Exploitation of the invasive Asian Hornet *Vespa velutina* by the European Honey Buzzard *Pernis apivorus*

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Invasive alien species represent a major factor of the current biodiversity crisis, the Sixth global extinction, second only to habitat loss and fragmentation (Mack *et al.* 2000). Understanding predation dynamics between native and alien species is crucial (Carlsson *et al.* 2019). The Asian Hornet *Vespa velutina* is a highly invasive alien wasp that was introduced in France in 2004 (Haxaire *et al.* 2006) and is currently expanding across Western Europe (Smit *et al.* 2018 and references therein). The presence of this wasp creates an important social alarm because it is a threat to native biodiversity, to economic activities in the first sector (especially due to predation on Western Honey Bee *Apis mellifera*), and to human health (Monceau *et al.* 2014).

A number of birds are known to predate on the Asian Hornet in the native range, notably the Crested Honey Buzzard *Pernis ptilorhynchus* (Becking 1989), but, to date, few species have been reported in Europe, only preying on individual adults (e.g. European Bee-eater *Merops apiaster*) or abandoned nests (Eurasian Magpie *Pica pica*, Great Tit *Parus major* and Eurasian Nuthatch *Sitta europaea*) (Villemant *et al.* 2010). In this paper we report the first case of Asian Hornet nest predation by the European Honey Buzzard *Pernis apivorus*, as well as the use of this resource by a reproductive couple to feed the chicks. This migratory raptor breeds in Europe during the summer and overwinters in Africa. The adults have specific adaptations in order to prey wasps, the main part of their diet (76.4%; Gamauf 1999).

During 2011-2018 we surveyed a breeding population of European Honey Buzzard in Catalonia, NE Iberian Peninsula. The area covered 177 km² (Figure 1), including the protected area Serres del Litoral Septentrional (Zona Especial de Conservació ES5110011). The density of the species is fairly low (0.6-2.8 pairs/100 km² during 2010-2015; Macià *et al.* 2017).

Remains of preys were collected in one or two nests per year, except for 2017, when no breeding pair was detected. In parallel, camera-traps were installed for five of these nests. For the first time, three fragments of a wasp nest with unusually big-sized cells were observed and collected the 2nd August 2018 from a nest with chicks (Figure 2). These fragments were not present on the 20th July, when samples were last taken. Only a few fragments of wasps were found inside the cells, but morphological identification of the insect species was not possible. Based on the nest morphology, they could only belong to either the native European Hornet *Vespa crabro*, which is uncommon in the area, or the alien Asian Hornet. We carried molecular analysis of the wasp remains through DNA barcoding, using a 658 bp fragment of the mitochondrial COI sequence, following the protocol by Dincă *et al.* (2013), i.e. extracting the DNA using Chelex resin and amplifying with the primers LepF1 and LepR1. The sequences obtained from the nest fragments were uploaded to the BOLD Identification Engine (www.uniboldsystems.org/index.php/IDS_OpenIdEngine) and an unambiguous 100% match to Asian Hornet was obtained.

This finding represents the first unambiguous case of predation on an Asian Hornet nest during the active period of the wasp. A few potential cases, also by European Honey Buzzard, were mentioned on the mass media but apparently not yet scientifically confirmed (e.g. Vigneaud 2013, mentioned in Monceau *et al.* 2014). The Asian Hornet is extremely aggressive and venomous, and thus, it is remarkable that the European Honey Buzzard exploits the active nests.

The European Honey Buzzard main foraging distance apparently does not usually surpass 10 km (van Manen *et al.* 2011). Until 2018, no Asian Hornet nests were documented within this distance from the monitored European Honey Buzzard nests. The Asian Hornet arrived to Catalonia in 2012 (Pujade-Villar *et al.* 2012-2013) and to the region studied in 2014. Since then, recorded wasp nest-to-bird nest distances were: 2014, 21 km; 2015, 29 km and 42 km; 2016, 25 km; 2017, no European Honey Buzzard breeding recorded. On the contrary, on 2018 the monitored European Honey Buzzard nest was much nearer to a number of Asian Hornet nests, the closest being at only 1.8 km (Figure 1).

