Pakistan J. Zool., vol. 48(1), pp. 195-199, 2016.

Determination of Annual Colony Development of the Yığılca Local Honeybee in Turkey and Comparison with *Apis mellifera caucasica* and *A.m. anatoliaca* Hybrids

Ayhan Gosterit,[1*] Yakup Cikili[2] and Meral Kekecoglu[3]
[1]*Department of Animal Science, Faculty of Agriculture, Suleyman Demirel University, 32260 Isparta, Turkey*
[2]*Cilimli Vocational School, Duzce University, Duzce, Turkey*
[3]*Department of Biology, Duzce University, Duzce, Turkey*

ABSTRACT

Populations of locally adapted honeybee (*Apis mellifera* L.) have adaptive traits in their native habitat to take maximum advantage of the local flora. In this study, the annual brood production and colony population development of the Yığılca local honeybee colonies in their natural habitat were determined and compared with the other commonly used honeybee hybrids to expose adaptation to local ecological conditions. A total of 34 colonies headed by naturally mated queens were used in the experiment; 10 colonies of Yığılca local honey bee, 12 colonies of *A. m. caucasica* hybrid and 12 colonies of *A. m. anatoliaca* hybrid. The present results demonstrated that the Yığılca local honeybee colonies adapted to their local ecological conditions and regulated the brood production and population development according to regional flora. Although there were no differences in the worker populations between the genotype groups at the end of the winter, Yığılca honeybee colonies produce more broods before the main nectar flow and had a larger worker population during period of nectar flow than *A.m. anatoliaca* and *A.m. caucasica* hybrids. The results demonstrated that Yığılca local honey bee is a valuable genotype in their native habitat. However, experiments should be repeated at different locations for their use in breeding programs.

Article Information
Received 1 June 2015
Revised 25 August 2015
Accepted 6 September 2015
Available online 1 January 2016

Authors' Contributions
AG designed the study and wrote the article. AG, YC and MK executed the experimental work.

Key words
Yığılca honeybee, brood production, population development, ecological adaptation.

INTRODUCTION

The honeybee (*Apis mellifera* L.) is distributed from Europe, and Africa to Western Asia. Based primarily on morphological characters 27 subspecies of *A. mellifera* have been described (De la Rua *et al*., 2009; Meixner *et al*., 2013). They differ in their morphology, behavior and physiology according to the environmental conditions they have adapted (Ruttner, 1988). Among these subspecies, five of them are known to exist in Turkey: *A.m. caucasica* in the northeast, *A.m. meda* and *A.m. syriaca* in the southeast, *A.m. carnica* in Thrace (European part of Turkey) and *A.m. anatoliaca* in west and central Anatolia (Smith *et al*., 1997; Kandemir *et al*., 2000; Palmer *et al*., 2000; Bodur *et al*., 2007; Tunca and Kence, 2011).

A.m. anatoliaca and *A.m. caucasica* are used intensively for commercial queen bee rearing in Turkey. Therefore, it is presumed that these two honeybee genotypes and their reciprocal crosses constitute the majority of honeybee population in the country. *A.m. caucasica* also has been used in beekeeping in many places around the world especially in higher elevations (Adl *et al*., 2007; Guler, 2010). Widespread migratory beekeeping activities also impact the purity of the honeybee genotypes and the geographical difference among them (Guler and Kaftanoglu, 1999; Ozdil *et al*., 2009). The Anatolian bees, *A.m. anatoliaca*, have some ecotypes and local populations that are differ from each other with morphologically, physiologically and behaviorally. However, these populations are not isolated in their geographical range, are less well defined and need further investigation (Bouga *et al*., 2011; Tunca and Kence, 2011). Kekecoglu (2009) reported that different honeybee population existed in Yığılca province (Düzce) in Western Black Sea Region of Turkey based on both SspI resitriction polymorphism of COI gene segment of mtDNA and Principal Component analysis of the cordinates of 18 landmarks. According to morphometrical data, honeybee samples from Yığılca province were also formed exceptional group (Kekecoglu and Soysal, 2010). In another study using the morphological data, Guler *et al.* (2013) found that honeybee from Yığılca (Düzce) overlapped with honeybees from Sakarya and Bolu (borders with Düzce), and Yığılca honeybee had shortest proboscis in Western Black Sea Region of Turkey.

