The influence of different bee traps on undertaking behaviour of the honey bee (Apis mellifera) and development of a new trap

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4 authors, including:

Ingrid Illies
Bavarian State Institute for Viticulture and Horticulture

Norbert Sachser
University of Münster

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Original article

The influence of different bee traps on undertaking behaviour of the honey bee (*Apis mellifera*) and development of a new trap

Ingrid ILLIES[a,b*], Werner MÜHLEN[a], Gerti DÜCKER[b], Norbert SACHSER[b]

[a] Landwirtschaftskammer Westfalen-Lippe, Aufgabengebiet Bienenkunde (Department of Apiculture and Beekeeping), Postfach 5980, 48143 Münster, Germany
[b] Westfälische Wilhelms-Universität Münster, Institut für Neuro- und Verhaltensbiologie, Abteilung für Verhaltensbiologie (Department of Behavioural Biology), 48419 Münster, Germany

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Abstract – In this study the efficiency of bee traps used to evaluate mortality in a bee colony and their influence on undertaking behaviour was tested in twelve colonies of *Apis mellifera* L. Four types of bee traps (Original-Gary-Trap, a Modified-Gary-Trap, the IPSAB-Trap and the Muenster-Trap), commonly used in practical research, were compared to each other and to control colonies without a trap. The use of different bee traps led to incomparable results. In the Original-Gary-Trap, many stray bees were trapped and eventually died within the glass collecting jars, leading to artificially high estimates of mortality. Bees removed the dead bees from the Modified-Gary-Trap, especially during good flight conditions. Dead bees disappeared from the IPSAB-Trap because of predators and wind. Both Gary-Traps had a negative effect on undertaking behaviour; the number of behavioural components involved in removing a dead bee from the colony was large and thus, undertaking took a long time. In IPSAB-Trap, the undertaker bees showed the same number of behavioural components and took similar times to remove dead bees as the control colonies without traps. The newly developed Muenster-Trap, equipped with an easily accessible hive entrance, a collecting box for dead bees and an outlet for stray bees, gave a significantly improved performance.

***Apis mellifera* / undertaking behaviour / bee traps / mortality evaluation**

* Correspondence and reprints
E-mail: illiesi@gmx.de

1. INTRODUCTION

Honey bee (*Apis mellifera* L.) colonies remove debris and dead adult and immature bees from the hive (Suzuki et al., 1974; Morse, 1972). This behaviour protects against pathogenic microorganism, especially in regard to diseased brood and stores of honey and pollen (Visscher, 1980). Bees which remove dead adult bees from the hive are called "undertakers" and "undertaking behaviour" was defined by Visscher (1983, 1988).

To determine the rate of mortality in bee colonies, the number of bees dying inside and outside the hive has to be established. Bee traps have been developed to determine the number of bees dying inside the hive. These traps are placed at the hive entrance to collect all bees that die in the hive and are subsequently removed by undertakers.

A number of different types of bee traps are used in practical research, such as in estimating the hazards of pesticides to bees (EPPO, 1992; Stute, 1991). A frequently used trap is the Gary-Trap (Gary, 1960). Other well-known traps are the "Underbasket Trap" (Accorti et al., 1991) and the "Todd-Trap" (Atkins et al., 1970).

To enter the colony through the different traps, the bees have to pass through small slots or wire netting, which places various demands on the bees, and the results of experiments carried out with different bee traps may not be comparable.

In this study, the efficiency of three types of bee traps, the Original-Gary-Trap, a Modified-Gary-Trap and the IPSAB-Trap (constructed by the Institut of Plant Protection, Seed Control, Apiculture and Beekeeping (IPSAB) in Muenster, Germany) were tested and their influence on undertaking behaviour was compared. The study was carried out in the summers of 1998 and 2000.

2. MATERIALS AND METHODS

2.1. Experiment 1: Efficiency of bee traps

Twelve colonies from a breeder line derived from *Apis mellifera carnica* Pollmann were kept in multiple-story hives with 11 combs per story (37 cm × 22.3 cm). The strength of the colonies was estimated by the method of Liebefeld (Imdorf et al., 1987). All colonies had ample brood and stores of honey and pollen. The colonies were divided into four groups and each of the three colonies within a group was equipped with the same type of bee trap. To compensate for the different sizes of the traps, linen sheets (1.2 m^2) were placed in front of all colonies covering the area in front of the hives which allowed us to record dead bees that were dropped in front of the hive. The following trap types were tested in summer of 1999.

