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BIRDS AND HONEY BEES: A BRIEF OVERVIEW ON THIS ANTAGONISTIC RELATIONSHIP AND ITS POTENTIAL IMPACT ON BEEKEEPING

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Floris I., Pusceddu M., Satta A. - Birds and honey bees: a brief overview on this antagonistic relationship and its potential impact on beekeeping.

The human-wildlife conflict between beekeeping and wild birds is complicated, and further detailed studies are needed for a deeper understanding of the role and possible impact of predation by wild birds on honey production and bee colony health. Another potentially negative effect of birds on bees could be the dissemination of pathogens, such as *Nosema ceranae*. However, other important aspects of the complex relationship between bees and wild birds should be considered. First, honey bees have developed behavioural defences against the pressure of native predatory birds. Second, the ethology of some of these predators is fascinating like the interesting mutualistic relationship established between the so-called honeyguides and beekeepers. Finally, predatory birds could be important in the biocontrol of other bee enemies such as the invasive Asian hornet. Taking these additional aspects into consideration would provide a better insight into the conflict between wild animal conservation and human activity.

KEY WORDS: insectivorous birds, honey bee predation, actual damage, potential advantages

“Birds and insects are virtually unique among extant forms, sharing only with bats the ability of fly. Having this characteristic in common, it is not surprising that these groups have developed intricate and fundamental ecological interrelationships. Perhaps best known, and to be discussed here, is the preying of birds upon insects” (Morse, 1971).

Thousands of bird species are recognized as, partly or largely, insectivorous. Among them, the best known occasional bee predators are the following: *Pernis apivorus* (European honey buzzard), *Apus* spp. (swifts), *Dendrocopos major* (great spotted woodpecker), several species of Laniidae (shrikes), *Dicurus* spp. (dron-gos), *Cyanistes caeruleus* (blue tit), *Parus major* (great tit), *Delichonurbicum* (house martin), and other bird species that have developed the ability to avoid or tolerate the venomous stinging defence of the bees. The ethology of these birds also includes some fascinating examples like the so-called honeyguides (Indicatoridae). For instance, *Indicator indicator* (black-throated honeyguide) and *Indicator variegatus* (scaly-throated honeyguide) establish a very interesting mutualistic relationship with humans. First, they attract beekeepers towards the nests of bees through flitting and chirping (WOOD *et al.*, 2014) and, after the nests are ransacked, they feed on the remains, especially larvae (SPOTTIS-WOOD *et al.*, 2016). It is important to highlight that the major and most famous bee eaters belong to the Meropidae family, e.g. *Merops apiaster* (European bee-eater) and *M. orientalis* (Green bee-eater). They prey

honeybees in the air and during their presence near the apiaries, due to their specific sounds that can be recognized by honey bees, they may force honey bees to stay inside the hive (ALI *et al.*, 2012). The European bee-eater is a widely distributed insectivorous migrant bird, abundant mainly in arid and semi-arid areas (CRAMP, 1985). This species breeds in the Mediterranean basin (Southern Europe and parts of Northern Africa), in Western Asia, and recently in Central Europe and Great Britain (FRASER and ROGERS, 2001). Its feeding area is around 5 km of gregarious colony nests (HIGHER *et al.*, 2008). In a study on the seasonal dietary variation in adult and nestling bee-eaters of breeding colonies, the analyses of their regurgitated pellets (mainly composed by exoskeleton of insects) showed that adult bee-eaters preyed on a wide range of insect species, with more than 97% being Hymenoptera, Coleoptera and Odonata, and showed a clear preference for Hymenoptera Aculeata, which are deprived of their stingers before being swallowed (INGLISA *et al.*, 1993a; ARBEITER *et al.*, 2014). In addition, seasonal changes in adult diet composition occurred from the pre-incubation to the late chick-rearing period. In fact, the dry mass proportion of dragonflies in the adult diet decreased as chick rearing began, whereas that of small Hymenopterans increased in the late chick rearing period (ARBEITER *et al.*, 2014). Differences in diet composition between adults and nestlings were also found. An increase in the amounts of bumblebees and dragonflies in the nestling diet were associated with a simultaneous decrease in these food sources in the adult diet,

suggesting that breeding birds prefer to feed larger prey items to their offspring compared to those of their own diet (ARBEITER *et al.*, 2014). Another study conducted in Italy on regurgitated pellets of *M. apiaster*, collected near nesting places weekly confirmed a large seasonal variability diet in insect composition (FERRAZZI *et al.*, 2004). In fact, bumblebees were more abundant in May-June, bees in July and wasps (superfamily Vespoidea) in August. Several studies have shown that *Apis mellifera* is the most important prey for *M. apiaster* (INGLISA *et al.*, 1993a; HIGHERS *et al.*, 2008; ARBEITER *et al.*, 2014).

