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"The Best Management Strategy for *Vespa velutina* in Italy" Action C.2

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Abstract

The Asian yellow-legged hornet *Vespa velutina* is a Hymenoptera species native to South-East Asia and accidentally introduced into France in 2004. In few years, the species has spread throughout the French territory and in neighbouring states, such as Spain, Portugal, Italy, Germany, Belgium, Great Britain and Netherlands. In Italy, the species was detected for the first time in 2012 in Liguria, and from 2013 began to colonize the province of Imperia and the southern part of Piedmont. LIFE STOPVESPA started in 2015 and its activities allowed to contain the expansion of *V. velutina* in Italy. However, it is likely to assume that, in the coming years, the species may spread to other Italian regions and become a national issue.

V. velutina is considered an invasive species due to its spread ability and its impacts on both beekeeping and biodiversity. In fact, honey bee colonies are particularly attractive for the species, which can produce serious losses to beekeeping productions and compromise the survival of bee colonies. In addition, the workers of *V. velutina*, especially during summer and autumn, actively prey on other native insects to feed their larvae, concentrating their activity particularly on the superfamily Apoidea, and therefore altering the pollinating activity of these insects.

V. velutina builds nests in both natural and urban areas, and may represent a risk for citizens. The nests, of small dimensions in spring and early summer, can reach great sizes in autumn and contain several thousands of individuals. The species can be aggressive near the nest, both if is accidentally approached or intentionally disturbed to remove the nest.

Considering these reasons, the LIFE STOPVESPA project had developed a management strategy for *V. velutina* - BMS (Best Management Strategy - Action A.6) - that included information to develop an effective management plan for this species. The document has been updated at the end of the project as part of action C.2, with information collected over the years, and contains: distribution of *V. velutina* in Italy at the end of 2018, impacts caused by the species, regulation framework, recommended techniques for the control of the species, methods for organizing training courses and strategies that must be developed in the involved areas.

1. Distribution of Vespa velutina *in Italy and species identification*

The Asian yellow-legged hornet *Vespa velutina* is an invasive species introduced in France in 2004, through passive and involuntary transport of founder queens (Haxaire et al. 2006). Thanks to its spread capabilities, the species has rapidly colonized several European countries and Italy (Fig. 1) since 2012 (Demichelis et al. 2014). The first Italian populations were detected in the western Liguria (Imperia District) and in the southern part of Piedmont (Cuneo District) (Porporato et al. 2014). In these two regions, the species has increased its range in a different way, probably due to the different climatic conditions that determine a different environmental suitability (Fournier et al. 2017).

In Liguria, *V. velutina* has progressively increased its range since 2012, spreading from the municipality of Ventimiglia (Imperia District) towards east, along the coast, and towards north, ascending the valleys and colonizing the internal territory of Liguria (Bertolino et al. 2016). At the end of 2017, the species was spread continuously from Ventimiglia to Alassio (Savona District), occupying an area of approximately 1.110 km^2. In 2018, the presence of the species has been confirmed in the municipalities of Finale Ligure (Savona District) and La Spezia, several kilometres away from the main colonized area. In Piedmont, *V. velutina* has been sporadically detected over the years, mainly in some municipalities of Cuneo District (Monastero di Vasco, Vicoforte Mondovì, Monasterolo Casotto and neighbouring municipalities).

V. velutina is able to colonize new territories by natural diffusion or by passive and involuntary transport of founder queens hidden in different materials (e.g. timber, straw, hay, soil, gardening stuff) (Robinet et al. 2016). The second modality of diffusion allows the species to establish new populations even many kilometres away from the main colonized area (Annex 1). This spread modality is probably the origin of the reports from an area at the border with Veneto (Bergantino, Rovigo District) and Lombardy regions (Borgofranco sul Po, Mantova District) and from an area in Tuscany (Pietrasanta, Lucca District).

V. velutina can be identified from other native insect species due to the characteristic body colour and size, which vary between 19-30 mm in length (Fig. 2). The main characters that allow the identification of the species are: *i*) the coloration of the legs, dark in the proximal segments and yellow in the distal segments (tarsus); *ii*) the black colour of the thorax*; iii*) the colour of the abdomen, with the first three segments dark brown tending to black and with the rear margin yellow, the fourth segment reddish-yellow with a dark triangular spot, and brown terminal segments. Annex 2 report some additional information for the identification of *V. velutina* from other native Italian species.