* Corresponding author: ayhangosterit@sdu.edu.tr
0030-9923/2016/0001-0195 $ 8.00/0

In addition to genetic and morphometric differences, the variation between the behavioral and physiological traits is also considered when identifying of honeybee population (Hunt *et al*., 1998; Villa, 2004). While some physiological characters correlate with the morphological characters (Guler, 1999), others such as brood cycle, are genetically determined (Louveaux, 1973; Strange *et al.,* 2007). Therefore, these physiological characters and their adaptation to ecological conditions in their geographical range are crucial to describe particular honeybee population as subspecies or ecotype. The present study was conducted to determine the annual brood cycle and colony population development of the Yığılca local honeybee and to compare these with those of the *A.m. caucasica* and *A.m. anatoliaca* hybrids which are the most common honeybee genotypes in Turkey.

MATERIALS AND METHODS

Thirty four colonies had a naturally mated queens were used for this study; 10 colonies of Yığılca local honeybee, 12 colonies of *A.m. caucasica* hybrid and 12 colonies of *A.m. anatoliaca* hybrid. *A.m. caucasica* and *A.m. anatoliaca* cross were commercially reared in the Central Anatolia Region (Tokat province) from a selected breeder colony of each genotype. The Yığılca honeybee queens were reared from original breeder colonies of this genotype in Yığılca province of Düzce in Western Black Sea Region of Turkey, according to Laidlaw (1985). Each mated queen was introduced into 6-frame colonies and these colonies were managed identically for 60 days prior to the beginning of the experiments to allow time for workers in the colony to be replaced by daughters of the new queens (Arechavaleta-Velasco and Hunt, 2003). The Varroa control was done and experimental colonies were equalized with regard to adult bee, brood and food stocks (Mahmood *et al.,* 2012).

The experiment was carried out in local ecological conditions of Düzce, Turkey. Colonies were located in a research apiary 25 km from Yığılca to prevent possible hybridization among local and imported genotypes. Colonies were evaluated for brood rearing activity and colony population development between October and September. All colonies were checked at 21-days interval and the amount of bees and total brood area (sealed brood + open brood + eggs) were recorded. The number of frames covered with bees were used to evaluate the colony population development. Total brood areas of genotype groups were determined to the nearest cm^2 using PUCHTA method (Fresnaye and Lensky, 1961). Colonies which lost their queens and swarmed despite the techniques to inhibit swarming were excluded from the experiment. The wintering ability was calculated as follows: the number of frames covered with bees after winter / the number of frames covered with bees before winter x 100.

For statistical analysis, SPSS statistical program (version 11.0) was used. A Chi square analysis was used to test the wintering ability. Brood areas and number of frame trait belonging to three genotype groups were analyzed by ANOVA and means were compared using the Duncan multiple comparison test.

Table I.- Number of frames covered with bees before and after winter in genotype groups.

Genotype groups	Before winter	After winter
A.m. anatoliaca	5.25±0.22 (n=12)	5.00±0.17(n=12)
A.m. caucasica	5.00±0.21 (n=12)	4.40±0.54 (n=10)
Yığılca honeybee	5.90±0.23 (n=10)	5.10±0.23 (n=10)

Data show the mean ± s.e; n: number of colonies; df: 2.

RESULTS AND DISCUSSION

The number of frames covered with bees before and after winter in genotype groups were given in Table I. Two colonies of *A.m. caucasica* died during winter. Colony wintering abilities averaged of 95.23%, 88.00% and 86.44% in *A.m. anatoliaca*, *A.m. caucasica* and the Yığılca honeybee, respectively. Although the lowest wintering ability was found in Yığılca honeybee groups, differences were not statistically significant in the wintering ability between the groups (X^2=2.62, df=2, P=0.27).

Although the mean worker brood cycle of genotype groups were similar and all groups began to rear brood in early spring, the Yığılca local honeybee colonies produced more brood than other two treatment groups prior to July when the main nectar flow began (Fig. 1). Total brood area was significantly different between the Yığılca and other two honeybee genotypes on 29 March, 22 April (P<0.01) and 20 July (P<0.05). After the main nectar flow began, brood rearing activity of the *A.m. caucasica* and the *A.m. anatoliaca* colonies continued at almost the same level, while it declined quickly in the Yığılca local honeybee colonies.

The average number of frame covered with bees and annual colony population development are shown in Figure 2. Colony populations developed in parallel with brood rearing activities. Significant differences were determined in the colony population levels between the Yığılca and other two honeybee genotypes on 29 March, 22 April, 15 May (P<0.01) and 7 June (P<0.05). Curves in Figure 2 shows that worker population in Yığılca local honeybee colonies increased quickly before the main nectar flow and remained large during the main nectar flow period. All genotypes had a same level of worker population after the period of nectar flow ends in region.