2.1.1. Original-Gary-Trap (OG, Fig. 1a)

The OG was constructed as described by Gary (1960), with dimensions of 46.8 cm (width) × 36 cm (length) × 11 cm (height). The bees can enter or exit the trap through two slots in the lid. One of the slots is situated near the hive entrance and the bees use it to move in and out during regular flight activity. The other slot, not in proximity to the hive entrance, is mainly used as a trap exit. In the bottom of the trap front, two glass jars are inserted to collect the dead bees.

2.1.2. Modified-Gary-Trap (MG, Fig. 1b)

The MG as described here is one of many variations of the OG. The dimensions of the MG are 34.7 cm (width) × 35.5 cm (length) × 8 cm (height). In contrast to the OG, there are no glass jars to collect the dead bees. The bees can pass only through

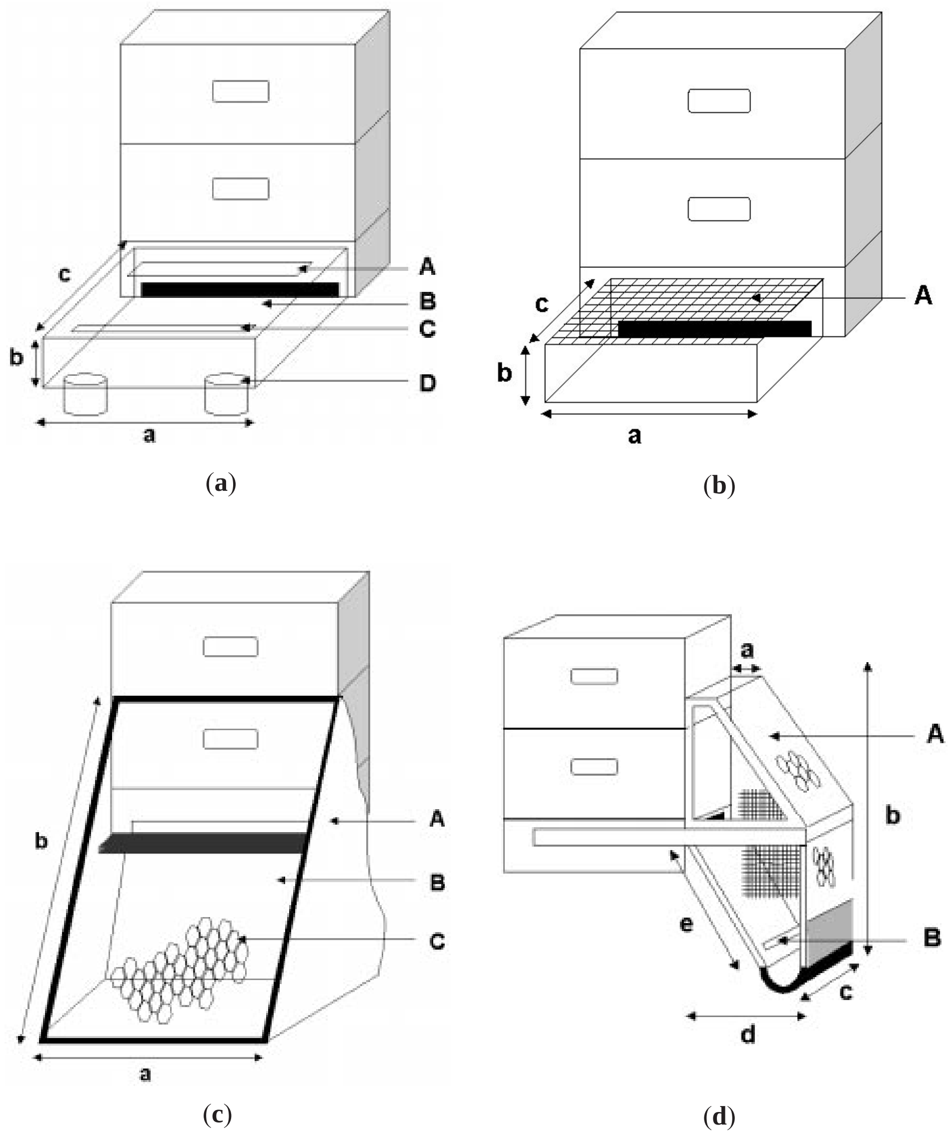

Figure 1. Tested traps. (**a**) Original-Gary-Trap (OG): a = width (46.8 cm), b = height (11 cm), c = length (36 cm), A = slot used for entrance and exit (41.8 cm × 5 cm), B = lid of the trap, C = slot mainly used for exit (41.8 cm × 2.5 cm), D = glass jars to collect dead bees (∅ = 5 cm). (**b**) Modified-Gary-Trap (MG): a = width (34.7 cm), b = height (8 cm), c = length (35.5 cm), A = lid with wire netting (width 1 cm). (**c**) IPSAB-Trap (IP): a = 50 cm, b = 120 cm, A = linen sheet covering the sides and the back side (B) of the trap, C = wire netting (side length of the meshes = 1.5 cm). (**d**) Muenster-Trap (MT): a = 7 cm, b = 61.5 cm, c = 50 cm, d = 34.4 cm, e = 35 cm, A = wire netting (side length of the meshes = 1 cm), B = board to keep the collecting box in dark.

a wire mesh with 1 cm openings attached to the lid. All sides and the bottom of the trap are covered with wire netting (mesh smaller than 3 mm) as in the OG.