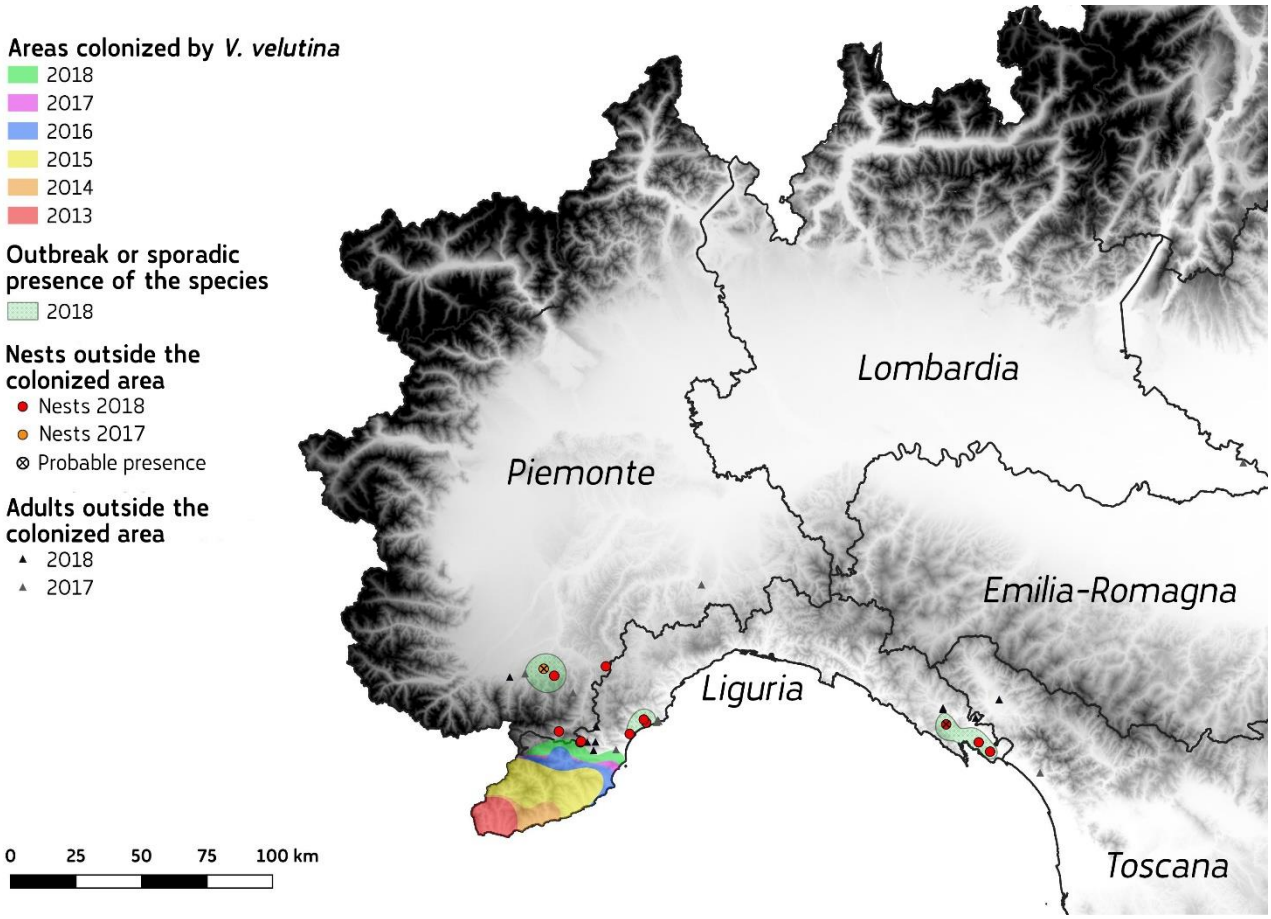

Figure 1 - Distribution of *V. velutina* in Italy at the end of 2018: the areas from red to green highlight the expansion of *V. velutina* from 2013 to 2018; adults (triangles) and nests identified in 2017 (orange circles) and 2018 (red circles) outside the area of stable presence are also reported.

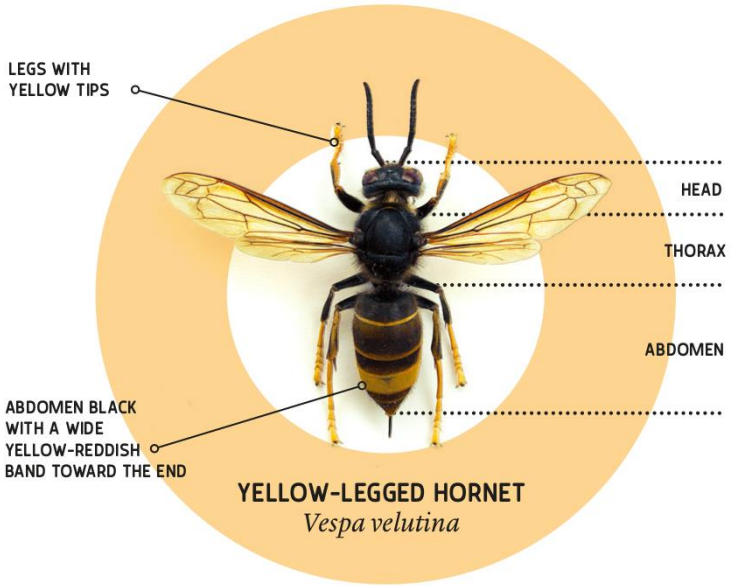

Figure 2 - *V. velutina* individual and main identification characters.

2. Impacts

Although *V. velutina* is present in Europe since many years, the number of studies that quantify the impacts associated with its presence are limited, also due to the complexity of discriminating the impact of this species from external or confounding factors. Nevertheless few data are available, both in scientific and grey literature.

Apis mellifera is the main species affected by the presence of *V. velutina* (Fig. 3), and consequently the beekeeping industry is damaged, since worker bees are among the favourite preys of this hornet (Perrard et al. 2009). *V. velutina* causes the weakening or the collapse of honey bee colonies, with losses that depends on the area, the density of nests, the beekeeping practices adopted and the presence in the colonies of bee's pathologies. Some studies reported values of honey bee losses that vary from 5% to 80% (Monceau et al. 2014a, 2014b). Impacts were also confirmed in the experimental apiaries of LIFE STOPVESPA, followed in 2017 and 2018 in the province of Imperia (final report of action D.1).

