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STUDY ON THE THERMOREGULATION OF THE HONEYBEE COLONY (A. MELLIFERA) IN WINTER

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Abstract

The thermoregulation of the honeybee colony in most countries in the moderate climate is essential for the overwintering. The winter cluster can survive under hard climatic and meteorological conditions. There are many studies on the individual bee and colony behaviour, however the influence of the environment and temperature need further observations.
Between 5 December and 26 February 2012/13, at Gödöllő we studied the temperature of the environment and the colony with 30 and 15 minutes frequency. During the whole period the mean temperature inside and outside the colony was 22,5 and -0,66 °C, respectively.
Clear relation was found between the winter cluster- and outside temperature. Similar trends could be followed when the outside temperature rose in the colony at different intervals. Due to temperature rises or mechanical disturbances the success of overwintering may decrease. High frequency temperature recordings can help to understand the reaction and behaviour of the colonies through the environmental adaptation process.
Keywords: apiculture, colony, wintering, thermoregulation.

Összefoglalás

A mézelő méhcsaládok hőszabályozása a mérsékelt éghajlati öv legtöbb országában kiemelkedő jelentőségű az áttelelésben. A téli méhfürt túléli a zord klimatikus és meteorológiai körülményeket is. Számos tanulmány született a méhegyedek és a méhcsalád hőmérséklettel kapcsolatos viselkedéséről, mindazonáltal a környezeti és a hőmérsékleti összefüggések tisztázása további vizsgálatokat igényel.
2012/13-ban, Gödöllőn, december 5. és február 26. között a külső környezet és a méhcsalád hőmérsékletének változását 30, illetve 15 perces gyakoriságokkal vizsgáltuk. A teljes periódusban a méhcsalád belső hőmérsékletének átlaga 22,5 °C, míg a külső értéké -0,66 °C volt.
A telelő fürt és a külső hőmérséklet között egyértelmű összefüggést tapasztaltunk. A külső hőmérséklet emelkedésével azonos tendenciákat figyeltünk meg a méhcsaládban is. A telelés sikerét veszélyezteti, ha a hőmérséklet nő, vagy mechanikai zavarás történik. A kellően sűrű hőmérsékleti adatrögzítés segítheti a méhcsaládok viselkedésének megértését a környezeti alkalmazkodási folyamatban.
Kulcsszavak: méhészet, méhcsalád, telelés, hőszabályozás.

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Introduction

Brood nest temperature is of extreme importance to the colony and controlled with utmost precision. Honey bees maintain the temperature of the brood nest between 32°C and optimally 35°C, so that the brood develops normally. Research indicated that even small deviations (more than 0.5°C) from the optimal brood temperatures have significant influence on the development of the brood and health of the resulting adult bees. Bees raised at suboptimal temperatures are more susceptible to certain pesticides as adults. Stabilisation of brood temperature from an unstable state can be a very reliable indication that the queen has started laying as the bees have started to regulate brood temperature. This means brood temperature rising and stabilising at 34°C in early spring as new season brood rearing begins. The temperature in the centre of an overwintering cluster is maintained at an average value of 21.3°C (min 12.0°C, max 33.5°C). With rising ambient temperatures the central temperature of a winter cluster drops whereas the peripheral temperature increases slightly. With decreasing external temperatures the peripheral temperature is lowered by a small amount while the cluster's centre temperature is raised. Linear relationships are observed between the central and the ambient temperature and between the central temperature and the temperature difference of the peripheral and the ambient temperatures. The slopes point to two minimum threshold values for the central (15°C) and the peripheral temperature (5°C) which should not be transgressed in an overwintering cluster (***Fahrenholz et al,*** 1989, ***Stabentheiner et al,*** 2010, ***Jones et al,*** 2004, ***Medrzycki et al,*** 2009, ***Matthias et al,*** 2009).

Material and methods

The study took place at an apiary in Gödöllő, Hungary (***Figure 1.***). Temperature observation started on the 5th of December 2012, at 7:30 pm. and lasted till the 26th of February 2013, at 1 pm. The hive type was "Hunor" with one 10-frame nest (frame size: 42×27 cm). Datalogger in the hive: Ebro EBI 20-TE1; frequency of recording: 15 minutes. Meteorologic station (probe: HMP45C) at Gödöllő, with collection and harmonization of data of 30-minute frequency. Data processing and visualisation was made with Microsoft Excel and PAST (***Hammer,*** 1999-2005, ***Hammer et al,*** 2001) software.

