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First European report of social wasps trapped in response to acetic acid, isobutanol, 2-methyl-2-propanol and heptyl butyrate in tests conducted in Hungary

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Abstract

Five species of social wasps were captured in trapping tests in Budapest (Hungary) that evaluated the attractiveness of acetic acid, isobutanol, 2-methyl-2-propanol, and heptyl butyrate. Both *Vespula vulgaris* (L.) and *Vespula germanica* (F.), were captured in traps baited with isobutanol, the combination of acetic acid and isobutanol, and the combination of acetic acid and 2-methyl-2-propanol. *V. germanica* did not respond to acetic acid or to heptyl butyrate. *V. vulgaris* also responded to acetic acid alone, and 2-methyl-2-propanol alone, but did not respond to heptyl butyrate. Both *V. germanica* and *V. vulgaris* responded more strongly to the combinations of acetic acid with isobutanol and acetic acid with 2-methyl-2-propanol, compared to any of these chemicals tested alone. Small numbers of European hornets, *Vespa crabro* L. were captured in traps baited with acetic acid with isobutanol, but not with any other lures. Small numbers of *Dolichovespula media* (Retzius) were captured in traps baited with acetic acid, and with the combination of acetic acid and isobutanol, but not with any other lures. The small numbers of *Polistes nimpha* (Christ) trapped were not large enough for any statistical analyses. These findings are the first European report of attracting and trapping vespid wasps with these chemicals.

Key words: Vespidae, *Vespula*, *Vespa*, *Dolichovespula*, wasp, yellowjacket, trap, attractant, Europe.

Introduction

Temperate species of social wasps in the genera *Vespula*, *Dolichovespula* and *Vespa* (Hymenoptera: Vespidae, Vespinae), can be pestiferous to humans and their animals (Akre *et al*., 1980; Spradbery, 1973). Wasps related to *Vespula vulgaris* (L.) in particular can be a nuisance and stinging hazard because of their large average colony size, long colony duration into autumn, and scavenging habits which bring them into frequent contact with people. In Europe, major pest species are the common wasp *V. vulgaris* and the German wasp *Vespula germanica* (F.). Other European social wasps, such as the European hornet *Vespa crabro* L. and aerial nesting wasp *Dolichovespula media* (Retzius), can be a problem when the nests are encountered. All of these wasps will vigorously defend the colony when disturbed, and are then likely to attack and sting. Pestiferous species of vespine wasps are found throughout Europe, Asia and North America, and *V. germanica*, *V. vulgaris*, and *Vespula pensylvanica* (Saussure) have been spread by human activities to parts of Africa, South America, Australia and a number of islands (Archer, 1998).

In certain circumstances, it is desirable to detect or suppress such wasp populations. Management techniques have included lures, baits, and traps. Many species of vespine wasps are attracted to sweet materials (Christie, 1992; Dvořák and Landolt, 2006; Reid and MacDonald, 1986; Ross *et al*., 1984; Spurr, 1996; Wegner and Jordan, 2005), as well as meats (Spurr, 1995; Wood *et al*., 2006). The discovery or identification of volatile chemicals that attract wasps provides the opportunity to formulate long lasting and effective lures that do not need to be frequently replaced, as food lures do. Davis *et al*. (1969) discovered *V. pensylvanica* attraction to heptyl butyrate, which is useful as a lure in traps for *V. pensylvanica* and *Vespula squamosa* (Drury) in the U.S. (Landolt *et al*., 2003, MacDonald *et al*., 1973). Aldrich *et al*. (1986) trapped *Vespula maculifrons* (Buysson) with a 3-component blend of a pentatomid bug sex pheromone, also in the U.S. More recently, the combination of acetic acid and isobutanol has been found to be attractive to a number of North American vespine wasp species, as well as some species of *Polistes* (Landolt *et al*., 1999, 2005; Reed and Landolt, 2002). Landolt *et al*. (2000) also showed wasp attraction to acetic acid with other short chain alcohols.

Little work has been conducted to date on chemical attractants for social wasps in Europe. Efforts to trap wasps in Europe have used food materials such as beer and fruit (Boller and Bauer, 2000; Dvořák and Landolt, 2006). Aldiss (1983) in England studied wasp responses to ginger syrup and attempted to isolate attractants. We are not aware of any published records of evaluations of chemical attractants for social wasps in Europe, although Aldiss (1983) referred to unsuccessful screenings of aromatic compounds for attractiveness to *V. germanica* and *V. vulgaris* wasps in England.