2.1.3. IPSAB-Trap (IP, Fig. 1c)

This trap is made of a wooden frame (0.5 m wide and 1.2 m long) that is covered with wire netting. The mesh is hexagonal with a side length of 1.5 cm. This frame leans against the hive in a slanting position and the bees can enter and exit the trap through the wire netting "in flight". The bottom and the open sides of the trap are closed with linen sheets.

2.1.4. Control (C)

The control consists of a normal hive with a flight board in front and a linen sheet as described before but without any trap (trapless control).

2.1.5. Data recording and statistical analysis

The honey bees were given time to adapt to the bee traps for a period of four days. On the following five days (test period), 50 colour-marked dead bees were deposited on the bottom board of the hive, which could be pulled out from the rear of the hive.

The number of marked and unmarked dead bees found in traps or on the linen sheets was determined 10 times in 24 hours. The counted bees were not removed. The first four counts ($t_1 - t_4$) were made every fifteen minutes, the next four counts ($t_5 - t_8$) at hourly intervals. The last count of dead bees on the day of the experiment was made 7 hours (t_9) after putting dead bees on the floorboard, and another count was performed on the following morning (t_{10}). From t_4 on, marked and unmarked dead bees on the floorboard were also counted. After five days the traps were interchanged so every trap type was tested on each colony to control for the influence of individual differences between the colonies.

Data were recorded five times for every trap per colony and the means of the respective five values for every colony were calculated, resulting in 12 mean values for every trap. Mean values were analysed using a Kruskal-Wallis test for differences among treatments, followed by pairwise comparisons using the Mann-Whitney U test to evaluate which traps differed (Siegel, 1985).

The average temperature of each day of the trap experiment was determined. The days with the highest and the lowest average temperature were classified as days with good and bad flight conditions within one test period. To compare the efficiency of bee traps under different flight conditions, samples were treated as related measures in the Wilcoxon matched-pairs signed-ranks test (Siegel, 1985).

2.2. Experiment II: Behavioural observations

Behavioural observations were carried out on four colonies so each trap type (including control) was only considered once. All behaviour components linked to undertaking behaviour were defined and recorded. An observation started when an undertaker with a marked dead bee appeared at the hive entrance and finished when the dead bee was removed from the trap and linen sheet, or 60 min after the dead bee was last contacted by an undertaker bee. The success of transport and the transporting time were also determined. A transport was scored as successful, when the dead bee was taken away from the trap and linen. The transporting times of unsuccessful transports lasted from the appearance of a dead bee at the hive entrance until the last contact with an undertaker.

The Mann-Whitney U test was used after the Kruskal-Wallis test to evaluate differences in the number of different behaviour elements and the transporting time between the traps (Siegel, 1985).

Fisher's exact probability test was used after χ2-test for k independent samples to define differences in successful transports (Siegel, 1985).

2.3. Experiment III: Efficiency of a new trap

Based on the results of experiments I and II, a new trap was constructed (Fig. 1d), in which the bees could pass in and out of the trap front through a wire netting similar to the IPSAB-Trap, but with a smaller mesh size (side length = 1 cm). The trap has a flight board inside, so incoming bees had a normal landing area. A wire netting connected the dark collecting box below the hive entrance with the flight board. The sides of the traps were closed with wire nettings (mesh size smaller than 3 mm).

The efficiency of the new trap was tested in the summer of 2000. The new trap, named the Muenster-Trap, was compared with the Original-Gary-Trap, the Modified-Gary-Trap and a control without a trap. The test was carried out in a similar experiment as described in Section 2.1. Data recording and statistical analyses were identical to those in experiment I.