V. velutina can also generate an impact on entomological biodiversity, due to the predatory activity towards other insect species besides *A. mellifera*, such as other Hymenoptera (wild bees and wasps), Diptera or other insects (Villemant et al. 2011). A three-year study in Liguria demonstrated that *V. velutina* can generate an impact on wild bees, in particular on species with late-summer and autumn flying period (final report of action D.1). Besides to the possible negative effect caused by a direct predation (primary effect), a secondary effect may derive on pollination ecosystem services.

Finally, the presence of the species is associated with a social impact due to the presence of nests in urban and rural environment, with consequent economic costs for the removal of colonies (Monceau et al. 2014a). *V. velutina* builds nests that in autumn reach great sizes and can, in some cases, produce over 13.000 individuals during the year (Rome et al. 2015). Although a significant increase in the number of hospitalizations due to *V. velutina* stings has not been recorded in France (de Haro et al. 2010, Tabar et al. 2015), some fatal events were documented in Europe and various, luckily not fatal, incidents have also been reported in Italy. The possibility of stings and nest size therefore generate states of anxiety in citizens, who requires a rapid removal of the colonies.

Figure 3 – Honey bee colony completely besieged by *V. velutina* individuals.

3. Legislative framework

The management of *V. velutina* is regulated both at European and national level.

International regulation framework:

- The Rio Convention (1992), implemented by the European Community (Counsel Decision 93/626/CEE), prohibits the introduction of invasive alien species or require their control or eradication, if they are threatening ecosystems, habitats or species (Annex A, Art. 8 – h).
- The Regulation (EU) 1143/2014 of the European Parliament and of the Council of 22nd October 2014 provides dispositions in order to prevent and manage the introduction and spread of invasive alien species. This Regulation introduces several innovative aspects such as the prevention of new introductions, the identification and control of vectors and pathways of introduction, the eradication, control and/or management of invasive alien species.
- The Implementing Regulation (UE) 1141/2016 of the Commission of the 13th July 2016, implementing the Regulation n. 1143/2014, adopts a first list of Invasive Alien Species of Union Concern for which a rapid activation of efficient measures to prevent or limit its spread is required: *V. velutina* is included in such list.

National regulation framework:

- The Italian law 230/2017 of the 15th December 2017, for the adaptation of the national legislation to the dispositions of the EU Regulation 1143/2014 of the European Parliament and of the council of 22nd October 2014, establishes provisions to prevent and manage the introduction and spread of invasive alien species in Italy.

The Regulation (EU) n. 1143/2014 of the European Parliament and of the Council of 22 October 2014, defines in art. 3, paragraphs 1 and 2, that an "exotic species" is " any live specimen of a species, subspecies or lower taxon of animals, plants, fungi or micro-organisms introduced outside its natural range" and an "Invasive exotic species" as "an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services". Furthermore, the EU Reg. 1143/2014 introduces specific obligations for the species included in the list of alien species of Union concern: they should be eradicated in the initial stages of invasions (art. 17) or, for widely distributed species, effective management measures, consisting of physical, chemical or biological interventions, aimed at the eradication, the numerical control or the containment of the populations, must be activated within 18 months of the entry into force of the regulation (art. 19). *V. velutina* was included in the first list of "invasive alien species of Union concern " that came into force in July 2016 (Commission Implementing Regulation EU 2016/1141 of 13 July 2016). This therefore requires the rapid activation of effective species eradication, containment and management measures for *V. velutina*.

4. Management methods

With reference to the recent national (Italian law 230 of the 15.12.2017) and European provisions (EU Regulation No. 1143/2014) concerning the management of invasive alien species, the prevention measures (Title II of Italian law 230 of the 15.12.2017, Action plans on vectors of invasive alien species) and the control at importation measures (Title IV of Italian law 230 of the 15.12.2017) seems of limited applicability to prevent the further spread of *V. velutina* in Italy. This is due to the fact that *V. velutina* is present in Italy since 2012 and founder queens are able to hibernate in different materials frequently transported on the national territory, and consequently difficult to control with inspection measures (transport of wood, straw, hay, soil, etc.).

Therefore, the measures that should be pursued for the containment of *V. velutina* in Italy require the adoption of surveillance strategies, early detection and rapid response systems, and control measures aimed at containing the expansion of current populations.

4.1 Surveillance strategy

Given the diffusion capacity of *V. velutina* by natural dispersion or by passive transport over long distances (Robinet et al. 2016), which allows the species to quickly establish new populations in different areas of Italy, it is of fundamental importance to establish a surveillance strategy for the species in all Italian regions. This strategy must allow the early detection of the species for the application of appropriate containment measures. The methods that should be adopted for monitoring the presence of *V. velutina* are: i) capture of hornets with attractive bottle-traps; ii) observations in the apiaries of the presence of hornets preying honey bees (Fig. 4).