We report here assessments of the attractiveness of acetic acid, isobutanol, 2-methyl-2-propanol, and heptyl butyrate to social wasps in Hungary. Attractiveness of chemicals was indicated by capture of wasps in traps baited with the chemical lures. These compounds are known to attract some species of wasps in North America (Davis *et al*., 1969; Landolt, 1998; Landolt *et al*., 1999; 2000; 2005), but have not been evaluated in Europe. The objectives of the study were to determine if

the social wasps present in Europe are attracted to any of these chemicals, and to compare the patterns of European wasp responses to chemical attractants to what has been observed in North America. These findings may provide a basis for the development of trapping methods for detection, survey and management of pest social wasps in Europe.

Materials and methods

Traps used were the standard CSALOMON® VARL funnel traps produced by the Plant Protection Institute of HAS (Budapest, Hungary). These were originally developed for capturing noctuid moths and proved to be suitable as well for social wasps (Tóth *et al*., 2001). This trap consists of an opaque plastic funnel (top opening outer diameter: 13 cm, funnel hole diameter: 3 cm, height of funnel: 16 cm), with a 20 x 20 cm flat plastic roof and below a round transparent plastic container (ca 1 litre capacity; held in place below the funnel by a rubber band). In previous tests the VARL trap proved to be the most effective for the capture of yellowjackets, among several trap designs tested (Tóth *et al*., 2001). Each trap had a 1% solution of boric acid in the bottom of the trap to drown and preserve captured specimens.

Chemicals tested were dispensed from 15 ml polypropylene bottles (Nalge Nunc International, Rochester, NY, USA, 2118-9050) with 3 mm diameter holes in the lids. The bait dispenser was suspended from the middle of the trap roof into the funnel and the top of the dispenser was positioned 0.5 - 1.0 cm below the trap roof. Chemicals were loaded at 10 ml per bottle, onto cotton balls in the bottom of the bottle. Single chemical treatments of acetic acid, isobutanol, and 2-methyl-2-propanol were dispensed from bottles with a 3 mm diameter hole in the bottle lid. Heptyl butyrate was dispensed from bottles with a 6 mm diameter hole in the lid. Two component treatments were dispensed as one to one mixtures in the same bottle, with a 6 mm diameter hole in the lid. Acetic acid (glacial) was purchased from Baker Chemical Company (Philippsburg, PA, USA), isobutanol and 2-methyl-2-butanol from Sigma-Aldrich (St. Louis, MO, USA), and heptyl butyrate from Aldrich Chemical Company (Milwaukee, WI, USA).

Two experiments were conducted in the field during 2006. A randomized complete block design with 10 replicates was used. Traps were checked and serviced weekly. Lures were replaced after four weeks. Experiments were set up along an edge of a forested area near Budapest (Julianna major Expt. Stn. of Plant Prot. Inst., HAS), with traps hung on branches of trees and shrubs at a height of 1.5 meters, with 10 meters between traps.

The first experiment evaluated acetic acid, isobutanol, and heptyl butyrate, with 6 treatments. These treatments were 1) an unbaited control trap, 2) a trap with an acetic acid lure, 3) a trap with an isobutanol lure, 4) a trap with an heptyl butyrate lure, 5) a trap with a lure releasing both acetic acid and isobutanol, and 6) a trap with a lure releasing both acetic acid and heptyl butyrate. Traps were set up on August 7, and were maintained until September 15.

The second experiment compared acetic acid plus isobutanol with acetic acid plus 2-methyl-2-propanol. The treatments were 1) an unbaited control trap, 2) a trap with an acetic acid lure, 3) a trap with an isobutanol lure, 4) a trap with a 2-methyl-2-propanol lure, 5) a trap with a lure releasing both acetic acid and isobutanol, and 6) a trap with a lure releasing both acetic acid and 2-methyl-2-propanol. Traps were set up on September 15 and were maintained until October 28.

Statistical analyses of trap catch data were conducted for each species of wasp captured. Following an ANOVA at the 5% level, means were separated using the Games-Howell and Bonferonni-Dunn tests. Treatment trap catches statistically greater than control trap catches indicated lure attractiveness.

