**ORIGINAL**

# STABILITY OF TEMPERATURE, RELATIVE HUMIDITY AND DEW POINT INSIDE *Melipona eburnea* (Apidae: Meliponini) COLONIES

# ESTABILIDAD DE TEMPERATURA, HUMEDAD RELATIVA Y PUNTO DE ROCIO AL INTERIOR DE LAS COLONIAS DE *Melipona eburnea* (Apidae: Meliponini)

Solarte VM [1], Talero CA [2] , Sanchez A [3]

Universidad de Cundinamarca (Sede Fusagasugá) Facultad de Ciencias Agropecuarias, Grupo de Investigación GESPA, Grupo de investigación Bioguavio/AgroUdeC. Universidad Nacional de Colombia (Sede Bogota) Facultad de Medicina Veterinaria y de Zootecnia Grupo de Investigación AYNI Ciencia y Tecnología Apícola.

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## RESUMEN

Dentro de las colmenas de *Melipona eburnea* se presenta estabilidad de parámetros como temperatura, humedad relativa y punto de rocío. La temperatura y el punto de rocío externos a las colmenas se relacionan estrechamente con las temperaturas y puntos de rocío al interior de las colmenas ($p<0.001$). Se presenta una asociación débil al interior de las tres colmenas entre humedad relativa y temperatura ($r=0.042$, $r=0.259$, $r=-0.085$), y humedad relativa y punto de rocío ($r=0.262$, $r=0.476$, $r=0.310$), pero muy fuerte entre temperatura y punto de rocío ($r=0.975$, $r=0.972$, $r=0.921$). La humedad relativa es estable dentro de las colmenas y no se relaciona con las fluctuaciones externas.

**Palabras clave:** Abeja sin aguijón, fluctuaciones ambientales, condensación

[1] Biólogo, MSc. Docente Investigador Universidad de Cundinamarca.
[2] Zootecnista, MSc. Docente Investigador Universidad de Cundinamarca.
[3] Zootecnista, MSc. Docente Investigador Universidad de Cundinamarca. Investigador Universidad Nacional de Colombia – Sede Bogota, D.C.

Contacto: wmsolarte@unal.edu.co

***ABSTRACT***

*Temperature, relative humidity and dew point inside hives of Melipona eburnea present stability. Temperature and dew point outside the hives are closely related to temperatures and dew points into hives (p <0.001). We present a weak association inside the three hives between temperature and relative humidity (r=0.042, r=0.259, r=-0.085), and relative humidity and dew point (r=0.262, r=0.476, r=0.310), but very strong between temperature and dew point (r=0.975, r=0.972, r=0.921). Relative humidity is stable inside the hive and not related to external fluctuations.*

***Key words:*** *Stingless bee, environmental fluctuations, condensation*

## INTRODUCTION

Native bees that supplied resources should control the temperature and relative humidity inside the colonies. The stability of the environmental conditions inner the colony protects from drying out or drowning of larvae and pupae, and prevents hygroscopic deposits due to excess water [1]. Regulating the relative humidity within the colonies of bees allow control excess water condensation and strong temperature fluctuations, regardless of external environmental conditions. Positive correlations were found between flying duties and temperature, and between light intensity and relative humidity; apparently, these activities of stingless bees are limited by climatic factors such as temperature and humidity [2].

Moisture in stingless bee honeys (estimated between 19.9 and 41.9 g/100g) is usually 20% higher than in *Apis mellifera* honey [3]. It is also estimated that the rate of sucrose imbibition for Meliponini are affected by temperature and viscosity of the solution [4]. Particularly, nectar quality appears to be a function of the fluctuation of temperature and relative humidity of the external environment [2].

This paper examines the stability of environmental parameters inside hives of *Melipona eburnea* despite fluctuations in the same environmental parameters outside of colonies. The aim of this work is determine the variation of temperature, relative humidity and dew point inside colonies of *Melipona eburnea* during the daily cycle, and its relation to external environmental conditions.

## MATERIALS AND METHODS

Three parameters were measure: temperature (°C), relative humidity (%) and dew point (°C) inside three colonies of *Melipona eburnea* and outside environment. The colonies were located in "La Esperanza" farm, Sumapaz Province, municipality of Fusagasugá, Colombia (4°19'N, 74°24'W, 1500 m, 19 °C), between March and April of 2013, in a period of low rainfall and relatively dry conditions. The three hives had similar conditions like brood chamber, population, location, and environmental conditions (shade, wind direction, sun orientation, etc.), at distance about 10 meters between them. Environmental parameters were recorded with a sensor CEM DT-171, with a periodicity of 30 minutes. One sensor was located inside every colony and removed after 14 days, and other one was located outside colonies, approximate 2 meters above them. The records were carried spreadsheets and was analyzed (ANOVA and Pearson correlation analysis) using the software XLSTAT (2009.3.02).

