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Risk factors associated with the presence of *Varroa destructor* in honey bee colonies from east-central Argentina

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ABSTRACT

Varroa destructor is considered one of the major threats for worldwide apiculture. Damage caused by varroa mite includes body weight loss, malformation and weakening of the bees. It was also suggested as the main cause associated with colony winter mortality and as an important vector for several honey bee viruses. Little is known about multiple factors and their interaction affecting *V. destructor* prevalence in apiaries from South America. The aim of this study was to identify risk factors associated with *V. destructor* prevalence in east-central Argentina. Parasitic mite infestation level and colony strength measures were evaluated in 63 apiaries distributed in 4 different regions in east-central Argentina in a cross sectional study. Data regarding management practices in each apiary were collected by means of a questionnaire. A mixed-effects logistic regression model was constructed to associate management variables with the risk of achieving mite infestation higher than 3%. Colonies owned by beekeepers who indicated that they did not monitor colonies after mite treatment (OR = 2.305; 95% CI: 0.944–5.629) nor disinfect hives woodenware material (OR = 2.722; 95% CI: 1.380–5.565) were associated with an increased risk of presenting high intensity infestation with *V. destructor* (>3%). On the other hand, beekeepers who reported replacing more than 50% of the queens in their operation (OR = 0.305; 95% CI: 0.107–0.872), feeding colonies protein substitute containing natural pollen (OR = 0.348; 95% CI: 0.129–0.941) and feeding colonies High Fructose Corn Syrup (HFCS) (OR = 0.108; 95% CI: 0.032–0.364), had colonies that were less likely to have *V. destructor* infestations above 3%, than beekeepers who did not report using these management practices. Further research should be conducted considering that certain management practices were associated to mite infestation level in order to improve the sanitary condition in the colonies. Epidemiological studies provide key information to design surveillance programs against one the major threat to worldwide beekeeping.

1. Introduction

Varroa destructor (Anderson and Trueman) (Acari: Mesostigmata) is an obligate ectoparasite of the honey bee *Apis mellifera* L. (Hymenoptera: Apidae). Currently, this parasite is considered almost cosmopolitan (Oldroyd, 1999; Rosenkranz et al., 2010) and one of the main threats to

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worldwide apiculture (Genersch, 2010). During the larval and pupal stages of bees, varroa mites ingest hemolymph, causing body weight loss (Duay et al., 2003), malformation of bees and weakening of colonies (Marcangeli et al., 1992; Garedew et al., 2004) and reduction of the lifespan of workers (Amdam et al., 2004). In addition, *V. destructor* is the vector of several honey bee viruses (Chen and Siede, 2007) and has been suggested to be the main cause associated with colony winter mortality (Guzmán-Novoa et al., 2010).

In Argentina, control of *V. destructor* is especially important, given that Argentina exports about 95% of its national honey production and contributes to 6% of the global honey production (SAGPYA, 2009). Additionally, since numerous economically important crops depend on honey bees for pollination, the loss of honey bee colonies is of ecological concern and is also an economic issue at the global scale.

Alternative strategies to chemical control, including disease prevention and control programs based on epidemiological studies that attempt to identify factors that may explain or contribute to disease outbreak, should be assessed (vanEngelsdorp et al., 2013). Apicultural practices are thought to be responsible for maintaining the virulent forms of pathogens, especially because they contribute to horizontal transmission (Fries and Camazine, 2001). In addition, certain management practices in apiculture, such as having moving colonies or not rotating the acaricides, may indicate that socio-economic factors may tend to artificially improve the performance of certain diseases.

The availability of critical resources for bees depends on the environmental conditions of each geographical zone (Murray et al., 2009). Like in other countries, in Argentina, the amount and quality of forage sources have declined (vanEngelsdorp and Maixner, 2010), especially given that changes in land-use have reduced the diversity of flowering plants (Kremen et al., 2007). When outside food sources for bees become scarce, "robbing" ends up impacting on horizontal transmission of *V. destructor* (Fries and Camazine, 2001).