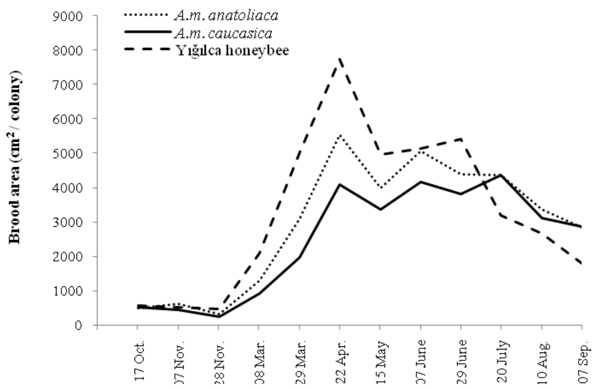

Fig. 1. Annual brood cycle of genotype groups.

Honeybees have adapted to wide range of climates and habitats during their evolution. Adaptation to environment reflects the ability of a colony to make the most profit of the plant nectar sources present in its surroundings (Costa *et al*., 2012). Interaction between bees and ecological conditions or floral characteristics combine to form honeybee populations that are differ from each other with morphologically, physiologically and behaviorally (Adam, 1983; Ruttner, 1988). Several honeybee subspecies and ecotypes have also adapted to different ecological regions in Turkey (Ruttner, 1988; Smith *et al*., 1997; Palmer *et al*., 2000). There are several local populations of the *A.m. anatoliaca,* such as Muğla, Yığılca, and Giresun bees (Kekecoglu, 2009; Bouga *et al*., 2011).

The survival of the locally adapted populations or ecotypes results from a number of traits, which confer advantage to the population within an ecologically distinct area. Annual brood cycle and colony population development are adapted to ecological conditions found in their native habitat to take maximum advantage of the local flora (Strange *et al*., 2007). Hatjina *et al.* (2014) reported that both genotype and environment affect colony development especially in terms of adult bee population and overwintering ability. Results of this study support the concept of ecological adaptation and annual colony development of local honeybee populations. Yığılca local honeybee population which defined in Western Black Sea Region of Turkey adapted to local ecological conditions and regulated the brood cycle according to regional flora. Although there is no difference in the worker population between the genotype groups at the end of the winter, local colonies produce more brood area before main nectar flow and had more crowded colonies during the nectar flow than imported colonies.

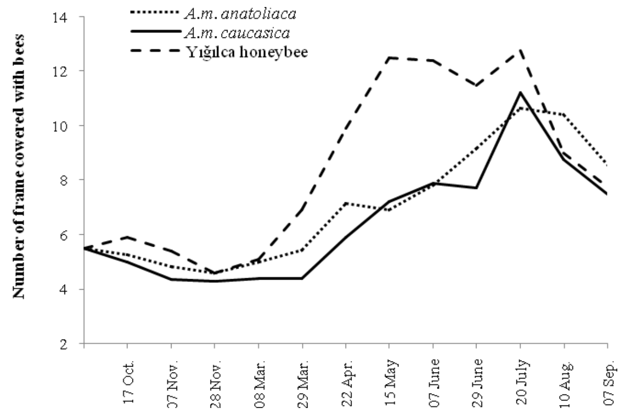

Fig. 2. Annual colony population development of genotype groups.

Although there have been many kinds of flowering plants in Yığılca location, the regional flora was dominated mainly by several pollen and nectar producing plants: dead nettle (*Lamium purpureum* L.) in early February through late April, forest rose (*Rhododendron ponticum* L.) in the middle of the May through middle of the June and chestnut (*Castanea sativa* Mill.) in the middle of the June through middle of the July. Chestnut trees are very important honey source for honeybee colonies and local beekeepers that not move their colonies to other locations produce the honey mainly from this plant. In this study, it is clearly shown that population of local colonies maximized in flowering period of chestnut to store maximum honey. Specific behavioral and phonological adaptations to local environmental conditions are reported for some honey bee populations (Ruttner, 1988). This reality of adaptation to local environmental conditions was also reported by Genc *et al*. (1999) for Erzurum honeybee in Turkey and Strange *et al*. (2007) for Landes ecotype in France. Extensive movement of honey bee colonies continues to occur in many regions of Turkey. The spread of imported genes into the local population is likely, and the resulting increase in genetic diversity is not universally beneficial (Meixner *et al.*, 2014). Therefore, conservation of these genetic resources in their natural habitats is essential. The conservation of bee diversity and the support of local breeding activities are also important in order to prevent colony losses and to optimize a sustainable productivity (Büchler *et al*., 2014).