3. RESULTS

3.1. Experiment I: Efficiency of bee traps

In more than 92 percent of all tests, the 50 marked dead bees were removed after 3 h from the floorboard from colonies with traps and from the control colonies. The recovery of marked dead bees was significantly higher in colonies with traps than in the control colonies (Figs. 2 and 3). The highest number of marked dead bees was

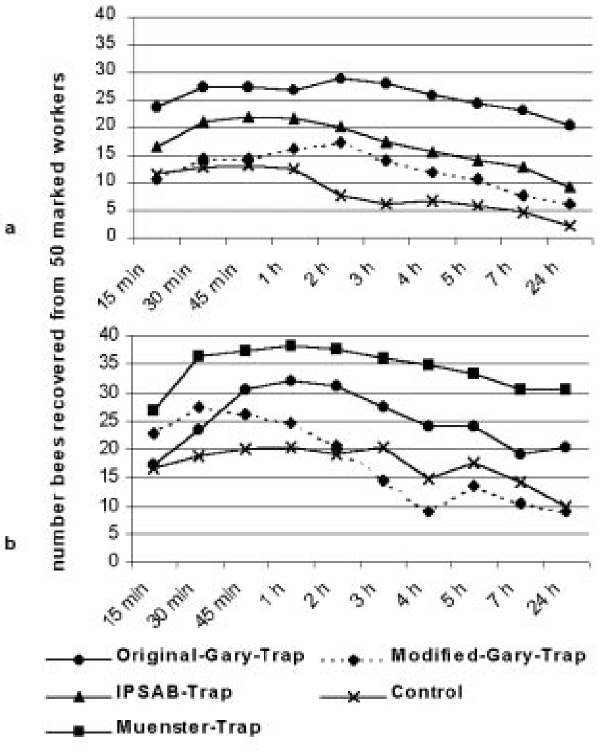

Figure 2. Number of marked dead bees in the traps and on the linen sheets in experiment 1 (a) and 3 (b). The medians of the 12 mean values are presented. Every mean value was calculated from the data collected over the five days of one test period.

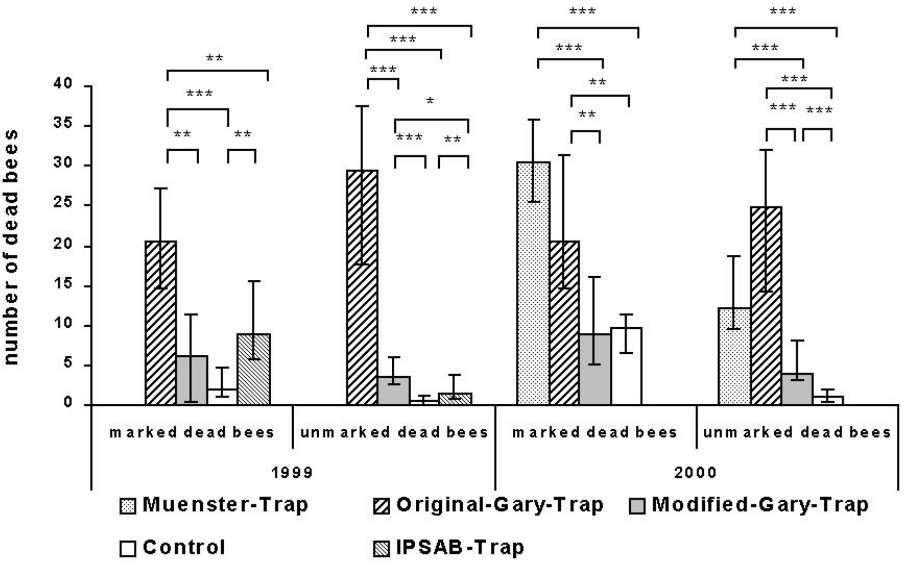

Figure 3. Number of dead bees in the traps and on the linen sheets 24 hours after 50 marked dead bees were put on the floorboard (experiment 1 and 3). The medians of 12 mean values (calculated by 5 values of each colony) and the range of the first and third quartil are presented.
* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$ (Mann-Whitney U test, two-tailed).

found in the Original-Gary-Trap, followed by the Modified-Gary-Trap and the IPSAB-Trap. The recovery of marked dead bees differed over the course of the experiment. The maximum number of marked workers was recovered after one hour, followed by a continuous decrease. The Gary-Traps reached the maximum recovery rate after two hours. The decrease of marked dead workers from one hour to 24 hours was significant for the IPSAB-Trap and the control (IP: $P = 0.002$, $z = -2.980$, C: $P = 0.004$, $z = -2.826$; Wilcoxon matched-pairs signed-ranks test). The decrease of marked dead bees using the Gary-Traps between two hours and 24 hours was also significant (OG: $P = 0.002$, $z = -3.061$, GG: $P = 0.023$, $z = -2.275$).

On days with good flight conditions the number of dead bees after 24 h in both Gary-Traps was significantly lower compared with days with bad flight conditions (GG: $P = 0.030$, $z = -2.176$; OG: $P = 0.023$, $z = -2.277$).

