

Establishment of the Invasive Hornet *Vespa velutina* (Hymenoptera: Vespidae) in Japan

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Abstract—The Asian hornet *Vespa velutina nigrithorax*, most probably originated from China, has been posing an ecological problem in Europe and Korea since its accidental introduction and the subsequent establishment during early 2000s. In 2012, the first specimen of the hornet was collected in Tsushima Island, Japan, which suggested that *V. velutina* invaded into the country. A field survey was hence made in 2013 to investigate whether the hornet had been established in the island. The survey confirmed the establishment of *V. velutina* in Tsushima, Japan. Morphological examination of the specimens obtained from the Island confirmed that the *velutina* belonged to the subspecies *nigrithorax* and was well coincided with the specimens from southern China. Field observations also confirmed that the invaded hornet was frequently found preying Japanese honeybee *Apis cerana japonica*, an important pollinator native to the island. The present observation suggested that *V. velutina* was accidentally introduced from South Korea, where the hornet had been well established since its invasion.

Keywords— invasive species, Asian hornet, apiculture, pest management.

I. INTRODUCTION

THE members of the genus *Vespa* are known as “hornets”, and are the largest social hymenopteran wasps. They are natively distributed in Eurasia and Asia, with more than 20 described species [1, 2]. It is well recognized that hornet’s venomous stings can pose risks for humans while hornets are an important component in ecosystems as generalist predators [2, 3]. The stings are painful and damaging, and can even be fatal if they trigger allergies called an anaphylactic reaction [4, 5, 6]. In Southeast and East Asia, hornets often attack humans [3, 7, 8, 9], and around 20 people die due to hornet stings every year in Japan [8].

Vespa velutina Lepeletier, 1836 (Hymenoptera: Vespidae), also known as the Asian predatory wasp or the yellow-legged hornet, is an invasive Vespine wasp [10]. In Europe, it was first recorded from southwest France in 2004 as an alien species [10, 11], and has rapidly been extending its range of invasion. This hornet species has now established throughout most of Southwest Europe, including France, Italy, Spain, and Portugal [10–13]. Also, *V. velutina* was discovered in South Korea during early 2000’s, and again has rapidly increased its population size, expanding its distribution within the country [8, 14].

Biological invasion by the hornet can cause several problems. Three major problems generally recognized are: (1)

it can pose a threat, as a top predator of invertebrates, to native ecosystems; (2) it can be a strong stressor to native honeybees, which are *V. velutina*’s preferred prey; and (3) it may aggressively injure humans. For these reasons, management programs are under urgent demand.

Those *V. velutina* invaded into Europe and South Korea are most likely to be originated in southern part of China, supported by some morphological and molecular evidence [10, 14]. It is believed that *V. velutina* was accidentally introduced into the countries through trade. Because South Korea is a neighboring country of Japan with an active trade and human exchange between the countries, caution has been raised about the potential risk of *V. velutina* invasion into Japan [15].

In 2013, an amateur entomologist placed on his blog a photo of an unknown hornet collected in 2012 at a northern part of Tsushima Island of Japan, and the hornet was seemingly *V. velutina*. Later, in 2014, Sakai and Takahashi [16] confirmed on the basis of a single specimen that it was *V. velutina*, which was firstly recorded from Japan.

The present study provides additional evidence that *V. velutina nigrithorax* has been established in Tsushima Island of Japan and that it has been quickly expanding its range within the island.

II. FIELD SURVEY

A. Locality

A field study was conducted in Tsushima Island, Nagasaki Prefecture, Japan. The island is located at northern part of Kyushu mainland of the country and is situated about 150km apart from Fukuoka City, the largest city in northern Kyushu (Fig. 1), which is connected directly to Tsushima Island by plane and ship. Beside, Tsushima Island is just 50km apart from Busan Metropolitan City, the second largest city of South Korea, which is famous as the largest port city in the country. Tsushima Island is also connected directly to Busan City by ship.

B. Field survey

A field survey was made in September 2013. Because available information suggested that *V. velutina* was found in northern Tsushima, searching efforts were concentrated particularly in northern part of the island. Also, to assess the risk of invasion into mainland Kyushu, areas in the vicinity of the airport and two main ports were included for the survey.