Monitoring activities with attractive traps containing sugary baits must be carried out in spring and autumn, periods in which the hornets seeks for carbohydrate sources (Demichelis et al. 2014). Monitoring must be widespread but not intensive, in order to avoid a bycatch negative effect on native insect fauna (Rome et al. 2011). Traps made of transparent polyethylene bottles containing 0.33 litres of lager beer, with an alcohol content of 4.7%, allow effective monitoring of *V. velutina* presence (Fig. 4). These traps must be checked every two weeks, together with the replacement of the bait. The presence of alcohol within the bait reduces the capture of non-target pollinating insects such as bees (Porporato et al. 2014). If attractive baits will be developed in the future, with greater selectivity (pheromones, volatile compounds, etc.), these should be used in the monitoring of *V. velutina*, after a verification of their effectiveness and selectivity.

Honey bees are a fundamental part of the diet of *V. velutina*, therefore the hornet can be easily spotted during its predation activity, thanks also to its characteristic predatory position (stationary flight with the head turned towards the foraging bees that are returning to the colony) (Monceau et al. 2014b). Regular observations performed by the beekeepers in apiaries allow to rapidly detect the presence of the species. These observations are simpler in summer and autumn, when the size of *V. velutina* colonies increases in dimension.

Beekeepers and their Associations are the subjects that should be involved in the surveillance strategy in Italy. Experts in the recognition of Hymenoptera ought to check every doubtful report quickly; the availability of detailed photos or specimens stored in alcohol are required for delayed identification.

Figure 4 - Monitoring methods for *V. velutina*: on the left, bottle-trap for catching hornets; on the right, observations of the presence of hornets in the apiary.

4.2 Nest detection and destruction

Detection and destruction of *V. velutina* nests is the most widely used technique in Europe for the control of the species; it is particularly effective when the colonies are identified before September, the months in which the gynes (future founder queens) begin to emerge (Monceau et al. 2014a, Robinet et al. 2016). This method has been adopted in Italy by LIFE STOPVESPA project for controlling *V. velutina* populations, and allowed to decrease the spread rate of the species in Liguria (see report of action C.2 and D.1). Nest destruction is also of fundamental importance in urban and rural environments, to decrease the possibilities that people are exposed to the species, causing accidents due to hornet stings.

Nest destruction is potentially a dangerous operation, both for the operators involved and for the people in proximity, as the hornets may exhibit defensive reactions during nest approach or during nest treatment. Destruction operations must be carried out by trained and equipped personnel. Nests can be built on trees, shrubs, in cavities of the ground or on artificial supports, such as in the protruding portion of houses roof or under balconies, and at different heights (from the ground level to over 20 m). The destruction techniques can therefore vary according to the position of the nest and the period of the year; the guidelines for the removal of wasp nests from buildings and urban areas (Action E.2 LIFE STOPVESPA) describe in details the necessary equipment, like the Personal Protective Equipment (PPE), and the techniques to be adopted in different situations.

V. velutina nests, when detected in the early stages of development and easily reachable, can be treated with insecticides for hornets, in spray cans, to be injected through the entrance hole of the nest; the operation must be performed preferably in the evening when all the animals are inside the nest. Commercially products are available; most of them contain pyrethroids such as permethrin, tetramethrin, cypermethrin, etc. Colonies already developed or positioned at several meters above the ground can be treated with telescopic poles, which allow to convey a powdery insecticide for wasps and hornets (containing a pyrethroid such as permethrin) directly inside the nest, through the entrance hole and through multiple perforations of the protective envelope (Fig. 5). This technique can be used practically in all situations and allows the treatment of *V. velutina* colonies up to a height of 20 m, depending on poles extension. The conformation of the nests (closed by a thick envelope), the treatment modality adopted (introduction of the insecticide directly inside

the nest), and the used dose of active substance, which does not exceed 0.5 g/nest even in largest nests, allow to perform a highly localized treatment without dispersion of the active substance in the environment. Permethrin based powdery formulations are usually indicated for the treatment of irregular surfaces rich in cracks, crevices or uncultivated vegetation at the dose of 1 kg (5 g of active substance) for 15-20 m^2. The amount used to destroy a nest of *V. velutina* is therefore 10 times lower than the dose recommended for generic treatments on irregular surfaces as indicated above. If operational conditions exist (accessibility of places, availability of suitable equipment), the use of high temperature steam, under pressure, could be evaluated. These measures are to be considered connected and necessary for the maintenance in a satisfactory state of conservation of the species and habitats as required by Habitats Directive.

Other destruction techniques must not be used (manual destruction, use of fire or weapons), because they are ineffective or prohibited and dangerous. Furthermore, the incorrect destruction of a nest causes the colony translocation and the rebuild of the nest.

Figure 5 - Destruction of a nest of *V. velutina* with the use of telescopic poles (left) or a ladder truck (right).

4.3 Methods to improve nest detection

V. velutina nests are often difficult to be detected, especially when hidden by vegetation or during spring and summer, when the colonies are small. Some techniques have been recently developed to improve nest detection: i) tracking the flight of hornets with harmonic radar; ii) tracking the flight of hornets with VHF radio-tracking techniques; iii) use of thermal imaging cameras to detect nest position. These methods are of particular relevance in the management of new invasion outbreaks, generated by the passive transport of founding queens or by their natural dispersion over great distances, since their application allows to increase the probability of finding nests before an extensive colonization of the area nearby the introduction point.

i) Tracking the flight of hornets with harmonic radar

This technique allows to follow in real time the flight of the hornets, exploiting the harmonic radar technology developed by the University of Turin and the Polytechnic of Turin within the LIFE STOPVESPA project (Milanesio et al. 2016, 2017; Maggiora et al. 2019). The hornets are trapped, equipped with tags (small diode connected to a short segment of metal wire), and released into the environment where they were captured; their flight is then followed by the harmonic radar, which emits a radio signal in the surroundings that is in turn retransmitted by the tag on the hornet thorax. In this way, it is possible to see in real time, on a laptop monitor, the flying paths of the hornets returning to the nest, thus locating the position of the colony (Fig. 6).

