REDIA, XCVII, 2014: 189-194

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VESPA VELUTINA LEPELETIER (HYMENOPTERA VESPIDAE): A FIRST ASSESSMENT TWO YEARS AFTER ITS ARRIVAL IN ITALY ([1])

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Porporato M., Manino A., Laurino D., Demichelis S. - *Vespa velutina* Lepeletier (Hymenoptera Vespidae): a first assessment two years after its arrival in Italy.

Vespa velutina nigrithorax is an invasive alien social wasp species known as harmful for its effective prey pressure on *Apis mellifera*. The aim of this work was to assess the presence of *V. v. nigrithorax* two years after the first capture in North West Italy, to evaluate its relative abundance and dominance in the social wasp communities sampled by means of bait-traps, and to describe some biological and nesting activity.

V. v. nigrithorax was trapped or observed in 4 localities in Piedmont and in 10 localities in Liguria, from 20 m a.s.l. up to 1100 m a.s.l. Five embryo and eight developed nests were counted in eight different localities. *V. v. nigrithorax* was a subdominant species in the social wasp community trapped at Giardini Hanbury (Liguria).

At present, *V. v. nigrithorax* is spreading in North West of Italy at a rate of 10-20 Km per year and measures for its spatial containment should be urgently implemented .

KEY WORDS: *Vespa velutina nigrithorax*, yellow-legged hornet, diversity, nest, trap

INTRODUCTION

Vespa velutina Lepeletier and relative subspecies are social wasps naturally distributed in South East Asia (DU BUYSSON, 1905), approximately between 30° 03' N, 8° 44' S, 88° 16' E and 122° 24' E. *V. velutina* consists of 11 subspecies (VAN DER VECHT, 1957, 1959; ARCHER, 1994) among which *V. v. nigrithorax* Du Buysson was originally present only in Continental Asia, as confirmed by PERRARD *et al.* (2014). Since 2003, the yellow-legged hornet is also present in South Korea, but it is unclear if it is a native species or not (KIM *et al.,* 2006); finally, in 2012 it arrived in Japan, on the Tsushima Island, Prefecture of Nagasaki (SAKAY and TAKAHASHI, 2014). *V. v. nigrithorax* arrived in France probably in 2004 (HAXAIRE *et al.,* 2006) by means of garden pots imported from China (VILLEMANT *et al.,* 2006) and it spread across this country arriving in the Navarra province and Basque country (Spain) in 2010 (CASTRO and PAGOLA-CARTE, 2010; LOPÉZ *et al.,* 2011), in the Minho province (Portugal) in 2011 (GROSSO-SILVA and MAIA, 2012), at Flobecq in the Hainaut province (Belgium) in 2011 (ROME *et al.,* 2012), and at Loano in Liguria (Italy) in 2012 (DEMICHELIS *et al.,* 2014). The spread of *V. v. nigrithorax* in Europe and in non native Asian regions seems to respect the predicted climatic suitability maps modelled by VILLEMANT *et al.* (2011).

V. v. nigrithorax is considered a pest and its arrival alarmed beekeepers, because the European honey bee is more vulnerable to attacks than Asiatic bee species, as the capture rates of *A. mellifera* showed (ABROL, 2006; TAN *et al.,* 2007; PERRARD *et al.,* 2009). For this reason, the predation pressure dynamics of *V. v. nigrithorax* on *A. mellifera* was studied (MONCEAU *et al.,* 2012, 2013).

In its native range, *V. v. nigrithorax* includes highland and lowland subspecies (ARCHER, 1994); the majority of *V. v. nigrithorax* specimens captured in mainland Asia seems to came from highland localities (VAN DER VECHT, 1957). In Europe, *V. v. nigrithorax* was found in an altitudinal range from about 20 m a.s.l. to about 410 m a.s.l. (HAXAIRE *et al.,* 2006; CASTRO and PAGOLA-CARTE, 2010; LÓPEZ *et al.,* 2011; GROSSO-SILVA and MAIA, 2012; DEMICHELIS *et al.,* 2014).

