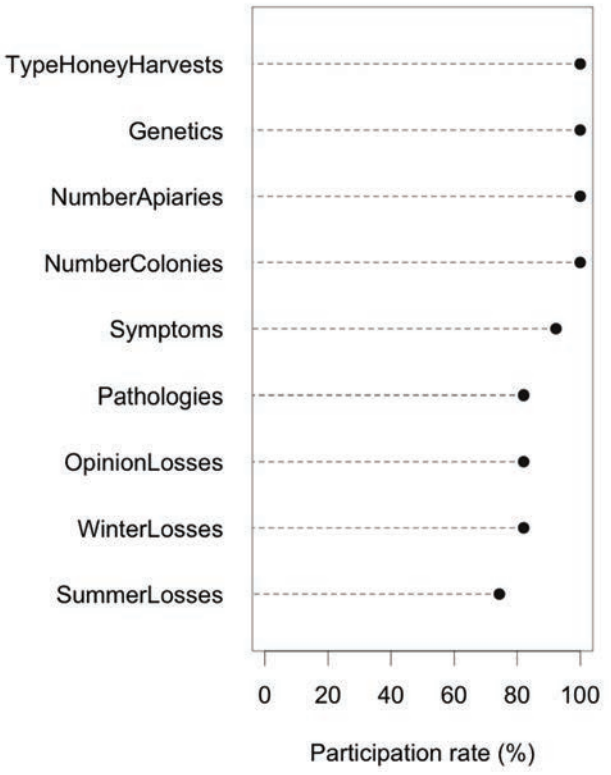

Figure 2: Rate of participation per questions (a subset of the presented questions).

however, increasing the length of the questionnaire can enhance the importance of the study in the respondent's eyes and improve the quality of responses. Conversely, shorter questionnaires are well known to significantly decrease the quality of answers (Burchell & Marsh 1992). Considering this trade-off in length of surveys, we recommend investing in similar or shorter questionnaires in future large-scale surveys, with careful attention to the packaging of the whole survey. We are happy to share, discuss and perform questionnaires in collaboration with other researchers, to develop a larger survey of honey bee health in South America. Such a large-scale survey could potentially benefit honey bee health and optimize practices for sustainable honey bee management on the continent. This could have positive effects on honey production, as well as stabilize future crop yields for important fruit and vegetable crops through better crop pollination.

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