The tag developed is light enough (0.019 g) for the insect to allow it to fly and hunt without particular problems for several days; this is due to the fact that the tag works passively, without the need of a battery. Based on the latest technological improvements, the harmonic radar is capable to follow the tags, and therefore the hornets, up to a maximum distance of about 500 m. Once the flight paths have been defined, it is possible to move the radar along these lines and consequently follow the hornets back to the position of the nest even if it is more than 500 m from the releasing point.

The time required to detect *V. velutina* nests depends to the number of hornets present in the environment and the orography of the territory, which can limit movability of the radar. The harmonic radar was successfully used in 2018 in the outbreaks of La Spezia and Finale Ligure (Italy), where it allowed to locate the position of 3 nests of *V. velutina* (Fig. 7). The removal of the nests was followed by the disappearance of the hornets from nearby apiaries (report of the action D.2 of LIFE STOPVESPA).

Figure 6 - Harmonic radar developed by the LIFE STOPVESPA project for tracking the flight of hornets (left) and one individual of *V. velutina* equipped with the tag (right).

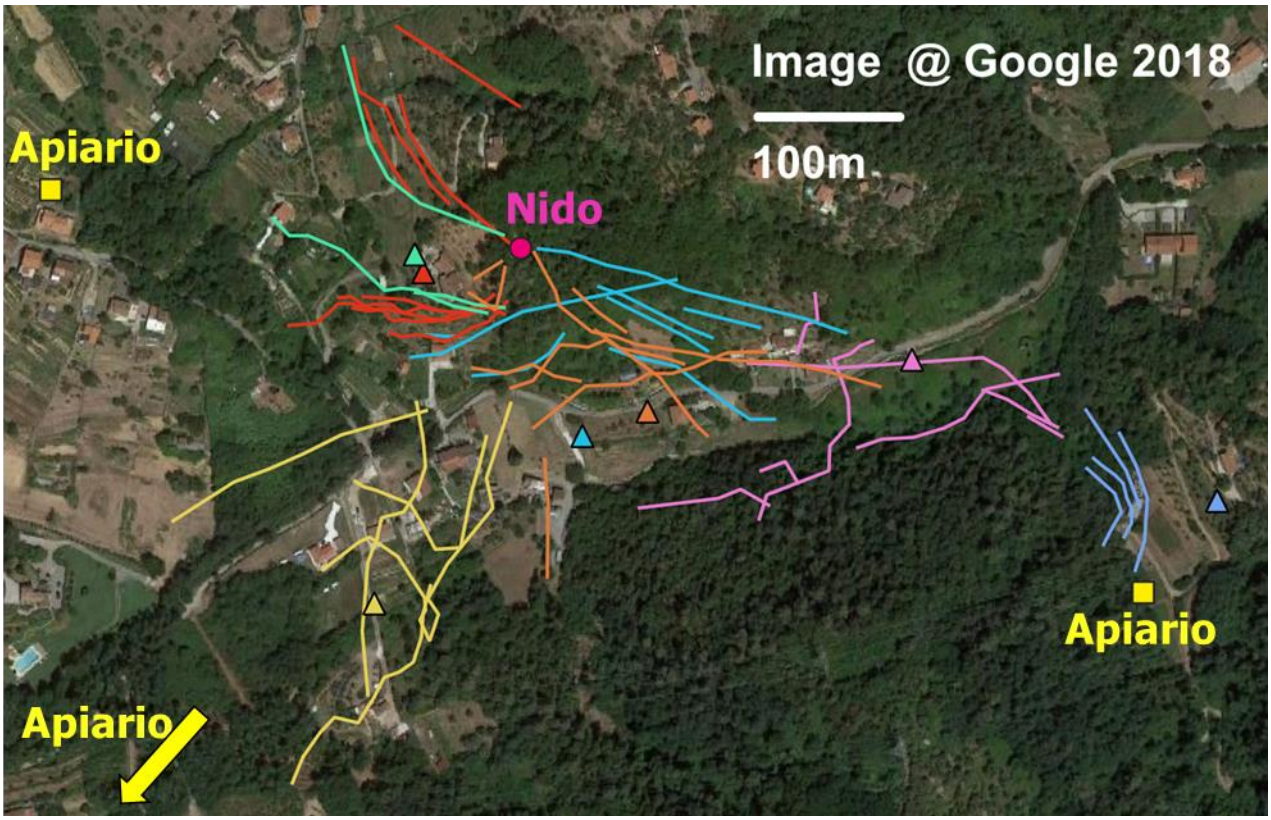

Figure 7 - Detection of *V. velutina* nest in the invasion outbreaks of Arcola (La Spezia) in 2018: the yellow squares show the position of the apiaries in which the individuals of *V. velutina* were tagged; the coloured lines are the flight paths of the hornets in relation to the position of the radar (triangle of the same colour); the fuchsia circle correspond to the position of the nest detected thanks to the LIFE STOPVESPA harmonic radar.