The number of unmarked dead bees reached the highest values in the OG (Fig. 3) and was significantly higher after 24 hours compared to the other traps and the control ($P \leq 0.001$). More than 90% of dead bees were counted in the glass jars of the trap. The dead bees on the bottom of the trap were found at the trap front, under the exit slot (Fig. 1a).

3.2. Experiment II: Behavioural observations

The transport of 42 dead bees was observed ($n_{OG} = 11$, $n_{MG} = 12$, $n_{IP} = 9$ and $n_C = 10$) and the following behaviour components were recorded:

Flight away: An undertaker bee flew with a dead bee out of the hive or the trap beyond the linen sheet. **Flight on linen:** An undertaker bee flew with a dead bee out of the hive or the trap and dropped the bee onto the linen sheet. **Flight-hopping:** Undertakers

Table I. Behavioural components shown by undertakers and the occurrence of these components during observation when using different bee traps (OG = Original-Gary-Trap, MG = Modified-Gary-Trap, IP = IPSAB-Trap, C = Control).

Behavioural elements	**OG**	**MG**	**IP**	**C**
Flight away		2	9	5
Flight on linen	2	8	1	7
Flight-hopping		2		
Dragging	11	12	9	9
Climbing	9	12		
Falling	8	9		
Stuffing		10		
Turning	1	4		
Touching	3	3		
Number of observed transports	**11**	**12**	**9**	**10**
Number of successful transports during observation	**2**	**8**	**1**	**10**

flew with dead bees a few cm. This behaviour was often repeated several times at short intervals. **Dragging:** An undertaker took hold of a dead bee by its wings or thorax and crawled forward. **Climbing:** An undertaker climbed up a trap side with a dead bee. **Falling:** An undertaker bee fell down from the flight board or trap side with a dead bee. **Stuffing:** A dead bee was pulled or pushed through a mesh of wire netting. **Turning:** An undertaker bee rotated on its axis holding a dead bee. **Touching:** Without moving an undertaker bee touched a dead bee.

The frequencies of different behavioural components shown by undertaker bees in different types of traps are presented in Table I and Figure 4. The bees showed a significantly higher number of behaviours when Gary-Traps were used (6 – 9) compared to the IP (3) and the control (3). The behaviour components shown by undertakers using IP and control were identical.

The percentage of successful transports was smaller when using the OG and IP traps compared to the MG trap or the control (Tab. I). Undertaker bees carried away eight of twelve observed dead bees from the MG. All observed dead bees were removed from the linen sheet by undertakers of the control colony. During observation, only the OG and IP were effective in collecting dead bees carried out by undertakers. With the Gary-Traps, the transport of dead bees took longer than with the IP trap and control (Fig. 4).

3.3. Experiment III: Efficiency of a new trap

As in experiment I, the recovery of marked dead bees decreased after one hour for the remaining recording time (Fig. 2). The decrease in the Original-Gary-Trap, the Modified-Gary-Trap and on the linen sheets of the control was highly significant (OG: $P = 0.003$, $z = -2.902$; MG: $P = 0.002$, $z = -3.059$, C: $P = 0.002$, $z = -3.059$; Wilcoxon matched-pairs signed-ranks test). The decrease of marked dead bees in

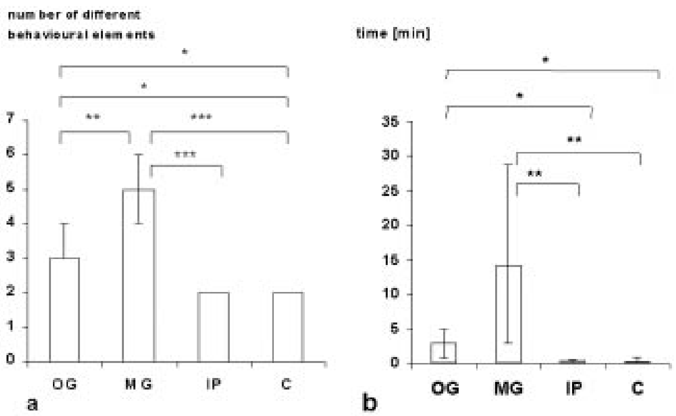

Figure 4. Number of different behavioural elements (a) and required times for transportation (b) of a dead bee when using various types of bee traps (experiment 2). The medians ($n_{OG} = 11$, $n_{MG} = 12$, $n_{IP} = 9$, $n_C = 10$) and the range of the first and third quartil are presented.
* $P \le 0.05$, ** $P \le 0.01$, *** $P \le 0.001$ (Mann-Whitney U test, two-tailed).

the Muenster-Trap between one hour and 24 hours was not significant ($P = 0.136$, $z = -1.490$).