Some records on phenology and nesting activity of *V. v. nigrithorax* in Asian countries demonstrated a continuous activity throughout the year, but with activity peaking between September and January, and no activity in the period January-March (ARCHER, 1994; MARTIN, 1995; NAKAMURA and SONTHICHAI, 2004; CHOI *et al.,* 2012); similar observations were made on *V. v. nigrithorax* in captive nest in France (PERRARD *et al.,* 2009).

The effect of *V. v. nigrithorax* on the native hornet was observed only in South Korea. In this country, the relative abundance for each hornet species across the years was reported and the dominance of the yellow-legged hornet demonstrated. As a consequence, *V. v. nigrithorax* conflicted with human activities for an increasing number of nests present in urban areas and its preying activity on hives (CHOI *et al.,* 2012). Nevertheless, in France, stung people in the areas colonised by *V. v. nigrithorax* did not increase (DE HARO *et al.,* 2010; SCHWARTZ *et al.,* 2012).

The aim of this work was to assess the presence of *V. v. nigrithorax,* two years after the first capture in North West Italy, to evaluate its relative abundance and dominance in the social wasp communities sampled by means of bait-traps, and to describe some biological and nesting activity.

[1] Original scientific contribution presented and discussed at XV Meeting of A.I.S.A.S.P., Italian Section of I.U.S.S.I. (International Union for the Study of Social Insects); Reggio Emilia - Italy, 18-19 September 2014.

– Received 6 October 2014 Accepted 5 November 2014 Published 10 December 2014

MATERIALS AND METHODS

Wasps were trapped in the period 2013-2014 by means of a colourless and transparent, 1.5 L polyethylene (PET) bottle with a proprietary coloured cap called TapTrap®, and filled with 0.33 L of lager beer 4.7% of alcohol; bait-traps were hung on a branch or a support approximately 1.7 m above the ground (Fig. I), and were checked weekly from mid March until the last social wasp adult was trapped. In each site two bait-traps, with yellow (BYC) and white (BWC) cap, were set up. This two bait-trap design proved to contain a social wasp community richer in species than a single coloured bait-trap, and it was less expensive for the monitoring activity (DEMICHELIS *et al.,* 2014). The position of bait-traps was changed weekly.

The monitoring activity with bait-traps was continued in localities already sampled in past years, and where *V. v. nigrithorax* was first trapped (Table 1); in this case the number of trapped individuals was reported. Moreover, beekeeper organisations present in Liguria and Piedmont were alerted so that each beekeeper reported to us if *V. v. nigrithorax* adults and nests had been observed. In this case data were simply reckoned as: observed or not observed (Table 1).

Six dominance classes were established according to ENGELMANN (1978) as following: eudominant >32%, dominant 10-31.9%, subdominant 3.2-9.9%, recedent 1.0-3.1%, subrecedent 0.32-0.99% and sporadic <0.32%.

For evaluating the change in diversity of social wasp community before and after *V. v. nigrithorax*'s arrival, the true diversity Gini-Simposon formula was applied according to JOST (2007): $D = 1/\sum^{s}_{i=1} p_i^2$; where p_i is the proportion of each species, and S is the number of species trapped. This value indicates the dominance level in a community.

The dominance was calculated only for Giardini Hanbury because we had data since 2010 for analyses. This site was chosen for its proximity to the French boundary and it was considered a possible entrance of *V. v. nigrithorax* along the Mediterranean coast.

Fig. I – Bait-trap.