ii) Tracking the flight of hornets with VHF radio-tracking techniques

The radio-tracking technique, widely used in the last decades to locate even small vertebrates, has recently been tested with success for tracking the flight of single individuals of *V. velutina* (Kennedy et al. 2018). This technique requires catching and equipping the hornets with a very small radio transmitter suspended with a thread to the segment that connects the thorax with the abdomen in wasps (petiole). The radio transmitters that have been tested have a weight (0.220-0.280 g) considerably higher than the tags used with the harmonic radar, as they need a battery. On the basis of the experiments conducted by Kennedy et al. (2018), if the weight of the radio transmitters does not exceed 80% of the weight of the hornet, the insect is able to fly and return to the nest, allowing to spot nest position. The tracking distance may vary depending on the radio transmitter used, reaching maximum distances of 800 m.

This technique can be limited by the availability of sufficiently large and robust individuals. This can represent a critical point in the areas where the hornet has just established primary nests and the workers are still not numerous. However, the method can be useful in the perspective of a rapid response strategy, although it has not yet been tested in Italy.

iii) Thermal imaging cameras to detect nest position

Given that *V. velutina* has a tendency to establish secondary nests in the upper part of the tree tops and to maintain temperatures higher than the environmental ones to allow the development of the brood, thermal imaging cameras may be useful to reveal the position of the nests (Keeling et al. 2017). This technique has been tested on several insect species (Al-doski et al. 2016). The possibility of detecting *V. velutina* nests has some limits connected to the

environmental temperature and to the presence of vegetation capable of covering the colonies, but could be used to increase the probability of nest detection. This technique, used at sunrise to exploit the differential in temperature between the nest and the environment, could be combined with the two previous methods (harmonic radar and radio-tracking) to speed up the location of *V. velutina* nests, once the area of nest presence has been restricted.

4.4 Intensive trapping of V. velutina *queens*

Trapping founder queens is a technique of direct control with the aim of catching *V. velutina* queens that in spring emerge from winter shelters to found their own colonies. This technique is carried out to decrease the number of queens present in the environment with the aim of consequently reducing the number of colonies built during the year by the species. The intensive trapping of queens is carried out using the traps described in the surveillance strategy (chapter 4.1). Unlike trap use for monitoring purposes, the density of traps must be higher (about 0.5 traps/ha), to allow a reduction effect to be generated on the number of nests founded in the year.

Since no selective baits specific for caching *V. velutina* are available, the application of this method may represent an issue to biodiversity, due to the impact that the traps exert on native insect fauna. Moreover, the application of this technique does not seem to generate a significant effect at the population level (Beggs et al. 2011; Monceau & Thiéry 2016).

4.5 Not applicable control methods

Many alternative control methods have been proposed over the years, such biological control or the use of poisoned baits. None of the proposed alternative techniques is currently applicable for controlling *V. velutina* in Italy, both for the lack of parasites, pathogens or predators able to regulate the population of *V. velutina* and because the efficacy of the proposed methods has not been scientifically demonstrated. Furthermore, the use of poisoned baits is forbidden in Italy by the law 157 of the 1992.

5. Staff training, subjects involved and management procedures

Training courses are a fundamental tool for transmitting and promote good practices to the personnel who must operate in *V. velutina* nest destruction activities. In order to ensure adequate training, the courses must be organized by accredited training institutions of the relevant Region and must be structured in both lectures and practical training.

The main topics to be addressed in the training courses are:

- Management of exotic species, impacts, prevention and control;
- European Regulation on invasive alien species;
- Biology of *V. velutina*;
- Diffusion of *V. velutina* in Europe and Italy;
- Species identification and comparison with native species;
- Monitoring techniques for adults and nests;
- Nests destruction techniques and protocols;
- Regulatory aspects (use of insecticides and biotechnical means, use of medical-surgical devices, use of devices for distributing insecticides);
- Workplace safety (regulations, behaviour, Personal Protective Equipment, preventive measures against Hymenoptera stings);
- National legislation concerning operations in the veterinary and agricultural fields.

The practical training must include specific insights on the following topics:

- Equipment necessary for nest destruction (telescopic poles, insecticide distribution machines, etc.);
- How to correctly use the equipment;
- Methods and techniques for nest destruction in different situations.

At the end of the training course it is advisable to organize a final examination, to evaluate the preparation of the participants, and release a participation certificate.

As part of the LIFE STOPVESPA project activities, three training courses were organized in Liguria and one in Piedmont, which allowed training 80 people for controlling activities against *V. velutina* (Fig. 8). The participants came in particular from the two regions where *V. velutina* is more widespread (Liguria and Piedmont), however people from Tuscany, Emilia Romagna, Lazio and Veneto also participated in perspective of a future colonization by the species.