The taxonomy and nomenclature of wasps here follows that of Carpenter and Kojima (1997).

Results

In the first experiment significant numbers of *V. germanica* wasps were captured in traps baited with isobutanol compared to controls, and in traps with the combination of acetic acid and isobutanol (table 1). Traps with the combination of these two compounds yielded significantly higher numbers of *V. germanica* in traps, compared to traps with either compound alone. *V. germanica* did not respond to acetic acid or heptyl butyrate. Numbers of *V. vulgaris* wasps captured in traps baited with acetic acid, isobutanol, and the combination of acetic acid and isobutanol, were significantly greater than numbers in control traps. Numbers of *V. vulgaris* in traps with the combination of acetic acid and isobutanol were greater than in traps with either compound alone.

Table 1. Mean numbers of social wasps captured per inspection in traps baited with chemical feeding attractants.

Chemical lure - 1st experiment	*V. germanica*	*V. vulgaris*	*D. media*	*V. crabro*
Control	0.04ab	0.51ab	0.00a	0.01a
Acetic acid	0.19b	2.19c	0.12b	0.12a
Heptyl butyrate	0.01a	0.17a	0.00a	0.00a
Isobutanol	1.08c	3.11c	0.01a	0.04a
Acetic acid + Heptyl butyrate	0.19ab	1.14b	0.03a	0.04a
Acetic acid + Isobutanol	5.89d	19.04d	0.11b	0.44b

Means within a column followed by the same letter are not significantly different by Games-Howell; Bonferroni-Dunn, at p=0.05.

V. vulgaris wasps also did not respond to heptyl butyrate. *D. media* wasps were captured in significant numbers in traps baited with acetic acid and acetic acid with isobutanol, but with no effect indicated by the combination of the chemicals. European hornets were captured in significant numbers only in traps baited with the combination of acetic acid and isobutanol. Numbers of *Polistes nimpha* (Christ) trapped were too few for statistical comparisons of treatments. Totals of 825 worker *V. germanica*, 2935 worker *V. vulgaris*, 21 worker *D. media*, 66 worker *V. crabro*, and 5 female *P. nimpha* workers were captured in this experiment.

In the second experiment (table 2), significant numbers of *V. germanica* were captured in traps baited with the combination of acetic acid and isobutanol, and the combination of acetic acid and 2-methyl-2-propanol, and not to acetic acid, isobutanol, or 2-methyl-2-propanol, when these chemicals were dispensed alone. Numbers of *V. germanica* in traps baited with the 2-component blends were not significantly different from each other. Significant numbers of *V. vulgaris* were trapped with all chemical lures tested. Numbers of *V. vulgaris* in traps with either of the 2-component blends were greater than in traps with either compound alone, and numbers of *V. vulgaris* captured in traps with both of the 2-component lures were quite similar. Significant numbers of European hornets were again captured in traps baited with the combination of acetic acid and isobutanol but not with any other lure. Numbers of *D. media* and *P. nimpha* wasps trapped were too small for any statistical analyses of the data. Totals of 676 worker *V. germanica*, 2379 worker *V. vulgaris*, 0 *D. media*, 31 worker *V. crabro*, and 4 female *P. nimpha* workers were captured in this experiment.

Discussion

Heptyl butyrate was the first chemical attractant developed for use in trapping social wasps. Wasp attraction to 2,4-hexadienyl butyrate (Davis *et al*., 1967) was discovered in screenings of chemicals for attractiveness to flies, and subsequent comparisons of similar compounds led to the use of heptyl butyrate as a lure in commercial traps (Davis *et al*., 1969). In North America, heptyl butyrate is a good lure for *V. pensylvanica* (MacDonald *et al*., 1973), *V. squamosa* (Landolt *et al*., 2003), and 4 species related to *Vespula rufa* (L.); *Vespula acadica* (Sladen), *Vespula atropilosa* (Sladen), *Vespula consobrina* (Saussure), and *V. vidua* (Landolt *et al*., 2005; Reed and Landolt, 2002). *V. pensylvanica* is a major pest in western North America, *V. squamosa* can be pestiferous at times in the southeastern United States, and species related to *V. rufa* are not commonly a pest (Akre *et al*., 1980). In North America, heptyl butyrate is not attractive to the other major pest species of *Vespula*, such as *Vespula maculifrons* (Buysson), *V. germanica,* or *V. vulgaris*, or *Vespula flavopilosa* Jacobson, or other genera of social wasps (*Dolichovespula*, *Vespa*, *Polistes*) (Landolt *et al*., 2005; Reed and Landolt, 2002). To our knowledge, this work represents the first report of testing of heptyl butyrate in Europe as an attractant for social wasps. As in North America, heptyl butyrate was not attractive to *V. germanica, V. vulgaris* or *V. crabro* in these tests in Hungary. Also, heptyl butyrate was not here attractive to *D. media*. A response by *V. rufa* was expected, because of the attractiveness of heptyl butyrate to the related species *V. acadica*, *V. atropilosa*, *V. vidua,* and *V. consobrina* in North America (Landolt *et al*., 2003; 2005; Reed and Landolt, 2002). *V. rufa* was probably not present in the study area.