## RESULTS

Taking environmental parameters, the three colonies of *Melipona eburnea* are different each other: internal temperature ($F=40.29$, $p<0.001$), relative humidity ($F=1981.7$, $p<0.001$) and dew point ($F=75.88$, $p<0.001$). However, the records take the same trend fluctuating through a diary cycle (Figure 1).

The temperature increases at noon and decreases near early morning hours; the relative humidity tends to remain constant over the daily cycle, but it is notorious that these are not equal between colonies (No. 1 about 95 % and No. 3 near 83%); the dew point increases toward noon and gradually decreases until the early hours of the day. The temperature inside the three colonies is about 25.5 – 26.5 °C (Table 1) higher than external environment (21.6 °C), the relative humidity is higher inside the colonies than outside of the colonies (between 8 AM to 6 PM), is similar to the outdoor humidity of the colonies No. 1 and No. 2, but much higher in relation to the colony No. 3; the dew point inside the colonies (23.4 – 24.8 °C) is maintained above of external dew point (18.5 °C).

As expected, the associations between temperature and relative humidity (r=–0.972), temperature and dew point (r=0.848), relative humidity and dew point (r=–0.709) are very narrow. Into the three colonies were observed very high correlations between temperature and dew point (hive 1: r=0.975, hive 2: r=0.972, hive 3: r=0.921). Nevertheless, the relationship between temperature and relative humidity inside the hive is dispersed and the association tends to be lost. Relative humidity is moderately associated with the dew point, showing intermediate correlations (Figure 2).

Although it is presents a stability of environmental parameters inside the hive in relation to external variations, both the temperature and the dew point inside each hive are strongly correlated with the same parameters measured on the outside. However, internal relative humidity of each hive is weakly associated with the relative humidity outside (Figure 3).

## DISCUSSION AND CONCLUSIONS

Biotic factor, such as time of food exposure, and abiotic factors, such as light intensity, temperature and humidity, may operate as modulating factors in the rhythm of activity of Meliponini species [5]. Despite external environmental variations, there is a tendency to maintain stability in temperature, relative humidity and dew point inside the colonies. Although the conditions of the three colonies were similar (population, brood chambers, location, etc.) it is important to note that the measured environmental parameters are not similar to each other, especially the relative humidity, a situation that leads to explore the peculiarities in each colony.

The humidity is regulated depending on the stability of the temperature inside the hive, but the dew point depends more on the fluctuations of the temperature than the stability of the relative humidity inside the hive. According to the tests, the temperature inside the hive is determined by temperature variations in the outside and not by variations in relative humidity; and conversely, the relative humidity inside the hive do not appear to be associated to fluctuations in the relative humidity outside. Apparently the relative humidity inside the hive is very high, and regulating the relative humidity can be

associated with rationalized hive construction. The external activity of bees is also directly affected by environmental conditions. For example, in Melipona bicolor bicolor, flight activity increases as the external relative humidity also increases, with an optimum of relative humidity between 80 and 89% [6]. Colonies must adapt to the typical humidity conditions in the Neotropic.

The effects of relative humidity control inside the hive are associated with bacterial growth, mortality in young and adults, thermoregulation and nectar concentration, etc.; in *Apis mellifera*, moisture influences these aspects [7], and no surprise that they can associate with the dew point. By definition, the dew point is the temperature at which the air is cooled and may reach saturation [8] and is directly related to the temperature and relative humidity. In the external environmental conditions, the dew point is closely related to temperature variations (directly and positively) and relative humidity (directly and negatively), but inside the hives that relationship is less evident (Figure 2): only the temperature variations affect directly the dew point, but in relation to the relative humidity the association is unclear. Although stingless bees can keep the hive temperature within safe limits, breeding of multiple species decreases or even stops if the ambient temperature is very low [9].

To reduce evaporative water losses and provide a hydric and thermal refuge, a favourable microclimate must be created by the nest architecture and its densely aggregated inhabitants [10]. Establish stable conditions of relative humidity and temperature inside colonies involves a step for eventual artificial breeding of *Melipona eburnea*. Menezes *et al*. determined that breeding of *Scaptotrigona depilis* (Meliponini) in artificial conditions, the ideal humidity must be 100% during the first six days of larval development and 75% for the additional development days, or 100% over the three first day, 85% for the next five days and 75% for the additional days of development [11]. Similar protocols should be explored for application in *Melipona eburnea*.