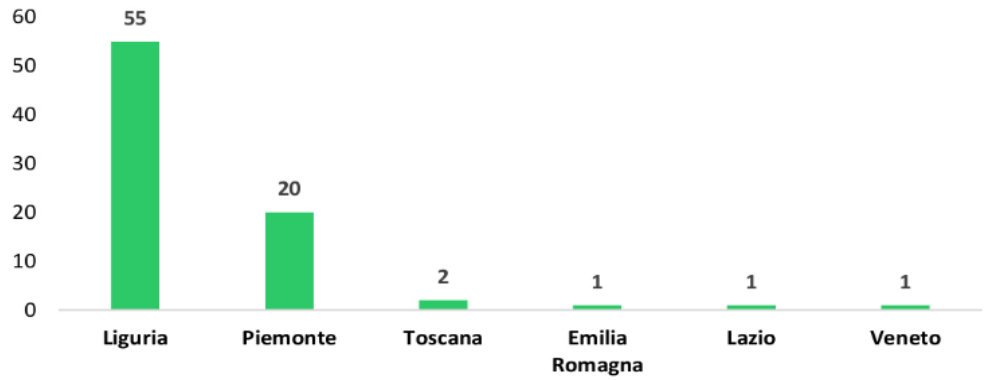

Figure 8 - People trained in Italy by Region in nest destruction procedures for *V. velutina*, thanks to four training courses organized by the LIFE STOPVESPA project.

The subjects that should be involved in a regional strategy for the control of *V. velutina* populations are: regional authorities, technical structures at the service of the region, civil defence teams, fire brigades, pest control operators, beekeepers teams or other suitable people. Personnel must be equipped with the necessary PPE for carrying out the activity (full hornet suit equipped with gloves, safety shoes, facemask, transparent glasses, safety helmet, etc.) and the equipment for treating the nests. Each operator should be provided with an adequate insurance.
An effective management strategy to contain the expansion of *V. velutina* requires the organization of procedures for the management of reports, which starts from report collection and ends with nest removal. The following diagram summarizes the ideal information flow, which must be the basis for the development of a management strategy for *V. velutina* (Fig. 9).

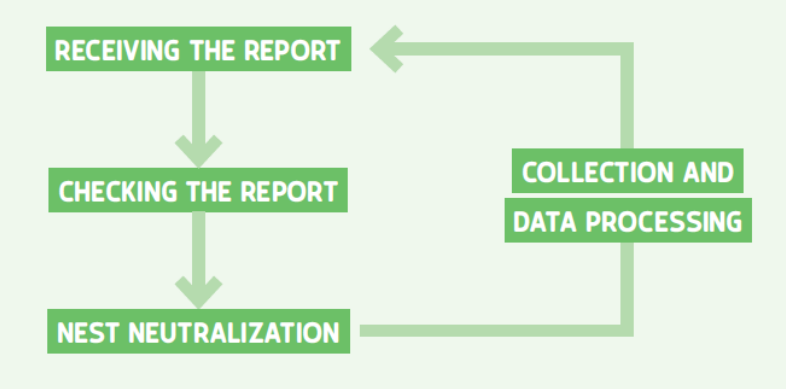

Figure 9 - Procedural scheme for the establishment of an early warning and rapid response system.

All the involved operators should keep a register of the destroyed nests, with references to the position (GPS coordinates), the size, the technique used for nest destruction, the date and time of treatment. The availability of good quality photos of the nest before its treatment allows to verify the species and the activity of the colony; photos after the treatment allow to demonstrate its successful accomplishment. Data concerning all the destroyed nests should be regularly communicated to the competent regional or national authority, so as to be able to verify the extent of the area colonized by *V. velutina* and the effectiveness of control activities.

Based on the number of reports that must be managed, a management strategy for *V. velutina* may require dedicated personnel for the collection and management of reports received by citizens, including the activation of a telephone number and/or an email associated with a dedicated web page.

The involvement of beekeeper associations is essential for the establishment of the surveillance strategy. The involved associations should periodically report to the competent Authority the number of beekeepers involved in the monitoring, the position of the monitoring stations and the results of the monitoring activity, taking care that any positive reports of *V. velutina* in new areas must be straightforward communicated.

A control strategy based on nest detection and destruction must also include procedures for the disposal of colonies; such procedures may depend on the following factors:

- Possibility to reach and physically remove the colony. The nests are often built at several meters from the ground, on the tops of the trees and buildings, and the operators cannot reach the colonies or reach them with safety all the times.

- Treatment method used. Colonies treated with pyrethroid insecticides must remain in place for a few days to allow the collapse of the entire colony, so their removal requires a subsequent intervention. The nests treated at night can instead be removed immediately, as all the hornets of the colony, at night, are inside the nest.
- Size of colonies. The primary nests can be easily removed, both because of their small size and because they are normally reachable by the operators. On the contrary, the removal of the developed nests is more complex, due to their large dimensions and location, often at many meters height above the ground.
- Number of nests in invaded area. In regions where the species is present with stable populations and the number of colonies is high, the removal of all treated colonies involves considerable efforts and costs. On the contrary, in new invasive outbreaks it is advisable to remove the colonies once they have been inactivated.

All the removed colonies must be disposed accordingly to the current legislation and in relation to the treatment modality (Directive 2008/98/EC of the European Parliament and of the Council, of November 19, 2008; Commission Decision 2014/955/EU of 18 December 2014). Before colony disposal, it is essential to verify its complete inactivity, to avoid translocations and accidental introductions due to hornets that survived the treatment or to individuals that are near to emerge from the cells.

6. Differentiated intervention strategies

The effective management of an invasive exotic species requires the development of a calibrated strategy for the species that is adaptable to different territorial scenarios. Given the potential of *V. velutina* to create new populations at a great distance from the colonized area, due to the passive transport of founder queens, it is essential to develop a control strategy based on prevention, on rapid detection of new outbreaks, and on the control of existing populations, as foreseen in the best practices for the management of invasive alien species (Fig. 10). Therefore, for an effective management of *V. velutina*, it is essential to implement the following strategies:

- monitoring network in all Italian regions;
- early warning and rapid response system for the management of new invasion outbreaks;
- control strategy in the colonized area.

