

# Factors Affecting the Variability of the Head Department Mass of the Honeybee *Apis Mellifera* L

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Research Article

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## Abstract

We studied the age variability of the head department mass and process modification under the influence of physical and chemical environmental factors. The mass of the head departments is steadily decreasing from the beginning of the imaginal stage by the end of the life. This process is intensified by low-concentration carbohydrate forage consumption, content of pollutants or anesthesia in the atmosphere of CO<sub>2</sub> or N<sub>2</sub>. Reducing the mass of the head departments accompanied by decreasing their water content and the temperature of maximum hypothermia lowering.

**Keywords:** Honeybee; Head department; Mass; Water content; Hypoxia; Freezing point

## Introduction

The head departments mass of the workers bees, queen bees and drones after reaching an imago stage depends on the temperature in the pupa stage. Under the influence of the temperature lowering within a vital range for the bees development their body mass increases [1,2]. However, on the queen bees found that weight gaining, due to the developments at a relatively low temperature, does not provide those advantages to their fecundity and viability [3].

The purpose of this work was to study the influence of age, physical and chemical factors on the dynamics of the head department mass of the worker bees.

## Materials and Methods

The studies were performed on bees that evolving and living in natural conditions (in the beehive) or containing approximately 400-500 individuals in entomological

cages. The mass of the head departments of bees was measured on an analytical balance AR2140 (China) with an accuracy of 0.1 mg. Water content was determined by drying to constant weight at 102°C in a thermostat SNOL-355 (Russia). The temperature of maximum hypothermia (TMH), which characterizes the bee tolerance to freezing [4], was determined by the temperature jump. It was controlled by implanted into the bee head electro thermometer micro thermode that a minimum scale factor was 0.05°C. For freezing we used a cold store, where the temperature was automatically maintained at  $-17 \pm 0.5^\circ\text{C}$ .

The age mass dynamics was studied on the bees that were paint marked and returned to their families after completion of the development in thermostats. The effectiveness of hyperthermia traced on the individually isolated bees placed into the Dry-air thermostat TS-80. Effect of forage quality on lifetime and head departments dynamics studied on bees contained in entomological cages at  $25 \pm 1^\circ\text{C}$ . To determine the effects of hypoxia CO<sub>2</sub>

or N<sub>2</sub> anesthesia. These gases were used to replace the air by a certain time into the desiccators where the cages with bees were.

## Results

Age variability of the head departments mass is expressed in its decreasing from the beginning of the imaginal stage by the end of the life of the bees. Bees spring and summer generations, whose life expectancy is limited to about 30-40 days, during the first 15 days (from the younger to middle age), the head departments mass of decreased by 5.3% ( $R > 0.95$ ) [ $R$  - confidence probability], and the by end of life - by 9.6 % ( $R > 0.99$ ). This is accompanied by their water content decreasing, on the average 6.2% ( $R > 0.95$ ) and lowering the freezing point of the liquid fractions (Table 1).

Bees age, day	Mass, mg		TMH, °C	
	M±m	C,v	M±m	C,v
0.1– 0.3	11.4 ± 0.21	7.2	-6.8 ± 0.18	25.6
14–16	10.8 ± 0.24	7.9	-7.7 ± 0.19	26.4
30–35	10.2 ± 0.18	7	-9.5 ± 0.22	27.4

Table 1: Age dynamics of the head of departments mass and freezing temperatures in their liquid fractions.

M- the arithmetic mean; m – error of the arithmetic mean; C, v - the coefficient of variation

In the spring and summer bees generations contained in entomological cages it was found that the duration of their lives was on average  $32 \pm 4$  days during the consumption of a 60% sucrose solution. In case of the same forage contamination with salt of lead ( $\text{Pb}(\text{CH}_3\text{CO}_2)_2 \cdot 3\text{H}_2\text{O}$ ) per 0.5 g/l, the duration of bees life was reduced on average by 26% ( $R > 0.95$ ). A significant reduction of the bees life duration occurred with consumption of a low concentrated sucrose solution. Decreasing its concentration in the distilled water solution from 60 to 20% reduction was reflected in the bees life reduction in 2.2 times ( $R > 0.99$ ).

Bees consumed within 15 days 60% sucrose in distilled water, had their head departments mass decreased by 6% ( $R > 0.95$ ). During the consumption of 20% sucrose that change was 12.1% ( $R > 0.99$ ). Reducing the sucrose concentration in the above range reflected in a decrease

of water content in the head departments accordingly 1.8 and 1.1%, and TMH- 3.5 and 2.7°C.

On the individually isolated bees the effect of hyperthermia was traced. It was found that the bees kept in a thermostat at 50°C and relative humidity in range of 13-15%, their lifetime was averaged  $87 \pm 2.9$  hours. During this time, the mass of the head of departments was reduced from  $10.3 \pm 0.23$  to  $9.8 \pm 0.28$  mg, water content - from  $68.4 \pm 0.75$  to  $63.8 \pm 0.48$ , and TMH decreased by  $-7.9 \pm 0.55$  to  $-9.9 \pm 0.51$ °C. During this time, the head departments mass was reduced from  $10.3 \pm 0.23$  to  $9.8 \pm 0.28$  mg, water content - from  $68.4 \pm 0.75$  to  $63.8 \pm 0.48$ , and TMH decreased by  $-7.9 \pm 0.55$  to  $-9.9 \pm 0.51$ °C.

Hypoxia in the atmosphere of CO<sub>2</sub> or N<sub>2</sub> anaesthetizes bees for 5-15 seconds. According to the lethal efficiency these gases do not have any significant differences. In particular, after 3-5 hours of anesthesia in the first gas or another one bees are eliminated on an average  $26.6 \pm 3.7\%$  of.

Anesthesia in the N<sub>2</sub> or CO<sub>2</sub> atmosphere was similar, but it had the differential impact on the dynamics of reducing the head departments mass. In the N<sub>2</sub> atmosphere head departments mass during 1, 2, 3, and 5 hours reduced on an average by 1.8, 7.9, 10.1 and 11.4%, and CO<sub>2</sub> - respectively by 2.6, 7.0, 9.7 and 10.5% ( $R \geq 0.95$ ). Initially, the water content in the head departments was  $67.3 \pm 1.43\%$ . Under the influence of these anesthetic periods in CO<sub>2</sub> water content decreased to  $66.1 \pm 1.31$ ,  $65.3 \pm 0.25$ ,  $65.1 \pm 0.41$  and  $64.7 \pm 0.29\%$ , and in N<sub>2</sub> - to  $66.4 \pm 1.04$ ,  $66.1 \pm 0.68$ ,  $64.9 \pm 1.12$  and  $64.5 \pm 0.65\%$ .

Thus, the age dynamics of the head departments mass decreasing from the beginning to the end of the imaginal stage of life is in direct proportion to the duration of the bees life. Biotic and abiotic factors affecting on the decrease in the length of the bees life intensify the dynamics of the head department mass, content reducing and TMH lowering that are accompanying the physiological aging.

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