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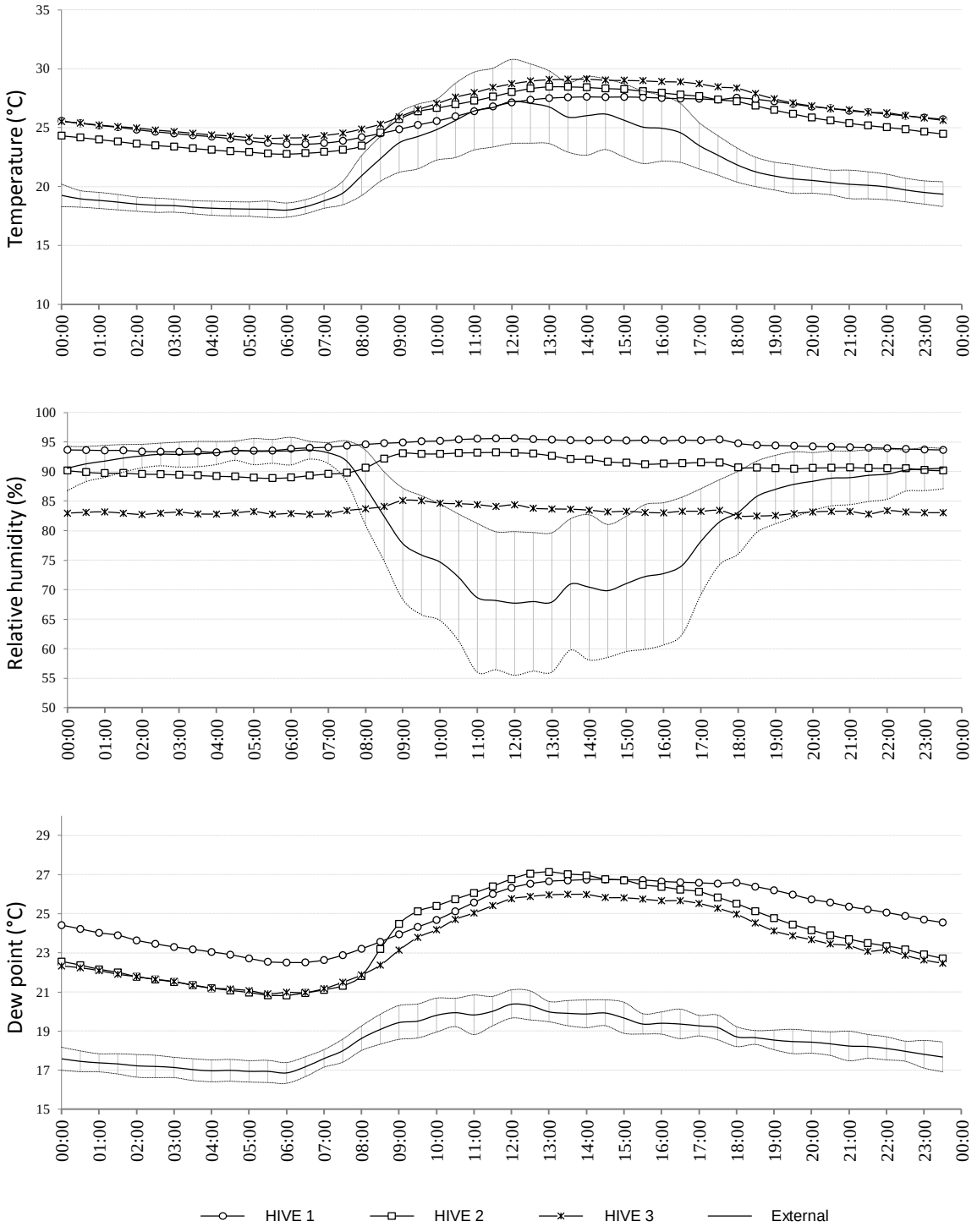


**Figure 1. Distribution of temperature (°C), relative humidity (%) and dew point (°C) inside three hives of *Melipona eburnea* and external environment.**