Given the spread modalities of the species, all Italian regions should establish both an active and passive surveillance strategy to monitor the presence of *V. velutina* (chapter 4.1). The surveillance strategy must involve the beekeepers and their Associations, to allow the establishment and the long-term maintenance of a widespread monitoring network that is effective in rapidly confirm the presence of the species, dynamic and sustainable over time.

After the confirmation of hornets or nests in a new invaded area, it is necessary to activate all the available measures for a rapid detection and destruction of nests in the area, before the species has the possibility of establish viable populations. These measures can also adopt innovative techniques to increase the probabilities of finding *V. velutina* nests (chapter 4.3). On the contrary, in areas colonized by *V. velutina* as western Liguria, it is necessary to develop or maintain a control strategy based on the rapid detection and destruction of the colonies and the management of reports received by citizens (chapter 4.2).

Figure 10 - Strategies for the management of *V. velutina* differentiated in relation to the involved area and the presence of the species.

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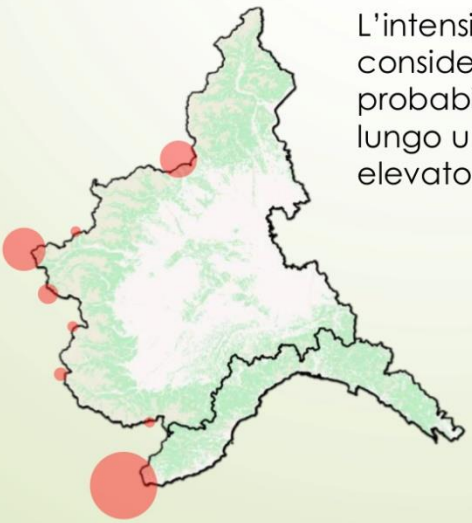
ANNEX 1

VESPA VELUTINA: MODALITÀ DI DIFFUSIONE

Lista dei Vettori di Introduzione - *Drivers*

- ✓ Diffusione naturale di regine fondatrici
- ✓ Trasporto di legname, derivati del legname, corteccia o materiale vegetale (paglia, fieno, foglie, …)
- ✓ Trasporto di merci di vario genere e dei relativi imballaggi (materiale vivaistico, …)
- ✓ Movimentazione di terreno associato al trasporto di piante
- ✓ Commercio di materiale ortofrutticolo
- ✓ Trasporto passivo di individui adulti ad opera di veicoli
- ✓ Movimentazione di materiale apistico (arnie, melari, colonie, regine, pacchi d'ape, …)

Vie d'ingresso in Piemonte & Liguria - *Pathways*



L'intensità del trasporto di merci può essere considerato un indice indiretto delle probabilità di trasporto passivo di organismi lungo una direttrice viaria. Il trasporto merci è elevato in corrispondenza di:

- ✓ Ventimiglia
- ✓ traforo del Frejus
- ✓ traforo del Monte Bianco

Queste aree possono rappresentare le principali vie di introduzione della specie in Piemonte e Liguria, grazie al trasporto passivo.

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STOP VESPA ASIATICA

ANNEX 2

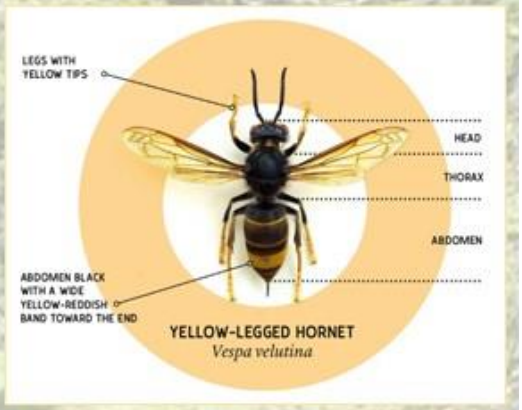
STOP VESPA ASIATICA

DISAFA

POLITECNICO DI TORINO

Associazione Produttori Miele Piemonte

Vespa velutina: how to identify it



Wasps and hornets present in Italy which can be misidentified as *Vespa velutina*.


Vespa crabro


Vespa orientalis


Vespula spp.


Dolichovespula spp.


Polistes spp.

...avoiding misidentifications


Xylocopa spp.


Uroceros gigas

Megascolia spp.

Also the nests can be recognized for morphology and location


Vespa velutina


Vespa crabro

Vespa velutina : in springtime the nest is few cm in diameter; in summer it can reach 80 cm. Normally built at elevated heights from the ground, on tree tops or buildings. In big nests the entrance is lateral, differently than in all other species.

Vespa crabro : in springtime the nest is few cm in diameter and in summer it reaches big dimensions. Usually located in tree holes or in sheltered areas on buildings. The entrance is central in the bottom part of the nest.

Vespa orientalis : nest usually built underground.

Vespula spp. : diameter of 30-35 cm, often in underground holes.

Dolichovespula spp. : diameter of 30-35 cm, usually hanging on trees and bushes. Entrance on the bottom, by side.

Polistes spp. : 1 comb, 10-15 cm, without protective envelope.


Polistes spp.


Dolichovespula spp.

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