RESULTS

V. v. nigrithorax was regularly trapped at Giardini Hanbury in 2013 and 2014; in both years, it was not trapped during July, August, and September (Fig. II), but in these months the yellow-legged hornet was directly observed to fly in the Giardini Hanbury area. The number of *V. v. nigrithorax* trapped at Giardini Hanbury was not statistically significant between BYC and BWC (=1.616; df=1; P=0.201). *V. v. nigrithorax* was also observed in 12 more localities in 2013 or 2014, but among them it was present only in six places during both years (Table 1). Considering all sites, *V. v. nigrithorax* adults were trapped and/or observed until mid December in 2013 and from end March 2014. Therefore, *V. v. nigrithorax* showed a continuous flight activity for more than 9 months during the year. No adults were trapped at Loano in 2013 and 2014, the first Italian locality where the yellow-legged hornet was captured in 2012. At the end of August 2014, *V. v. nigrithorax* has arrived as far as Monasterolo Casotto (44° 19' 33" N, 7° 56' 56" E) in Piedmont, and San Remo (43° 48' 12" N, 7° 44' 22" E) in Liguria, about 65 km and 30 km from the French boundary, respectively.

Five embryo nests and eight developed nests were counted in eight different localities (Table 1). Embryo nests (Fig. III) were found in sheltered positions such as corners of doors and windows, or inside warehouses, whereas five developed nests were found on higher branches of trees and three inside a glasshouse, a warehouse and a repository, respectively. The embryo nests have been collected since the end of March until mid May; their size ranged from 34 mm to 55 mm in diameter, and from 13 mm to 47 mm in height; moreover they showed only one comb with 6-17 cells. The developed nest collected at Dolceacqua on 14th November 2013 was 55 cm high and 57 cm in diameter, with 10 combs (Fig. IV); 706 adults were counted, of which 617 females and 41 males.

V. v. nigrithorax was trapped or observed in the altitudinal range from 20 m a.s.l. up to 1100 m a.s.l., but new queens seem to overwinter and show nest building activity at lower altitudes only, from about sea level up to about 900 m a.s.l. (Table 1).

The social wasp community trapped at Giardini Hanbury in the 2010-2014 period comprised seven species, among which *Vespa crabro* L. was always eudominant and euconstant, while *Vespula germanica* (F.) became recedent from dominant, and *V. v. nigrithorax* became subdominant from recedent. Moreover, the dominance value seems to fluctuate over the years, as the true diversity of Gini-Simpson demonstrated (Table 2). The changement in the dominance value coincided with *V. v. nigrithorax*'s arrival and the evident decrease of the relative abundances of native social wasp species.

Table 1 – Localities sampled during 2013 and 2014. Number of *Vespa velutina* captured by trapping activity and nests collected; watching data are indicated as: observed, not observed.