Results of this study show that the Yığılca local honeybee colonies may adapt to their local ecological conditions and regulated the brood production and population development according to regional flora. Results of the present study demonstrated that Yıgılca local honey bee is a valuable genotype in their native habitat. However, experiments should be repeated at different locations for their use in breeding programs.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation The Scientific and Technical Research Council of Turkey (TUBITAK-TOVAG; grant number: 110O432).

Statement about conflict of interest

There is no conflict of interest among authors.

REFERENCES

Adam, B., 1983. *In search of the best strains of bees*. Northern Bee Boks, Hebden Bridge, West Yorkshire, U.K. pp. 206.

Adl, M.B.F., Gençer, H.V., Firatli, Ç. and Bahreini, R., 2007. Morphometric characterization of Iranian (*Apis mellifera meda*), Central Anatolian (*Apis mellifera anatoliaca*) and Caucasian (*Apis mellifera caucasica*) honey bee populations. *J. Apic. Res. Bee World,* **46**:225–231.

Arechavaleta-Velasco, M.E. and Hunt, G.J., 2003. Genotypic variation in the expression of guarding behavior and the role of guards in the defensive response of honey bee colonies. *Apidologie*, **34**:439–447.

Bodur, C., Kence, M. and Kence, A., 2007. Genetic structure of honey bee, *Apis mellifera* L. (Hymenoptera:Apidae) populations of Turkey inferred from microsatellite analysis. *J. Apicult. Res.*, **46**:50-56.

Bouga, M., Alaux, C., Bienkowska, M., Buchler, R., Carreck, N.L., Cauia, E., Chlebo, R., Dahle, B., Dall'Olio, R., De La Rua, P., Gregorc, A., Ivanova, E., Kence, A., Kence, M., Kezic, N., Kiprijanovska, H., Kozmus, P., Kryger, P., LE Conte, Y., Lodesani, M., Murilhas, A.M., Siceanu, A., Soland, G., Uzunov, A. and Wilde, J., 2011. A review of methods for discrimination of honey bee populations as applied to European beekeeping. *J. Apicult. Res*., **50**:51-84.

Buchler, R., Costa, C., Hatjına, F., Andonov, S., Meıxner, M.D., Conte, Y.L., Uzunov, A., Berg, S., Bıenkowska, M., Bouga, M., Drazıc, M., Dyrba, W., Kryger, P., Panasıuk, B., Pechhacker, H., Petrov, P., Kezıc, N., Korpela, S. and Wılde, J., 2014. The influence of genetic origin and its interaction with environmental effects on the survival of *Apis mellifera* L. colonies in Europe. *J. Apicult. Res*., **53:** 205-214.

Costa, C., Lodesani, M. and Bienefeld, K., 2012. Differences in colony phenotypes across different origins and locations: evidence for genotype by environment interactions in the Italian honeybee (*Apis mellifera ligustica*). *Apidologie,* **43:**634-642.

De La Rua, P., Jaffe, R., Dall'olio, R., Munoz, I. AND Serrano, J., 2009. Biodiversity, conservation and current threats to European honeybees. *Apidologie,* **40:**263–284.

Fresnaye, J. and Lensky, Y., 1961. Methodes d'appreciation des surfaces de couvain dans les colonies d'abeilles (Methods of calculating the surface of brood in bee colonies). *Annles Abeille*, **4**:369-376.

Genc, F., Dulger, C., Dodologlu, A. and Kutluca, S., 1999. Comparision of some physiological characters of Caucasian, Central Anatolian and Erzurum honeybee (*Apis mellifera* L.) genotypes in the conditions of Erzurum. *Turk. J. Vet. Anim. Sci*., **23**:645-650.

Guler, A., 1999. The study on morphological and physiological characters affecting the productivity of some honey bee (*Apis mellifera* L.) genotypes of Turkey. *Turk. J. Vet. Anim. Sci.*, **23**:393-399.

Guler, A., 2010. A morphometric model for determining the effect of commercial queen bee usage on the native honeybee (*Apis mellifera* L.) population in Turkish province. *Apidologie*, **41**:622-35.