In North America, the species of social wasps in several genera that can be trapped with acetic acid with isobutanol include the vespine wasps *V. pensylvanica*, *V. maculifrons*, *V. squamosa*, *V. vulgaris*, *V. germanica*, *V. flavopilosa, Dolichovespula maculata* (L.)*,* and *V. crabro* (Landolt, 1998; Landolt *et al*., 1999; Reed and Landolt, 2002; Landolt *et al*., 2005). There are no prior reports of testing of this lure in Europe. The response in these tests to the combination of acetic acid and isobutanol by *V. germanica, V. vulgaris* and *V. crabro* appears to be a result of synergy of the two chemicals as co-attractants. Synergy is assumed because the responses to the combination of these compounds were greater than the summed responses to the compounds presented singly. Apparent synergy of these two chemicals was also seen in studies of wasp attraction in Alaska, Maryland, Michigan and Washington of the United States (Landolt, 1998; Landolt *et al*., 1999; Reed and Landolt, 2002; Landolt *et al*., 2005) where attraction of these three species of wasps to acetic acid or isobutanol is quite weak when the chemicals are presented alone. We note here a similar synergistic response by *V. germanica*, *V. vulgaris* and *V. crabro* to acetic acid with 2-methyl-2-propanol, compared to either chemical presented alone. The lack of an enhanced or synergized response to the combination of acetic acid and isobutanol by *D. media* was unexpected because the closely related

Table 2. Mean numbers of social wasps captured per inspection in traps baited with chemical feeding attractants.

Chemical lure - 2nd experiment	*V. germanica*	*V. vulgaris*	*V. crabro*
Control	0.00a	0.04a	0.00a
Acetic acid	0.07a	1.14b	0.01a
Isobutanol	0.46a	1.16b	0.04a
2-Methy-2-propanol	0.47a	1.16b	0.04a
Acetic acid + Isobutanol	3.46b	8.59c	0.24b
Acetic acid + 2-Methyl-2-propanol	1.67b	9.54c	0.09ab

Means within a column followed by the same letter are not significantly different by Games-Howell; Bonferroni-Dunn, at p=0.05.

North American *D. maculata* (Carpenter and Kojima, 1997) is strongly attracted to acetic acid with isobutanol, and weakly attracted to acetic acid or isobutanol alone (Reed and Landolt, 2002).

A comparison was previously made in the state of Washington of the attractiveness to wasps of a series of short chain alcohols presented with acetic acid, including isobutanol (Landolt *et al*., 2000). The purpose of that study was to appraise the relationship between chemical structure and co-attractant activity and determine the specificity of wasp responses to these compounds. In addition to isobutanol, several other compounds showed co-attraction with acetic acid. 2-Methyl-2-propanol with acetic acid, for example, was attractive to *V. pensylvanica* and *V. germanica,* but was significantly poorer in attractiveness than acetic acid with isobutanol. The lesser attractiveness of 2-methyl-2-propanol versus isobutanol may have been due to a lower release rate at some field temperatures. 2-Methyl-2-propanol has a melting point of 22 °C and may have been a solid during much of the prior field testing (Landolt *et al*., 2000), with a comparably poor rate of sublimation. In the study of Landolt *et al*. (2000), acetic acid and 2-methyl-2-propanol were dispensed in separate bottles. In this study (herein), the compounds were mixed, providing a liquid state for the chemicals in the bottle dispenser. If dispensed as a liquid, with a resultant higher evaporative release rate, 2-methyl-2-propanol may make a good co-attractant with acetic acid. We sought then to determine responses of wasps to this 2-component lure. Although the response of the German wasp to acetic acid with 2-methyl-2-propanol was numerically higher, it was not statistically different than the response to acetic acid with isobutanol. Also, the response of *V. vulgaris* to acetic acid with 2-methyl-2-propanol was nearly identical to the response of *V. vulgaris* to acetic acid with isobutanol. So, perhaps this combination of chemicals may, like acetic acid with isobutanol, be useful for trapping pestiferous social wasps.