The highest number of marked dead bees was counted in the Muenster-Trap (after one hour on average 34.2 bees, 76.4 percent). The recovery of marked dead bees in the Muenster-Trap was higher on each observation than in the other traps or on the linen sheet of the control, but was also fairly high in the Original-Gary-Trap. The recovery rates in the Muenster-Trap and Original-Gary-Trap after 24 hours were significantly higher than in the Modified-Gary-Trap and in the control (Fig. 3). Between the Modified-Gary-Trap and the control, no significant differences were found.

As in experiment I, the number of unmarked dead bees reached the highest values in the Original-Gary-Trap (Fig. 3). After 24 hours 24.8 unmarked dead bees (mean value) were found in the Original-Gary-Trap. The mean number of unmarked bees in the Muenster-Trap was 12.2 which was smaller than from the Original-Gary-Trap but the difference was not significant. In the Modified-Gary-Trap and on the linen sheet of the control less than five unmarked bees were found.

4. DISCUSSION

Honey bees were able to remove 50 dead adult bees from their colony within a short time. These results correspond with those of Greatti et al. (1994) who recaptured about 80 percent of 50 marked dead bees within half an hour.

Our trap experiment showed that the use of different bee traps led to different results when evaluating mortality in the bee hive. Barbattini et al. (1996) also described different results by use of different traps. They compared the Original-Gary-Trap, the Todd-Trap and the Underbasket-Trap.

The differences in evaluating mortality resulted from the various trap designs. The Gary-Traps are boxes placed over the hive entrance which collect many dead bees carried out by undertakers and which protect them against predators. However, the Gary-Traps interfered considerably with the undertaker bees. The range of behavioural components performed by undertakers was high and the transport times were long.

In the Original-Gary-Trap the number of marked and unmarked dead bees reached the highest values. The Original-Gary-Trap was effective in collecting dead bees but it appeared to capture high numbers of unmarked live bees. It was observed that bees within the glass jars repeatedly flew into the walls. Also, many bees on the bottom of the glass jars showed rapid and rhythmic pulsations with the abdomen. These respiratory movements (Dade, 1994) could have been signs of exhaustion. Many of the unmarked dead bees in the glass jars were fuzzy and their wings were in a good shape, indicating they were young bees which had strayed into the glass jars and died from exhaustion. The Original-Gary-Trap thus probably caused “artificial” mortality.

The decrease in marked dead bees from the Modified-Gary-Trap was mainly caused by undertakers. The dead bees in the trap were level with the hive entrance. Workers that entered or exited the hive must have passed the dead bees. Bees may have removed the dead bees from the Modified-Gary-Trap because they regarded the trap as a part of the hive. Greatti et al. (1994) described this effect in a long term experiment using a similar trap (Todd-Trap, Atkins et al., 1970).

The influence on undertaking behaviour was very small when using the IPSAB-Trap. The range of behaviour components and the transport times were similar compared to the control. However, the IPSAB-Trap cannot be considered as an effective dead bee trap because of the high losses of dead bees due to predators (for example wasps and birds) and wind.

Based on the results of experiments I and II, a new trap was constructed and tested in experiment III. This trap was very effective in collecting dead bees, avoided artificial mortality, and interfered minimally with the behaviour of the bees. The hive entrance of the Muenster-Trap did not interfere with normal flight behaviour and allowed bees to adapt to the trap quickly. The bees entered and exited the trap through the wire netting similar to the IPSAB-Trap after a short adaptation time. A collection box to protect dead bees from predators and wind, like the glass jars of the Original-Gary-Trap, was attached below the hive entrance to avoid contact between dead bees and incoming and outgoing bees. A board covering the collecting box protected against predators and kept the box in dark. A wire netting connected the dark collecting box below the hive entrance with the flight board. This wire netting offered stray bees an escape from the collecting box because the light guides them into the hive.

The results of experiment III showed that the Muenster-Trap was more effective in collecting dead bees than all the other tested trap types. However, less than 80 percent of marked dead bees were recaptured. The number of captured unmarked dead bees was lower than in the Original-Gary-Trap and stray and exhausted bees were not observed to die in the collecting box. The majority of the dead bees in the collecting box were old bees without hair, and drones. Thus, there was no artificial mortality in these traps.

The results presented in this study demonstrate that when using bee traps, only a part of the total mortality in the colony can be documented. The efficiency of bee traps depends on flight activity and it is difficult to compare the results of the evaluation of mortality in the bee hive when using different types of bee traps. To compare the results, it is necessary to know which type of bee trap was used. Thus, it is necessary that authors describe the traps used for the experiments. This applies especially for tests to estimate the hazards of pesticides to bees.

