

Repeatability of hoarding behavior of honeybee workers (*Apis mellifera carnica* Polm) in laboratory test cages

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Summary — The hoarding behavior of groups of 50 honeybee workers in test cages was measured under balanced circumstances in an incubator at 28°C and 60–70% relative humidity. The repeatability of the results was estimated using the maximum likelihood method and varied according to the series. This made the test less reliable. Both methods were tested on syrup hoarded from 1–12 d using 6–9-day-old bees. The methods gave results with a changeable level of repeatability. Therefore, testing hoarding behavior of worker bee groups cannot replace the monitoring of bee colonies throughout the whole season.

hoarding behavior / test repeatability / laboratory test

INTRODUCTION

Traits, such as the amount of honey produced according to family, are extremely complicated and represent the final result of many independent factors and processes. One reason is that honey production is recorded over a relatively long duration of 1 year. However, 20 years of intensive research using an experimental testing method to investigate the hoarding behavior of bees under balanced conditions in an incubator (Kulinčević and Rothenbuhler, 1973; Rothenbuhler *et al.*, 1979; Milne, 1980) did not lead to remarkable results. The aim of the present work was to establish the repeatability of hoarding behavior in selected honeybee populations.

MATERIALS AND METHODS

Hoarding behavior was measured in 134 cages for 67 original colonies in 4 series from 11 August to 15 September. The bees in the different series did not come from the same colonies.

Combs with emerging worker bees were placed separately into the incubator at 34°C and 65% relative humidity. Fifty newly emerged workers were counted into test cages (5 x 7.5 x 4 cm) furnished with a disinfected 30 cm² piece of dark comb. The amount of sugar syrup hoarded by 6–9-day-old bees and the total amount hoarded in 1–12 d were recorded.

The repeatability of test was estimated by the mixed-model least-squares method, using Henderson's method 3 (Henderson, 1953) and Harvey's program LSMLMW PC, Version 1 (Harvey, 1988). The between-group component of variance was set at 1.00 and the within-component at

0.00. The values given are estimates of repeatability. The number of repetitions required to give a result with a specific level of reliability was then calculated.

RESULTS

In the first series a high level of repeatability was reached by 6–9-day-old bees and also over the total time of the test. The repeatability of the amount of hoarded syrup from 1–12 d was high and significant (table I). The results on the reliability of the hoarding behavior test in the second series were quite different from the first series. The hoarding of syrup in both time periods was significant. The most reliable results concerned the amount of syrup hoarded in the whole time period of the test. The repeatabilities of the test in the third and fourth series were mostly not significant, with the exception of the total time of the test in the third series.

The common environment in the incubator is rarely satisfactory. Each cage has its own individual environment. Tests of hoarding behavior of worker bee groups cannot replace the monitoring of bee colonies throughout the whole season.

Résumé — Répétabilité du comportement d'amasement des ouvrières d'abeilles

(*Apis mellifera carnica* Polm) en cagettes.

On a mesuré le stockage de nourriture par des groupes de 50 ouvrières dans des cagettes comportant un morceau de rayon et placées dans une étuve à 28°C et 60-70% d'humidité relative. La répétabilité des résultats a été estimée d'après la méthode de la «vraisemblance maximum». Ils ont varié d'une série à l'autre, rendant le test moins fiable. Les 2 méthodes testées pour mesurer le stockage du sirop par des abeilles âgées de 1 à 12 j et de 6 à 9 j ont donné des résultats dont la répétabilité était variable (tableau I). La mesure du comportement d'amasement d'abeilles encagées ne peut donc pas remplacer le suivi des colonies d'abeilles en plein air tout au long de la saison.

comportement d'amasement / répétabilité / étude au laboratoire

Zusammenfassung — Wiederholbarkeit des 'hoarding behavior' (Einlagern von Vorräten in Versuchskäfigen) bei Arbeitsbienen (*Apis mellifera carnica* Polm). Es wurde das Einlagern von Futter bei Gruppen von 50 Arbeitsbienen in Versuchskäfigen mit Waben unter gleichen Bedingungen im Brutschrank bei 28°C und 60–70% relativer Feuchte gemessen. Die Wiederholbarkeit der Resultate wurde nach der Methode

Table I. Repeatability ($R(1)$) of hoarding behavior of honeybee workers in groups of 50 bees, standard error of estimate ($STE(1)$), number of repetitions (n) for $R(n) = 0,50$, $R(n) = 0,70$ and $R(n) = 0,90$.

Series	Age of bees time period	$R(1)$	$STE(R(1))$	n		
				$R(n) = 0,50$	$R(n) = 0,70$	$R(n) = 0,90$
1	6 – 9	0,525	0,190	0,9	2,1	8,1
2	6 – 9	0,163	0,275	5,1	12,0	46,2
3	6 – 9	0,179	0,219	4,6	10,7	41,3
4	6 – 9	0,122	0,259	7,2	16,8	64,6
1	1 – 12	0,449	0,212	1,3	3,0	11,5
2	1 – 12	0,287	0,259	2,5	5,8	22,3
3	1 – 12	0,411	0,188	1,4	3,3	12,9
4	1 – 12	0,184	0,254	4,4	10,3	39,9

der «maximum likelihood» geschätzt. Sie schwankte je nach der Serie und machte den Test weniger verlässlich. Beide geprüften Methoden von Einlagerung der Zuckerlösung durch Bienen im Alter von 1–12 Tagen und von 6–9 Tagen ergaben Resultate von wechselnder Wiederholbarkeit (Tabelle I). Es kann also die Messung des 'hoarding behavior' von Gruppen gekäfigter Bienen die Prüfung von Bienenvölkern im Freiland durch die ganze Saison nicht ersetzen.

Einlagern von Vorräten / Wiederholbarkeit / Labortest

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