Assuming that the wasp presence records are accurate, which is likely given the social alarm due to the expected arrival of the species in the area, we can infer that the European Honey Buzzard started using the Asian Hornet to feed the offspring within a maximum of a year since nests were accessible. It is well known that this raptor has a number of behavioural (e.g. excavation of the wasp nests) and morphological (e.g. densely imbricated feathers) adaptations to predate wasps, as is also the case for its sister species, the Crested Honey Buzzard.

Despite our discovery is limited to a few fragments on a single nest, it opens the door to a number of questions, and future long-term quantitative studies in various parts of the European Honey Buzzard range will be needed to establish the extent and evolution of the trophic exploitation of the Asian Hornet. The effects of this additional allochthonous resource on the European Honey Buzzard populations are especially intriguing.

Large colonies by social wasps that last 5-6 months, such as those of the Common Wasp *Vespula vulgaris* and the German Wasp *Vespula germanica*, are preferred by this raptor (Gamauf 1999). Thus, in principle, the European Honey Buzzard should easily detect the Asian Hornet secondary nests, which are spherical and large (up to 1 x 0.8 m), built preferably in the tree canopy (Villemant *et al.* 2010) and easier to find compared to other native species that nest in the ground or close to it (e.g. German Wasp and *Polistes* spp.). In this sense, taking advantage of the Asian Hornet may decrease the risk for the European Honey Buzzard of attacks from terrestrial or aerial predators (e.g. Northern Goshawk *Accipiter gentilis*, Voskamp 2000) while manipulating the nest and extracting the fragments suitable for transportation.

Taking into account the dates when samples in the nest of the European Honey Buzzard were collected, the transport of the Asian Hornet nest fragments was made between 20th July and 2nd August 2018, coinciding with the period of maximum activity of the invasive wasp colonies. The Asian Hornet builds secondary nests mainly from August and the production of individuals may be active until December (Rome *et al.* 2015). The European Honey Buzzard requires more food between mid-June and September, in order to feed the chicks (Hardey *et al.* 2013), but also because fuel deposition in Europe is critical for the species post-nuptial migration (Hake *et al.* 2003). Thus, the Asian Hornet could be a particularly profitable resource due to the huge amounts of larvae available in the nests exactly at the time when the trophic needs of the raptor are greater (Rome *et al.* 2015).

On the other hand, this raptor could be considered as a potential biocontrol agent, because it is possibly the only European species capable of destroying active Asian Hornet nests (i.e. secondary aerial nests) during the period of maximum generation of individuals. Predators located in high positions of the trophic networks are crucial in ecosystem processes and can structure the biological communities (Schmitz *et al.* 2000; Sergio *et al.* 2007). It is premature to speculate about the impact of the European Honey Buzzard on the apparently unstoppable expansion of the Asian Hornet, but it seems wise favouring the presence of this raptor.

The bioaccumulation process means that raptors are highly sensitive to pollutants and, in the case of the European Honey Buzzard, it has been reported the presence of neonicotinoids in the blood (Byholm *et al.* 2018 and references therein), a group of insecticides with negative effect on birds (Millot *et al.* 2017 and references therein). This underlines the need to eliminate from the natural environment the wasp colonies treated with pesticides (Beggs *et al.* 2011), a practice that is frequently ignored or even discouraged by the official protocols (e.g. that issued by the Government of Catalonia in 2018).

The discovery here reported highlights the need for research on the breeding biology of the European Honey Buzzard, one of the less studied raptors in Europe (Hagemeijer & Blair 1997), with the aim of obtaining detailed information on its ecological relationship with the Asian Hornet and the derived consequences for the populations of both species.

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Figures:

Figure 1. Map of the study region. The inset shows the location of the study region and the breeding distribution range of European Honey Buzzard (BirdLife International 2004). The green triangle represents the European Honey Buzzard nest with Asian Hornet remains, sampled in 2018. Green line shows the protected area that was surveyed and grey lines the county borders. Points show the Asian Hornet nest recorded each year since its arrival in 2014 to the surrounding counties. Records were obtained from the Catalan Cos d'Agents Rurals del Departament d'Agricultura, Ramaderia, Pesca i Alimentació.

Figure 2. A) Picture of the European Honey Buzzard nest interior at the moment of the collection (2nd August 2018). Nest remains of Vespidae are visible and the one of Asian Hornet (with bigger cells) is marked with a red circle. B) The three Asian Hornet nest fragments analysed in the lab (scale bar represents 1 cm).