Results and discussion

The highest recorded internal and outside temperature was 39,3 and 11,78 °C, the minimum values were 15,8 °C and -9,82 °C , respectively. The mean temperature of the wintering colony was 22,5 °C while the external was only -0,66 °C (***Table 1.***). The temperature of the wintering cluster shows clear relation with the temperature of the environment (***Figure 2.***).

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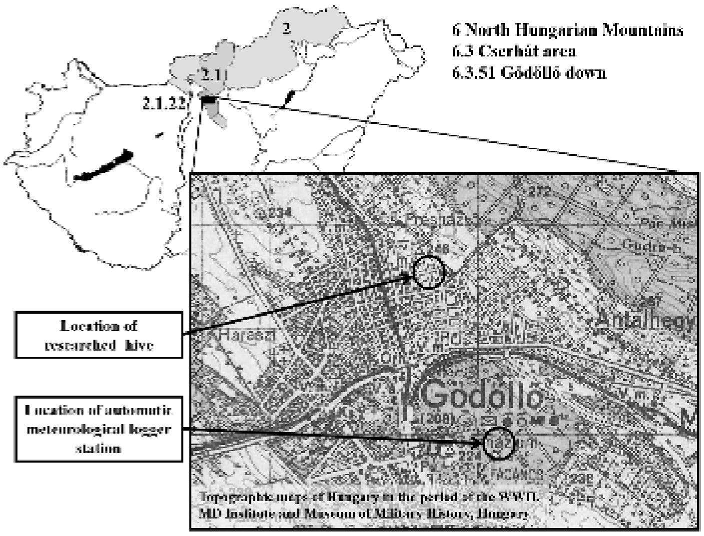
Figure 1: **Location of the apiary and the automatic meteorological logger station**



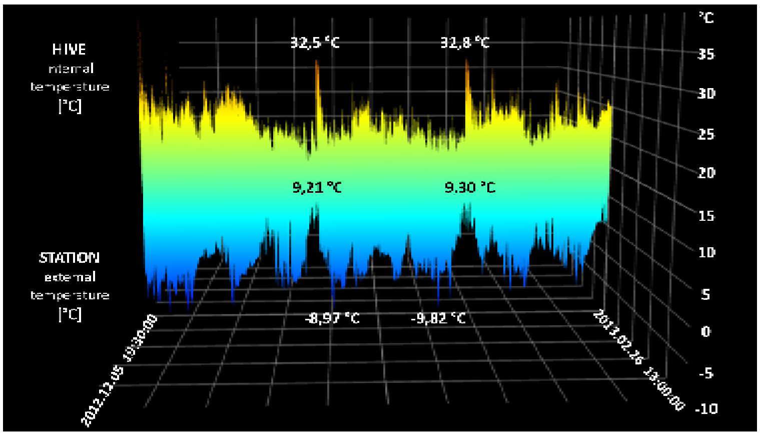
1. ábra: A méhészet és az automata meteorológiai adatrögzítő állomás helyszínei

***Table 1:*. Basic statistics of data series**

	HIVE/colony (internal temperature) [°C]	STATION (external temperature) [°C]
N	3972	3972
Min	15,8	-9,82
Max	39,3	11,78
Sum	90228,1	-2444,7
Mean	22,71604	-0,6154834
Std. error	0,04347725	0,05545915
Variance	7,508156	12,21685
Stand. dev	2,740102	3,495245
Median	22,5	-0,66
25 prcntil	20,8	-3,1675
74 prcntil	24,5	-0,66
Skewness	0,637585	0,3750793
Kurtosis	-145,4433	-103,5731
Geom. mean	22,5556	0
Coeff. var	12,06241	-567,8864