Because it is well known that the hornet visits honeybee nests to hunt honeybee workers, honeybee hives maintained for beekeeping were searched primarily. Each beehive was visited 3–5 times to check whether *V. velutina* was hovering in front

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of the hive.

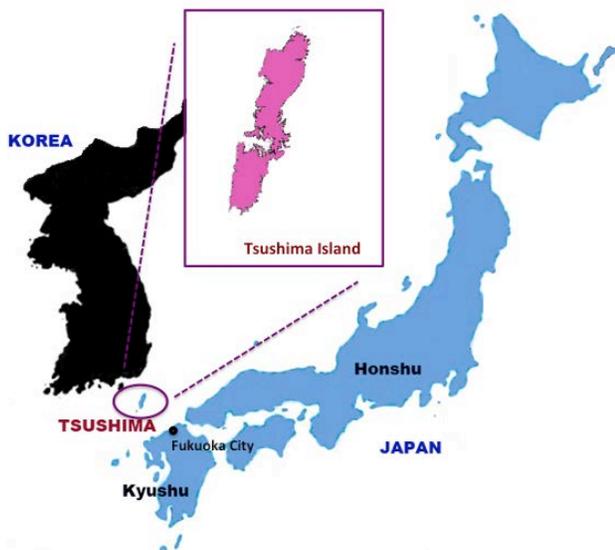


Fig. 1 Location of Tsushima Island, northern Kyushu, Japan

C. Behavioral observation

Behavioral observation was also made to confirm if *V. velutina* predated native honeybees. For this purpose, the hunting behavior of *V. velutina* was observed in front of honeybee hives.

III. RESULTS AND DISCUSSION

In 5 out of 15 localities in northern part of Tsushima Island, non-native hornets were detected. The majority of the hornets were found in front of honeybee hives, and, in all, more than 40 hornets were observed (exact number of hornets was unknown because it was difficult to identify if individuals found in different time on the same hive were the same individuals or not). The observed non-native hornets were identified as *V. velutina*; the identification was made on the basis of specimens collected and a key provided by previous researchers [17–19]. Given the high number of *V. velutina* observed in different localities, it was concluded that the invasive hornet has been established in Tsushima Island. Also, it was suspected that a considerable number of the nests were present in the northern Tsushima.

Although it was difficult to exactly identify whether the observed hornets were “workers” or “queens”, on the basis of the size, it is reasonable to assume they were all workers because queens are unlikely to search prey in Autumn season and because new queens produced in Autumn should not make hunting.

Although the invasive hornet was confirmed in northern Tsushima, it was not detected in central and southern part of the island, where the airport and a main port were located. The result suggested that *V. velutina* was not intruded into central and southern Tsushima, at least, in 2013, and was limited in northern Tsushima. It is therefore assumed that the invader has been introduced in northern part of the island and expanding its range there. In fact, *V. velutina* was confirmed in the vicinity of another main port, Hitakasu-kou, situated northernmost part of

Tsushima.

Vespa velutina comprises several subspecies described [17–19]. The morphological features of workers collected in Tsushima indicated that they belong to the subspecies *nigrithorax* (Fig. 2) described by de Buysson, 1905. Although in its original description, de Buysson (1905) included Sumatra and Celebes, Indonesia as localities, I agreed the treatment by van der Vecht (1957) that the subspecies “*nigrithorax*” should be used for populations in continental Asia, e.g., India, Bhutan and China [19]. This is the same subspecies that has been evoking a number of problems in Europe and Korea.



Fig. 2 A worker of the invasive hornet *Vespa velutina* ssp. *nigrithorax*, collected in Tsushima Island

Further, behavioral observations confirmed that *V. velutina* in Tsushima attacked and predated the native honeybee *Apis cerana japonica*. As already documented in several literatures [10, 13, 20], the invaded *V. velutina* was doing “sit and wait” tactics to hunt the honeybees; the hornets hovered in front of the entrance of beehives and waited honeybee workers returning to the hives (Fig. 3). I observed 16 cases in which the hornets successfully caught, while flying, the returning honeybee workers. The success of catching a bee appeared to be rather low because most of honeybees skillfully avoided the predation. In one case, *V. velutina* attacked and predated a honeybee worker on the entrance of the hive. No direct attack or intrusion into the hives was observed. The negative impact on the native honeybee would therefore be low or limited.