REGION	LOCALITY	LATITUDE	LONGITUDE	ALTITUDE	YEAR	*Vespa velutina*	*Vespa velutina* nests	
							embryo	developed
Piedmont	Grugliasco (TO)	45° 03' 58" N	7° 35' 33" E	286 m a.s.l.	2013	0	no	no
Piedmont	Grugliasco (TO)				2014	0	no	no
Piedmont	Reaglie (TO)	45° 03' 28" N	7° 44' 46" E	355 m a.s.l.	2013	0	no	no
Piedmont	Reaglie (TO)				2014	0	no	no
Piedmont	Vicoforte (CN)	44° 21' 59" N	7° 51' 33" E	550 m a.s.l.	2013	observed	no	no
Piedmont	Vicoforte (CN)				2014	not observed	no	no
Piedmont	Borgo San Dalmazzo (CN)	44° 19' 47" N	7° 29' 01" E	648 m a.s.l.	2013	observed	no	no
Piedmont	Borgo San Dalmazzo (CN)				2014	not observed	no	no
Piedmont	Monasterolo Casotto (CN)	44° 19' 33" N	7° 56' 56" E	906 m a.s.l.	2013	observed	no	1
Piedmont	Monasterolo Casotto (CN)				2014	observed	no	no
Piedmont	Suardi Sottani Prea Roccaforte Mondovì (CN)	44° 17' 00" N	7° 43' 35" E	1100 m a.s.l.	2013	observed	no	no
Piedmont	Suardi Sottani Prea Roccaforte Mondovì (CN)				2014	not observed	no	no
Liguria	Giardini Hanbury (IM)	43° 47' 04" N	7° 33' 11" E	115 m a.s.l.	2013	6	no	no
Liguria	Giardini Hanbury (IM)				2014	16	1	no
Liguria	Airole (IM)	43° 52' 34" N	7° 33' 18" E	400 m a.s.l.	2013	observed	no	no
Liguria	Airole (IM)				2014	observed	no	no
Liguria	San Lorenzo Latte (IM)	43° 48' 32" N	7° 34' 02" E	280 m a.s.l.	2013	observed	no	no
Liguria	San Lorenzo Latte (IM)				2014	observed	no	no
Liguria	Trucco (IM)	43° 50' 55"N	7° 35' 04" E	62 m a.s.l.	2014	observed	1	no
Liguria	Dolceacqua (IM)	43° 51' 33" N	7° 37' 19" E	118 m a.s.l.	2013	observed	no	2
Liguria	Dolceacqua (IM)				2014	observed	no	1
Liguria	Camporosso (IM)	43° 48' 13" N	7° 37' 30" E	37 m a.s.l.	2014	observed	1	no
Liguria	Camporosso (IM)	43° 48' 51" N	7° 37' 55" E	20 m a.s.l.	2014	observed	no	1
Liguria	Vallecrosia (IM)	43° 47' 12" N	7° 38' 54" E	20 m a.s.l.	2013	observed	1	no
Liguria	Terre Bianche Vallecrosia (IM)	43° 48' 26" N	7° 38' 48" E	162 m a.s.l.	2013	observed	no	no
Liguria	Bordighera (IM)	43° 47' 29" N	7° 39' 46" E	70 m a.s.l.	2014	observed	1	1
Liguria	Bordighera (IM)	43° 47' 38" N	7° 41' 29" E	135 m a.s.l.	2013	observed	no	1
Liguria	Strada Bonmoschetto Sanremo (IM)	43° 48' 12" N	7° 44' 22" E	102 m a.s.l.	2014	observed	no	1
Liguria	Loano (SV)	44° 08' 09" N	8° 14' 39" E	63 m a.s.l.	2013	0	no	no
Liguria	Loano (SV)				2014	0	no	no
Liguria	Savona (SV)	44° 18' 40" N	8° 28' 04" E	40 m a.s.l.	2013	0	no	no
Liguria	Savona (SV)				2014	0	no	no

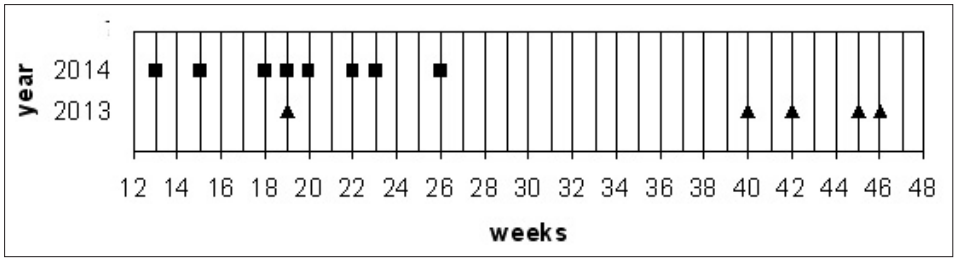

Fig. II – Occurrence of *Vespa velutina nigrithorax* at Giardini Hanbury during 2013 and 2014 monitoring activity. Weeks: week number in calendar year.

Fig. III – Embryo nest of *Vespa velutina nigrithorax* collected at Airole on 27th April 2014. Diameter 44 mm. (Photo Lanteri-Zagni Apiliguria)

Table 2 – Percentage and total number (N) of social wasp species trapped at Giardini Hanbury in the 2010-2014 period, and relative Gini-Simpson true diversity value.