1. táblázat: Az adatsorok alap statisztikai értékei

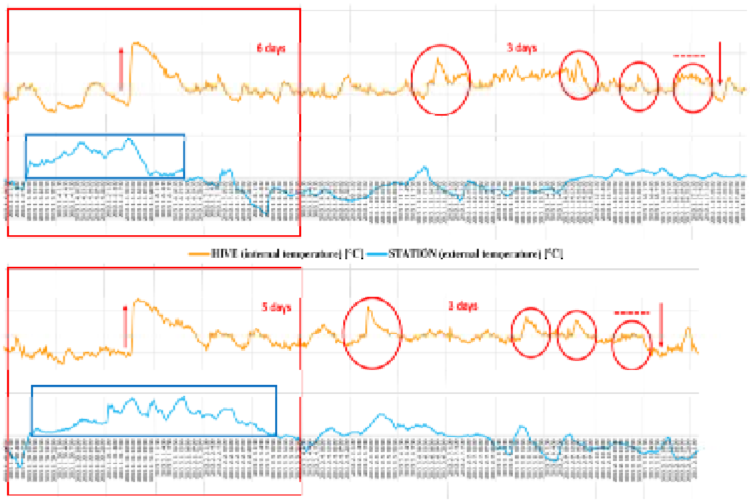
Figure 2: **Visualisation of data series**



2. ábra: Az adatsorok megjelenítése

In the demonstrated sectors two similar periods can be observed in the structure of the colony temperature that follows or starts with the rise of the outside temperature. The reaction generated significant heat (12-15 °C) within a few hours inside the colony. The beginning rapid temperature increase was followed within 5-6 days with similar increase then in two days two maximum values. Later, these short overheating periods were followed by stabilisation and lower temperature periods (*Figure 3. and 4.*).

Figure 3: **Similar periods of inner hive temperature data series between 1st and 18th of January and 31st of January and 12th of February in 2013**
(blue boxes: periods with higher external temperature; red graphics: characteristic signals)



3. ábra Hasonló lefutású szakaszok a kaptár belső hőmérsékletének grafikonján 2013. január 1-18. és január 31.-február 12. között. (kék keret: magasabb külső hőmérsékletű periódus; piros jelölések: jellegzetes szakaszok)

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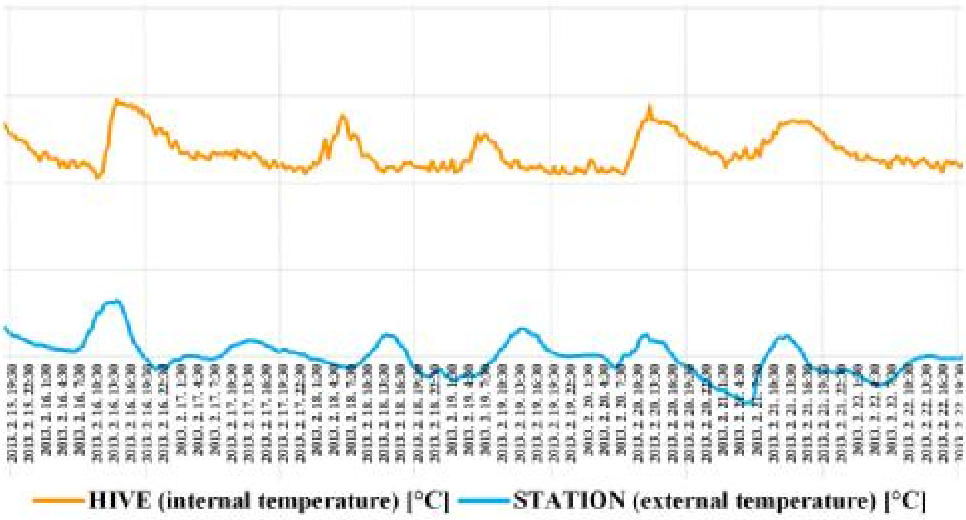
Figure 4: **Typical rhythm of the external and internal temperature between 15th and 22nd of February, 2013**



4. ábra: A külső és belső hőmérséklet alakulásának egy jellegzetes szakasza 2013. február 15-22. között

Conclusions

In our climate overwintering of colonies plays outstanding role in breeding and management as well. Before and after the winter period colony strength, feeding, honey consumption and rapid spring development are key factors in the life cycle of the colony and the economy of beekeeping as well.

Races of the honey bee (*Apis mellifera*) have good adaptation abilities to their environment. In Hungary the local race is called as Pannon honeybee (*Apis mellifera carnica pannonica*). Climatic conditions may partly depend on the geographical site, however through the global warming process extreme weather conditions occur more often. The proper regulation of the temperature within the colony has got importance both in the active (when brood is present) and inactive periods (brood less period). Physical disturbance may also cause extreme increase of the colony temperature. Unusual warming up of the site induces increased brood development. However, the clear explanation for the periodical rapid overheating of the colony needs further studies.

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