Many aspects of ecology and invasive nature of *V. velutina* remain unclear [10]. Human activities have been impacting ecological processes and enhancing accidental introduction and establishment of alien species. Although it is evident that countless introductions of alien species have occurred on a global scale, alien organisms appear to show markedly different rates of successful establishment.

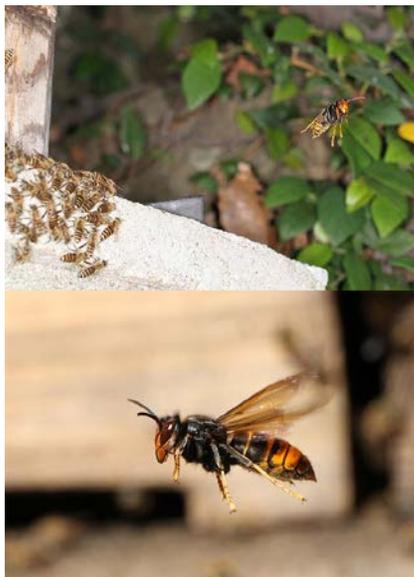


Fig. 3 *Vespa velutina nigrithorax* hunting Japanese honeybee *Apis cerana japonica* in front of the beehive

Among social wasps, hornets belonging to the genus *Vespa* are often found in quarantine systems but appear to rarely undergo successful establishment while hornets of the genus *Vespula* appear to show a greater success [2, 3]. Successful invasion by *V. velutina* into Europe, Korea and Japan in the recent 10 years suggests that the hornet species should have some ecological and behavioral features that enable it to be introduced and/or allow it to be a successful invader [8, 10, 21]. It is currently not known what features are involved. Also, ecological and behavioral traits related to the quick range expansion of the invasive hornet are not well understood so far. However, suggestions are given as the reasons why *V. velutina* can be a successful; climatic change enhances the successful establishment in temperate regions, and the invasive hornet can choose a wide range of environments as the nesting site [21, 22]. Future studies should thus address such features of *V. velutina*.

V. velutina invasion into Japan should lead to unwelcome consequences for the native ecosystems if the hornet rapidly increases its population, as with the case for many invasive species [23]. The invasive predatory *V. velutina* also may damage traditional apiculture in Tsushima. It is therefore urgent to establish the strategy to combat the invasive hornet. If the population size is small enough and the current distribution in Tsushima Island is restricted, we have to make a plan to eradicate the hornet but if not, an alternative project of managing it should be considered.

Further, the great concern is that the invasive *V. velutina* might spread to the mainland Japan, most likely to Kyushu, one of the four main islands of the country, which is located just south from Tsushima Island (Fig. 1). Thus, to avoid future invasion into other part of the country, monitoring is essential in locations, e.g., port and airport, where *V. velutina* could accidentally be introduced from Tsushima.