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Résumé – Influence de différentes trappes à abeilles sur le comportement d'élimination des cadavres par l'abeille domestique (*Apis mellifera*) et mise au point d'une nouvelle trappe. Le comportement d'élimination des cadavres (« undertaking behaviour » défini par Visscher, 1980 et 1983) désigne l'ensemble des comportements présentés par les abeilles domestiques (*Apis mellifera* L.) lorsqu'elles éliminent hors de la ruche les cadavres de leurs congénères. Les trappes à abeilles sont des dispositifs placés au trou de vol qui recueillent les abeilles mortes dans la ruche et empêchent que les abeilles « croque-morts » les emportent au loin. La trappe de Gary d'origine (OG), la trappe de Gary modifiée (MG) et la trappe IPSAB (IP) ont été utilisées dans les tests de produits phytosanitaires pour déterminer la mortalité dans la ruche. Notre étude visait à répondre à la question: l'évaluation de la mortalité varie-t-elle en fonction du type de trappe utilisée ?

Cinquante abeilles mortes marquées ont été déposées sur le plancher de 12 ruches et les abeilles mortes marquées et non marquées trouvées dans les trappes ont été dénombrées dix fois en 24 h, sans que les abeilles déjà comptées ne soient éliminées. Une colonie non pourvue de trappe, mais avec un drap de 1,2 m^2 devant le trou de vol, a servi de témoin. Chaque trappe a été testée durant cinq jours sur chacune des 12 colonies pour prendre en compte les différences entre colonies.

Dans une seconde série d'expériences, le comportement des abeilles « croque-morts » a été décrit pour chaque type de trappe. Des différences ont été enregistrées concernant le répertoire comportemental, la durée du transport et le résultat du transport (Tab. I, Fig. 4).

Une nouvelle trappe (trappe Münster, Fig. 1d) a été mise au point sur la base des résultats obtenus et a été comparée aux trappes OG, MG, IPSAB et au témoin. Les résultats montrent que les abeilles éliminent rapidement les 50 cadavres. L'adjonction d'une trappe augmente significativement le nombre de cadavres marqués retrouvés (Figs. 2 et 3). Les différentes trappes conduisent à des résultats différents dans l'estimation de la mortalité dans la ruche.

Avec la trappe OG la « mortalité naturelle » est significativement plus élevée à cause d'abeilles égarées dans le dispositif de réception et qui s'y épuisent (Fig. 4). Lors des tests de produits phytosanitaires il n'est pas possible de séparer la « mortalité naturelle » de la mortalité due au traitement. Avec la trappe MG les abeilles sortent les cadavres car elles considèrent la trappe comme partie intégrante de la ruche. Ceci est accentué les jours de beau temps. Dans le cas de la trappe IPSAB, les prédateurs et le vent sont à l'origine des pertes élevées d'abeilles mortes.

Un répertoire comportemental nettement plus varié a été observé avec les deux trappes de Gary par rapport à la trappe IPSAB et au témoin (Tab. I, Fig. 4). Les temps de transport aussi étaient nettement plus longs (Fig. 4). On peut en déduire que l'élimination des cadavres représente une charge pour les colonies puisque du temps et de l'énergie doivent être investis dans ce comportement. Il n'y a pas de différence en termes de répertoire comportemental et de durée de transport entre la trappe IPSAB et le témoin, ce qui signifie que la trappe IPSAB est plus proche de la réalité.

La nouvelle trappe Münster associe le front de vol de la trappe IPSAB, favorable aux abeilles, avec l'anneau de réception qui, à l'image du dispositif de réception de la trappe OG, protège les cadavres du vent et des prédateurs. Un plan incliné grillagé entre l'anneau et la planche de vol permet aux abeilles égarées et épuisées de retourner dans la ruche et évite ainsi une mortalité « artificielle » supplémentaire. Seule une partie des abeilles marquées est retrouvée, même avec une trappe perfectionnée. Les trappes à abeilles ne conviennent que pour déterminer la mortalité dans la ruche. Pour comparer des résultats expérimentaux il faut nommer et décrire le type de trappe utilisé, en particulier lors des tests de toxicité des produits phytosanitaires.