This work constitutes the first demonstrations of attracting and trapping of social wasps in Europe with synthetic chemical lures. These chemical lures are thought to be feeding attractants, based on wasp responses to natural sources of sugars (carbohydrate feeding) such as fruits, saps, and honeydews. Acetic acid is an abundant volatile product of fermentative bacteria (Eyer and Medler, 1940), and isobutanol has been found in fermented molasses insect baits (Utrio and Eriksson, 1977). Wasp response to heptyl butyrate appears to be analogous to their response to hexyl butyrate which is a fruit odorant (Mattheis *et al*., 1991). We hypothesize then that wasps respond to these compounds in search of carbohydrate foods which naturally occur in fermented saps, fruits and honeydews. It is not yet known how these wasp responses to chemicals in traps compare to natural materials, such as fruit juices, in traps. Additional work can be done to optimize the attractiveness of the lure and the efficiency of the trap in capturing attracted wasps. These include but are not limited to consideration of the release rate and ratio of the chemicals emitted by the lure, the design and capacity of the lure to provide a continuous optimum rate of release for an extended period of time, and aspects of the design of the trap that encourage wasp entry while denying wasp escape.

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References

AKRE R. D., GREENE A., MACDONALD J. F., LANDOLT P. J., DAVIS H. G., 1980.- Yellowjackets of America north of Mexico.- U.S. Department of Agriculture, Agriculture Handbook No. 552, 102 pp.

ALDISS J. B. J. F., 1983.- Chemical communication in British social wasps (Hymenoptera: Vespidae). 269 p., *Doctoral Dissertation*, University of Southhampton, UK.

ALDRICH J. R., LUSBY W. R., KOCHANSKY J. P., 1986.- Identification of a new predacious stink bug pheromone and its attractiveness to the eastern yellowjacket.- *Experientia*, 42: 583-585.

ARCHER M. E., 1998.- The world distribution of the Eurasian species of *Paravespula* (Hym., Vespinae).- *Entomologists' Monthly Magazine*, 134: 279-284.

BOLLER E., BAUR R., 2000.- Wespenbekämpfung im deutschschweizerischen Rebbau.- *Schweizerische Zeitschrift für Obst und Weinbau*. 18: 437-440.

CARPENTER J. M., KOJIMA J., 1997.- Checklist of the species in the subfamily Vespinae (Insecta : Hymenoptera: Vespidae).- *Natural History Bulletin Ibaraki University*, 1: 51-92.

CHRISTIE G. D., 1992.- Non-toxic bait trapping for yellow jackets.- *Pest Control*, 60: 30-32.

DAVIS H. G., EDDY G. W., MCGOVERN T. P., BEROZA M., 1967.- 2,4-Hexadienyl butyrate and related compounds highly attractive to yellow jackets (*Vespula* spp.).- *Journal of Medical Entomology*, 4: 275-280.

DAVIS H. G., EDDY G. W., MCGOVERN T. P., BEROZA M., 1969.- Heptyl butyrate, a new synthetic attractant for yellowjackets.- *Journal of Economic Entomology*, 62: 1245.

DVOŘÁK L., LANDOLT P. J., 2006.- Social wasps trapped in the Czech Republic with syrup and fermented fruit and comparison with similar studies (Hymenoptera Vespidae).- *Bulletin of Insectology*, 59: 115-120.

EYER J. R., MEDLER J. T., 1940.- Attractiveness to codling moth of substances related to those elaborated by heterofermentative bacteria in baits.- *Journal of Economic Entomology*, 33: 933-940.