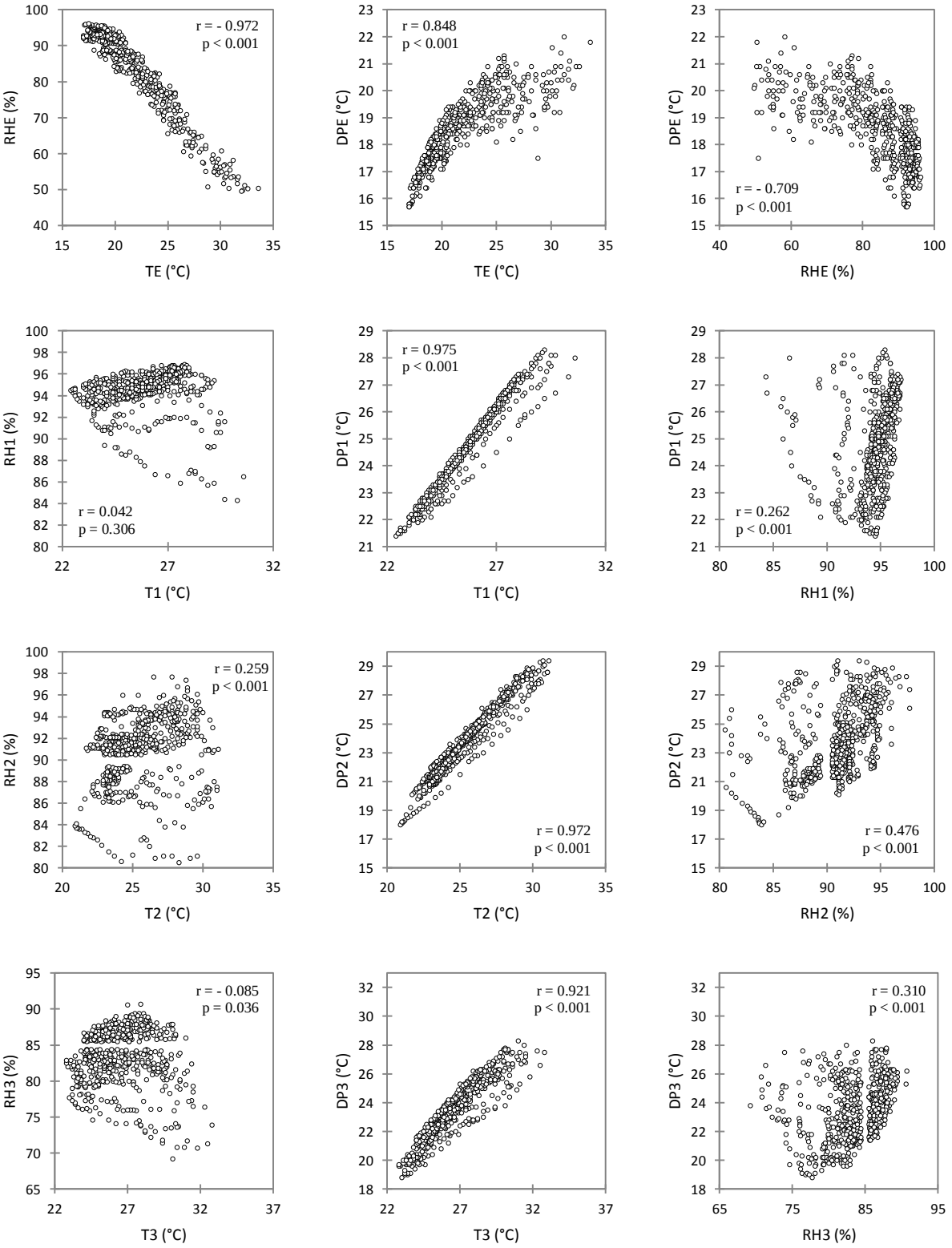


**Figure 2.** Correlations between temperature, relative humidity and dew point in external environment and inside of three hives of *Melipona eburnea*

T=Temperature (°C), RH=Relative humidity (%), DP=Dew point (°C); E=External, 1=Hive 1, 2=Hive 2, 3=Hive 3