***Apis mellifera* / comportement d'élimination des cadavres / trappe à abeilles / estimation de la mortalité**

Zusammenfassung – Der Einfluß verschiedener Bienenfallen auf das Austragverhalten der Honigbiene (*Apis mellifera*) und die Entwicklung einer neuen Falle. An der Honigbiene *Apis mellifera* L. wurde das Austragverhalten untersucht, welches alle Verhaltensweisen umfasst, die Bienen beim Austragen toter Artgenossen aus dem Stock zeigen. Austragverhalten wird auch als „undertaking behaviour" bezeichnet (Visscher, 1980 und 1983). Bienenfallen sind Vorrichtungen am Flugloch, die im Stock gestorbene Bienen auffangen und verhindern, dass „undertaker" diese entfernen. Die Original-Gary-Falle (OG), die Geschlossene-Gary-Falle (MG) und die IPSAB-Falle (IP) (Abb. 1) werden in Pflanzenschutzmittelprüfungen zur Bestimmung der Sterblichkeit im Stock eingesetzt. Es sollte die Frage beantwortet werden, ob verschiedene Fallen zu unterschiedlichen Ergebnissen bei der Bewertung der Sterblichkeit führen.

Es wurden 50 markierte tote Bienen auf die Bodenbretter von zwölf Völkern gelegt und die Anzahl markierter und unmarkierter toter Bienen in den Fallen zehn mal in 24 Stunden ermittelt, ohne die Toten zu entfernen. Als Kontrolle dienten Völker ohne Falle, mit einem 1,2 m^2 großen Stück Schattenleinen vor dem Flugloch. Jede Falle wurde über fünf Versuchstage an jedem der zwölf Völker getestet, um Unterschiede zwischen den Völkern zu berücksichtigen.

In einem zweiten Ansatz wurden die Verhaltensweisen der austragenden Bienen bei Vorbau verschiedener Fallen beschrieben. Ermittelt wurden Unterschiede im Verhaltensrepertoire, in der Dauer des Transports und im Transporterfolg (Tab. I und Abb. 4). Auf Grund der Ergebnisse wurde eine neue Falle entwickelt (Münster-Falle, Abb. 1d), die mit der Original-Gary-Falle, Geschlossenen-Gary-Falle und einer Kontrolle verglichen wurde. Die Untersuchungen zeigten, dass Bienen 50 Tote innerhalb kurzer Zeit austragen. Der Vorbau einer Bienenfalle erhöht den Wiederfund markierter Toter signifikant (Abb. 2 und 3). Die Fallen führen zu unterschiedlichen Ergebnissen bei der Bewertung der Sterblichkeit im Stock.

In der Original-Gary-Falle war der „natürliche Totenfall" durch verirrte und ermattete Bienen in den Auffangbehältern signifikant höher als in den anderen Fallen (Abb. 4). Bei Pflanzenschutzmittelprüfungen ist eine Differenzierung zwischen diesem „natürlichen Totenfall" und einem behandlungsbedingten Totenfall nicht möglich. Aus der Geschlossenen-Gary-Falle tragen die Bienen die Toten aus, da sie die Falle als zum Stock gehörigen Raum betrachten. Dies trat verstärkt an Schönwettertagen auf. Prädatoren und Wind verursachten den hohen Verlust bei der IPSAB-Falle.

Bei beiden Gary-Fallen wurde gegenüber der IPSAB-Falle und der Kontrolle ein signifikant größeres Verhaltensrepertoire gezeigt (Tab. I, Abb. 4). Die Transportzeiten waren ebenfalls deutlich länger (Abb. 4). Dies lässt auf eine Belastung der Völker beim Austragen der Toten schließen, da in das Austragen zusätzliche Zeit und Energie investiert werden muss. Zwischen IPSAB-Falle und Kontrolle gibt es in Bezug auf das Verhaltensrepertoire und die Transportzeit keine Unterschiede. Dies deutet darauf hin, dass die IPSAB-Falle der natürlichen Situation nahe kommt.

Die neu entwickelte Münster-Falle verbindet die bienenfreundliche Flugfront der IPSAB-Falle mit einer Auffangrinne, die analog zu den Behältern der Original-Gary-Falle die Toten vor Wind und Prädatoren schützt. Eine Drahtschräge von der Rinne zum Flugbrett ermöglicht erschöpften und verirrten Bienen eine Rückkehr in den Stock und vermeidet eine zusätzliche „künstliche" Mortalität. Auch bei der verbesserten Falle wird nur ein Teil der markierten Toten wiedergefunden. Bienenfallen sind nur bedingt zur Bestimmung der Mortalität im Bienenstock geeignet. Beim Vergleich von Versuchsergebnissen müssen die Fallen genannt und beschrieben werden, dies gilt insbesondere bei der Prüfung von Pflanzenschutzmitteln auf Bienengefährlichkeit.

***Apis mellifera* / Austragverhalten / Bienenfallen / Mortalität**

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