	YEARS				
SPECIES	2010	2011	2012	2013	2014
Vespa crabro	82.8	95.0	91.6	89.3	87.9
Vespa velutina nigrithorax	0	0	0	2.4	8.0
Vespula germanica	11.2	3.7	6.0	7.8	2.5
Vespula vulgaris	6.0	0.4	1.4	0.4	0.5
Dolichovespula media	0	0.8	0	0	0.5
Polistes dominulus	0	0	0.5	0	0.5
Polistes gallicus	0	0	0.5	0	0
N	116	242	215	253	199
Species richness	3	4	5	4	6
True Gini-Simpson diversity	1.43	1.10	1.19	1.24	1.28

DISCUSSION

V. v. nigrithorax is well established in North West Italy as demonstrated by adults trapped and nests observed in the 2013-2014 period. *V. v. nigrithorax* seems to spread at a rate of 10-20 Km per year in Italy as in South Korea (Choi *et al.,* 2012), while it spread at a rate of about 100 km per year in France (Rome *et al.,* 2013). In any case, freight traffic can contribute to transport this species far from the invasion front, as the captures and observations in isolated valleys and localities near highways in South Piedmont demonstrated.

V. v. nigrithorax flight periods observed in Piedmont and Liguria were similar to those observed in a captive nest in France (Perrard *et al.,* 2009), and in South Korea (Choi *et al.,* 2012). The lack of captures at Giardini Hanbury in the July-September period could depend on the bait used. Beer was a good lure for trapping native social wasp species throughout the whole year in Italy (Demichelis *et al.,* 2014), but *V. v. nigrithorax* was trapped in the July-September period when the bait consisted of a sugar-based food and a proteinic wasp bait (Monceau *et al.,* 2012). Moreover, flight periods of *V. v. nigrithorax* and *V. crabro* coincided over the year, and could contribute to increase the preying pressure on honey bees, which represent up to 80% of the prey spectrum preferred by *V. v. nigrithorax* (Perrard *et al.,* 2009).

The altitudinal range of *V. v. nigrithorax* in Italy, confirms that it is a highland subspecies (Archer, 1994), but in our localities and, more generally, in Europe it is a lowland subspecies too (Haxaire *et al.,* 2006; Castro and Pagola-Carte, 2010; López *et al.,* 2011; Grosso-Silva and Maia, 2012).

Fig. IV – Developed nest of *Vespa velutina nigrithorax* collected at Dolceacqua on 14th November 2013. Diameter 57 cm.

The 5:3 ratio of the location of developed nests on trees and on buildings, deviates significantly from the 9:1 ratio observed in France (P=0.01; df=1); the difference could depend on the sample size, but in South Korea urban areas *V. v. nigrithora* shows a preference for nesting also under eaves (CHOI *et al.,* 2012). At present, available data do not allow any biological, ethological and ecological inference.

The yellow-legged hornet seems to be a competitive species, which is able to displace native social wasp species (CHOI *et al*., 2012). To day, the relative abundances of social wasp species trapped before and after *V. v. nigrithorax*'s arrival are available for Giardini Hanbury only. In this locality the Asian hornet is always subdominant in the social wasp community trapped, while *V. germanica* has dropped to a subrecedent level, and *V. crabro* has maintained the status of eudominant species in spite of an evident drop in its relative abundance. Further monitoring is required to determine if *V. v. nigrithorax* will displace native social wasp species in this and other areas, since the relative abundance of each species is a changeable value over the years.

The bait-trap design adopted in this study proved to be useful for monitoring the activity of *V. velutina*, but further investigations on lures should be undertaken for improving the monitoring activity and eventual mass trapping of the yellow-legged hornet.

ACKNOWLEDGEMENTS

We thank all the people of Giardini Hanbury, CERSAA and beekeepers who helped us monitoring during the 2013-2014 period. This article reports the results of research only. Mention of a commercial or proprietary product does not constitute an endorsement of the product by the University of Turin.

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