All this suggests that beekeeping is threatened by multiple and complex drivers involving biological, ecological and socio-economic factors. Neumann and Carreck (2010) reviewed the recent bee colony losses reported in Europe, Japan and the USA and suggested the central role of *V. destructor*, although they also stated that the mite alone cannot explain all the recent losses. Although colony losses have not been recorded in South America, drug resistance and colony losses are some of the most severe problems concerning mite population control at regional scale. In South American apiaries, little is known about risk factors associated with *V. destructor* infestation. Thus, the aim of this study was to identify risk factors associated with autumn *V. destructor* prevalence in east-central Argentina.

2. Materials and methods

2.1. Study design and sample size

A cross-sectional study was carried out from February to May 2013 in Santa Fe province (total surface of 133,007 km^2), east-central Argentina. The percentage of

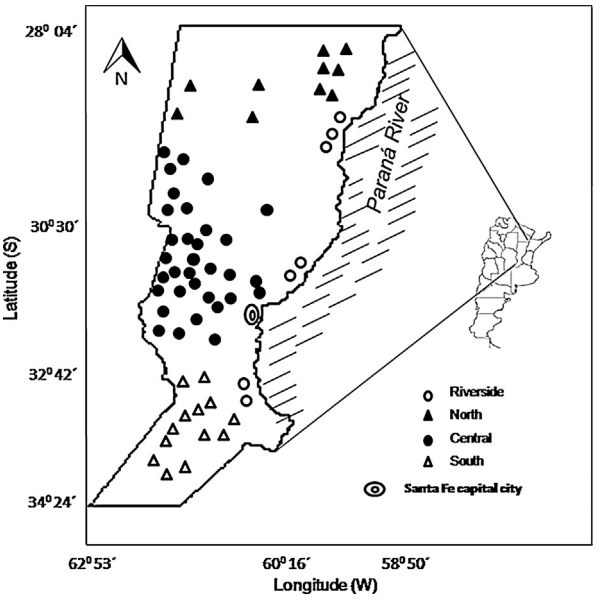

Fig. 1. Apiaries distribution consistent with zone classification of Santa Fe province, in east-central Argentina.

infestation of *V. destructor* was estimated after honey yield and prior to autumn acaricide treatment given that colonies are commonly monitored at this time of the year (Department of Agriculture from Santa Fe province, 2008) and because this is a key practice to guarantee healthy overwintering conditions (Currie and Gatien, 2006). The study was carried out during an extended period (from February to May) because the honey harvest season and treatment time frame vary according to the geographical zone and the beekeeping management practices. During this period, mite loads might be higher because ambient factors such as climate and nectar flow are favorable for mite population growth (Rosenkranz et al., 2010).

In previous studies, we determined a critical threshold of 3% (mite load above which it is recommended to treat colonies during autumn to avoid severe winter losses) for temperate climate colonies of Argentina. Our results suggested that colonies that go through winter with more than 3% of mite load hardly survive until the following spring (Bulacio Cagnolo, 2011).

A total of 63 apiaries (owned by different beekeepers) were sampled. The sample size was estimated based on the fact that there are 3735 apiaries in Santa Fe province (Department of Agriculture of Santa Fe province, 2008) and 74% of expected prevalence of colonies with >3% (3 mites per 100 bees) of infestation intensity (SENASA, 2007), with 95% confidence level and a precision <10.5%. Four zones were defined based on the nectar flow period and their beekeeping management schedule, the eco-region categorization (Burkart et al., 1999; Arzamendia and Giraudo, 2004) and agricultural practices (Giorgi et al., 2008): North, Central, Riverside, and South (Fig. 1). Apiaries were randomly chosen following stratified randomization procedures (computerized random numbers) and assigned to one of the different regions (Moher et al., 2010), according to their proportional distribution. Spatial stratification

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