As a response to predatory pressure by birds, honey bees have evolved behavioral defenses against these natural enemies such as the mass release of guard bees by the colony under attack and by unthreatened colonies (intercolonial defense) (KASTERBERGER and SHARMA, 2000). The relationship between beekeeping and wild birds is complicated and this human-wildlife conflict has received less attention compared to other types of husbandry (MORENO-OPO *et al.*, 2018). Considering the beekeepers' concern about the negative effects of predation from bee-eaters on honey production and colony health (FRY, 1983; GALEOTTI and INGLISA, 2001; FARINÓS-CELDRÁN *et al.*, 2016), further specific studies are needed for a deeper understanding of the role and the possible impact of predation by bee-eaters on beekeeping. INGLISA *et al.* (1993b) proved that the predation pressure by *M. apiaster* may reach a total of 381,699 foragers being preyed during a season (from May to July), with a peak in July. In a study on predation of virgin honey bee queens, ALI and TAHA (2012) found that flight survival was reduced by bee-eating birds, with only 47% of the queens successfully mating in presence of bee-eaters compared to 80% when bee-eaters were absent in the apiary, whereas colony strength was not affected. In fact, the number of frames covered with adult bees or containing brood in the honey bee colonies was not influenced by the presence of bee-eaters. In the same study, bee-eating birds did not affect pollen foraging activity from plant flowers but decreased foraging activity on ground pollen and sugar syrup from dishes located up to 150 meters far from the entrance of the hives. In another study, the density of bee-eaters was negatively correlated with stored food (honey and pollen) and brood amount, whereas colony survival was not affected (MORENO-OPO *et al.*, 2018). In addition, GALEOTTI and INGLISA (2001) demonstrated that the impact by *M. apiaster* on honeybee foragers (on average 0.37%) was independent from prey density, whereas predation on drones was negatively associated with prey density, being thus diluted at high hive densities. As a result, the economic damage by predators to beekeeping was in general minor, but losses of drones were locally important and potentially detrimental to small or specialized beekeeping activities. On the contrary, KÄRCHER *et al.* (2008) found that insectivorous birds preyed drones very sporadically and did not create particular disturbance in the drone congregation areas.

Another important issue on the wild birds-bee relationship regards the possible dissemination of bee-pathogens by birds over large areas. For instance,

VALERA *et al.* (2011) assessed the role of the bee-eater *M. apiaster* as a large-scale dispersive agent of *Nosema ceranae*, the microsporidian etiological agent of the nosemosis type C. The authors found a high presence of viable spores of *N. ceranae* in pellets regurgitated by *M. apiaster* in different sites in the Iberian Peninsula, Central Europe and Central Asia, concluding that this bee-eater may have played an important role in the spreading of *Nosema ceranae*.

On the other hand, we also have to consider that the predatory birds could play a role as biocontrol agents against other hive enemies (FELICOLI, 2014). An example could be the predation of the invasive Asian hornet by the European honey buzzard (MACIÀ *et al.*, 2019). Although there is insufficient quantitative evidence on the impact of bee-eaters on honey bee colonies, beekeepers and farmers often kill birds in order to protect their hives or provide pollination services to their crops (ŁANGOWSKA *et al.*, 2018). A new perspective in the resolution of this conflict between wild animal conservation and human activity is the use of non-lethal techniques such as the use of shading meshes around the apiary (MORENO-OPO *et al.*, 2018). In fact, ŁANGOWSKA *et al.* (2018) showed that beehives surrounded by mist nets were 6.44 times heavier than unprotected beehives. GALEOTTI and INGLISA (2001) proposed the following management practices to reduce damage to apiaries by bee-eating birds in a Mediterranean area: 1) the location of apiaries should be at least 5-10 km far from the colony sites of bee-eater birds, especially in the case of nomadic beekeeping; 2) when avoiding bird areas is impossible or inconvenient, because very important nectar and pollen sources are available there, bee-density should be increased up to an optimum level, which assures sufficient food supply, avoids interference competition, and potentially reduces predation impact on drones and foragers; and 3) bee-hives should be closed in periods when the predation pressure by bee-eaters is high but, at the same time, weather conditions are unfavourable for bee foraging on flowers.

In conclusion, among the various bird species that can eat honey bees under Mediterranean environmental conditions, the main concern is the bee-eater *Merops apiaster*, which is considered as a major bee predator due to its selective search for and consumption of bees. However, only occasionally bee colonies suffer damage by this bird species. The most serious conditions are when few hives are located on bee-eater nesting areas, or when virgin queens are hunted during the mating flight, with potentially substantial losses, particularly for beekeepers who are queen breeders. However, further studies are needed to support the delicate balance between ecofriendly beehive management and the conservation of wild birds.

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