LANDOLT P. J., 1998.- Chemical attractants for trapping yellowjackets *Vespula germanica* (Fab.) and *Vespula pensylvanica* (Saussure) (Hymenoptera: Vespidae).- *Environmental Entomology*, 27: 1229-1234.

LANDOLT P. J., REED H. C., ALDRICH J. R., ANTONELLI A. L., DICKEY C., 1999.- Social wasps (Hymenoptera: Vespidae) trapped with acetic acid and isobutanol.- *Florida Entomologist*, 82: 609-614.

LANDOLT P. J., SMITHHISLER C. S., REED H. C., MCDONOUGH L. M., 2000.- Trapping social wasps (Hymenoptera: Vespidae) with acetic acid and saturated short chain alcohols.- *Journal of Economic Entomology*, 93: 1613-1618.

LANDOLT P. J., REED H. C., ELLIS D. J., 2003.- Trapping yellowjackets (Hymenoptera: Vespidae) with heptyl butyrate

emitted from controlled release dispensers.- *Florida Entomologist*, 86: 323-328.

LANDOLT P. J., PANTOJA A., GREEN D., 2005.- Yellowjacket wasps (Hymenoptera: Vespidae) trapped in Alaska with heptyl butyrate, acetic acid, and isobutanol.- *Journal of the Entomological Society of British Columbia*, 102: 35-42.

MACDONALD J. F., AKRE R. D., HILL W. B., 1973.- Attraction of yellowjackets (*Vespula* spp.) to heptyl butyrate in Washington state (Hymenoptera: Vespidae).- *Environmental Entomology*, 2: 375-379.

MATTHEIS J. P., FELLMAN J. K., CHEN P. M., PATTERSON M. E., 1991.- Changes in headspace volatiles during physiological development of Bisbee Delicious apple fruit.- *Journal of agricultural and food chemistry*, 39: 1902-1906.

REED H. C., LANDOLT P. J., 2002.- Trap response of Michigan social wasps (Hymenoptera: Vespidae) to the feeding attractants acetic acid, isobutanol, and heptyl butyrate.- *Great Lakes Entomologist*, 35: 71-77.

REID B. L., MACDONALD J. F., 1986.- Influence of meat texture and toxicants upon bait ingestion by the German yellowjacket (Hymenoptera: Vespidae).- *Journal of Economic Entomology*, 79: 50-53.

ROSS D. R., SCHUKLE R. H., MACDONALD J. F., 1984.- Meat extracts attractive to scavenger *Vespula* in eastern North America (Hymenoptera: Vespidae).- *Journal of Economic Entomology*, 77: 637-642.

SPRADBERY J. P., 1973.- *Wasps. An account of the biology and natural history of social and solitary wasps*.- University of Washington Press, Seattle, USA.

SPURR E. B., 1995.- Protein bait preferences of wasps (*Vespula vulgaris* and *V. germanica*) at Mt. Thomas, Canterbury, New Zealand.- *New Zealand Journal of Zoology*, 22: 281-289.

SPURR E. B., 1996.- Carbohydrate bait preferences of wasps (*Vespula vulgaris* and *V. germanica*) (Hymenoptera: Vespidae) in New Zealand.- *New Zealand Journal of Zoology*, 23: 315-324.

TÓTH M., IMREI Z., SZÖCS G., UJVÁRY I., KÁRPÁTI ZS., JERMI T., 2001.- Development of new and more efficient funnel trap designs for pest moths of larger size (Lepidoptera, Noctuidae, Geometridae) and yellowjackets (*Vespa* spp., Hymenoptera, Vespidae), p. 68. In: *Abstract Conference 47th Plant Protection Days*, Budapest, 27-28 February 2001. (in Hungarian)

UTRIO P., ERIKSSON K., 1977.- Volatile fermentation products as attractants for Macrolepidoptera.- *Annales Zoologici Fennici*, 14: 98-104.

WEGNER G. S., JORDAN K. K., 2005.- Comparison of three liquid lures for trapping social wasps (Hymenoptera: Vespidae).- *Journal of Economic Entomology*, 98: 664-666.

WOOD G. M., HOPKINS D. C., SCHELLHORN N. A., 2006.- Preference by *Vespula squamosa* (Hymenoptera: Vespidae) for processed meats: Implications for toxic baiting.- *Journal of Economic Entomology*, 99: 263-267.

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