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REFERENCES

- [1] J. M. Carpenter and J. Kojima, "Checklist of the species in the subfamily Vespinae (Insecta: Hymenoptera: Vespidae)", *Natural History Bulletin, Ibaraki University*, vol. 1, pp. 51–92, 1997.
- [2] M. E. Archer, "*Vespine Wasps of the World: Behaviour, Ecology and Taxonomy of the Vespinae*", Siri Scientific Press, Manchester, UK. 352 pp., 2012.
- [3] M. Matsuura and S. Yamane, "*Biology of Vespine Wasps*", Springer-Verlag, Berlin, 1990.
- [4] J. O. Schmidt, S. Yamane, M. Matsuura, and C. K. Starr, "Hornet venoms: lethality and lethal capacities", *Toxicon*, vol. 24, pp. 950–954, 1986.
- [5] J. R. Warpinski and R. K. Bush, "Stinging insect allergy", *Journal of Wilderness Medicine*, vol. 1, pp. 249–257, 1990.
- [6] K. T. Fitzgerald and A. A. Flood, "Hymenoptera stings", *Clinical Techniques in Small Animal Practice*, vol. 21, pp. 194–204, 2006.
- [7] H. Yamauchi, "*Outbreaks of Hornets in Urban Areas*", Chunichi Syuppan, Nagoya, Japan, 113 pp., 2009.
- [8] M-B. Choi, S. J. Martin and J-W. Lee, "Distribution, spread, and impact of the invasive hornet *Vespa velutina* in South Korea", *Journal of Asia-Pacific Entomology*, vol. 15, pp. 473 – 477, 2012.
- [9] S. Makino, S. Yamane, T. Ban, and I. Kunou, "The Japanese hornet *Vespa simillima* Smith, an important nuisance pest in urban areas (Hymenoptera: Vespidae)", *Japanese Journal of Sanitary Zoology*, vol. 32, pp. 203–213, 1981.
- [10] K. Monceau, O. Bonnard, and D. Thiéry, "*Vespa velutina*: a new invasive predator of honeybees in Europe", *Journal of Pest Science*, vol. 87, pp. 1–16, 2014.
- [11] K. Monceau, O. Bonnard, and D. Thiéry, "Chasing the queens of the alien predator of honeybee: a water drop in the invasiveness ocean", *Open Journal of Ecology*, vol. 2, pp. 183–191, 2012.
- [12] C. Villemant, M. Barbet-Massin, A. Perrard, F. Muller, O. Gargominy, F. Jiguet, and Q. Rome, "Predicting the invasion risk by the alien bee-hawking Yellow-legged hornet *Vespa velutina nigrithorax* across Europe and other continents with niche models", *Biological Conservation*, vol. 144, pp. 2142–2150, 2011.
- [13] K. Monceau, M. Arca, L. Lepre'tre, F. Mougel, O. Bonnard, J-F. Silvain, N. Maher, G. Arnold, and D. Thiéry, "Native prey and invasive predator patterns of foraging activity: the case of the yellow-legged hornet predation at European honeybee hives," *PLoSOne*, vol. 8, e66492, 2013.
- [14] J-K. Kim, M. B. Choi, T-Y. Moon, "Occurrence of *Vespa velutina* Lepelletier from Korea, and a revised key for Korean *Vespa* species (Hymenoptera: Vespidae)", *Entomological Research*, vol. 36, pp. 112–115, 2006.
- [15] T. Ueno, "Hornets in Kyushu and Okinawan regions in Japan", website at Institute of Biological Control, Kyushu University, <http://www.agr.kyushu-u.ac.jp/lab/ine/ueno/suzumebachi7.html>
- [16] Y. Sakai and J. Takahashi, "Discovery of a worker of *Vespa velutina* (Hymenoptera: Vespidae) from Tsushima Island, Japan", *Kontyu (new series)*, vol. 17, pp. 32–36, 2014.
- [17] J. van der Vecht, "The Vespinae of the Indo-Malayan and Papuan Area (Hymenoptera: Vespidae)", *Zoologische Mededelingen (Leiden)*, vol. 34, pp. 1–83, 1957.
- [18] J. van der Vecht, "Notes on Oriental Vespinae, including some species from China and Japan (Hymenoptera: Vespidae)", *Zoologische Mededelingen (Leiden)*, vol. 36, pp. 205–232, 1959.
- [19] M. E. Archer, "*A key to the world species of the Vespinae (Hymenoptera)*", Research Monograph of the University College of Ripon & York St. John, York, UK, 1989.
- [20] K. Tan, S. E. Radloff, J. J. Li, H. R. Hepburn, M. X. Yang, L. J. Zhang, and P. Neumann, "Bee-hawking by the wasp, *Vespa velutina*, on the honeybees *Apis cerana* and *A. mellifera*", *Naturwissenschaften*, vol. 94, pp. 469–472, 2007.
- [21] M. B. Choi, G. S. Jang, J. K. Kim, and J. W. Lee, "Distribution characteristics by species and comparison of social wasps in two metropolitan cities (Busan, Daegu)", *Journal of Asia-Pacific Entomology*, 2014, in press.
- [22] M. Barbet-Massin, Q. Rome, F. Muller, A. Perrard, C. Villemant, and F. Jiguet, "Climate change increases the risk of invasion by the yellow-legged hornet", *Biological Conservation*, vol. 157, pp. 4–10, 2013.
- [23] W. E. Snyder, E. W. Evans, "Ecological effects of invasive arthropod generalist predators", *Annual Review of Ecology and Systematics*, vol. 37, pp. 95–122, 2006.