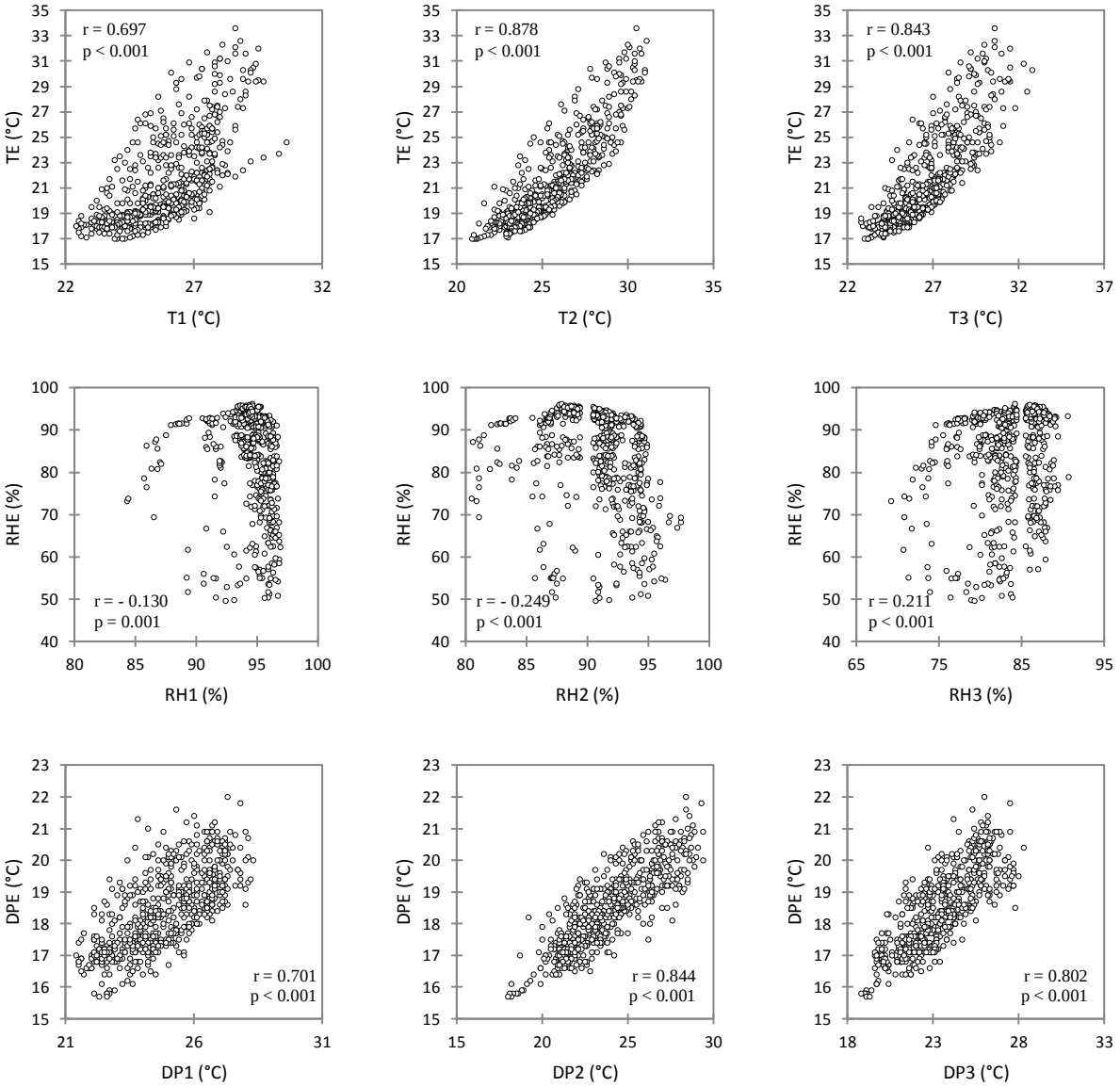


**Figure 3.** Correlations of environmental variables between external environment and internal colonies

T=Temperature (°C), RH=Relative humidity (%), DP=Dew point (°C); E=External, 1=Hive 1, 2=Hive 2, 3=Hive 3

**Table 1.** Descriptive statistics of environmental variables in three colonies of *Melipona eburnea* and external environment

| Variable | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|
| TE | 17,0 | 33,6 | 21,574 | 3,610 |
| T1 | 22,4 | 30,6 | 25,871 | 1,599 |
| T2 | 20,9 | 31,1 | 25,531 | 2,264 |
| T3 | 22,8 | 32,8 | 26,540 | 2,024 |
| RHE | 49,6 | 96,2 | 83,908 | 11,694 |
| RH1 | 84,3 | 96,9 | 94,418 | 1,970 |
| RH2 | 80,5 | 97,7 | 90,857 | 3,159 |
| RH3 | 69,2 | 90,7 | 83,303 | 3,930 |
| DPE | 15,7 | 22,0 | 18,467 | 1,261 |
| DP1 | 21,4 | 28,3 | 24,850 | 1,638 |
| DP2 | 18,0 | 29,4 | 23,870 | 2,449 |
| DP3 | 18,8 | 28,3 | 23,405 | 2,058 |

T=Temperature (°C), RH=Relative humidity (%), DP=Dew point (°C); E=External, 1=Hive 1, 2=Hive 2, 3=Hive 3