Guler, A., Biyik, S. and Guler, M., 2013. Morphological characterization of the honeybee (*Apis mellifera* L.) population of Western Black Sea Region. *Anadolu J. Agric. Sci.*, **28**:39-46.

Guler, A. and Kaftanoglu, O., 1999. Morphological characters of some important races and ecotypes of Turkish honeybees (*Apis mellifera* L.)-I. *Turk. J. Vet. Anim. Sci*., **23**:565-70.

Hatjına, F., Costa, C., Buchler, R., Uzunov, A., Drazıc, M., Fılıpı, J., Charıstos, L., Ruottınen, L., Andonov, S., Meıxner., M.D., Bıenkowska, M., Darıusz, G., Panasıuk, B., Conte, Y.L., Wılde, J., Berg, S., Bouga, M., Dyrba, W., Kıprıjanovska, H., Korpela, S., Kryger, P., Lodesanı, M., Pechhacker, H., Petrov, P. and Kezıc, N. 2014. Population dynamics of European honey bee genotypes under different environmental conditions. *J. Apicult. Res.*, **53:**233-247.

Hunt, G.J., Guzman-Novoa, E., Fondrk, M.K. and Page, R.E., 1998. Quantitative trait loci for honey bee stinging behavior and body size. *Genetics*, **148**:1203–1213.

Kandemir, I., Kence, M. and Kence, A., 2000. Genetic and morphometric variation in honeybee (*Apis mellifera* L.) populations of Turkey. *Apidologie*, **31**:343-356.

Kekecoglu, M., 2009. Honey bee biodiversity in Western Black Sea and evidence for a new honey bee ecotype in Yığılca province. *Res. J. biol. Sci*., **2**:73-78.

Kekecoglu, M. and Soysal, M.I., 2010. Genetic diversity of bee ecotypes in Turkey and evidence for geographical differences. *Rom. Biotechnol. Lett*., **15**:5646-5653.

Laidlaw, H.H., 1985. *Contemporary queen rearing*. A Dadant Publication, Dadant and Sons; Hamilton, Illinois, U.S.A.

Louveaux, J., 1973. The acclimatization of bees to a heather region. *Bee World*, **54**:105–111.

Mahmood, R., Wagchoure, E.S., Raja, S. and Sarwar, G., 2012. Control of *Varroa destructor* using oxalic acid, formic acid and bayvarol strip in *Apis mellifera* (Hymenoptera: Apidae) colonies. *Pakistan J. Zool.*, **44**, 1473-1477.

Meixner, M.D., Buchler, R., Costa, C., Francis, R.M., Hatjina, F., Kryger, P., Uzunov, A. and Carreck, N.L., 2014. Honey bee genotypes and the environment. *J. Apicult. Res.*, **53**:183-187.

Meixner, M.D., Pinto, M.A., Bouga, M., Kryger, P., Ivanova, E. and Fuchs, S., 2013. Standard methods for characterizing subspecies and ecotypes of *Apis mellifera*. *J. Apicult. Res*., **52:**1-27.

Ozdil, F., Yildiz, M.A. and Hall, H.G., 2009. Molecular characterization of Turkish honey bee populations (*Apis mellifera*) inferred from mitochondrial DNA RFLP and sequence results. *Apidologie*, **40**:570–576.

Palmer, M.N., Smith, D.R. and Kaftanoglu, O., 2000. Turkish honeybees: genetic variation and evidence for a fourth lineage of *Apis mellifera* mtDNA. *J. Hered*., **91**:42-46.

Ruttner, F., 1988. *Biogeography and taxonomy of honeybees*. Springer-Verlag; Berlin.

Smith, D.R., Slaymaker, A., Palmer, M. and Kaftanoğlu, O., 1997. Turkish honey bees belong to the east Mediterranean mitochondrial lineage. *Apidologie*, **28**:269-274.

Strange, J.P., Garnery, L. and Sheppard, W.S., 2007. Persistence of the Landes ecotype of *Apis mellifera mellifera* in southwest France: confirmation of a locally adaptive annual brood cycle trait. *Apidologie*, **38**:259–267.

Tunca, R.I. and Kence, M., 2011. Genetic diversity of honey bee (*Apis mellifera* L.: Hymenoptera: Apidae) populations in Turkey revealed by RAPD markers. *Afr. J. agric. Res.*, **6**:6217-6225.

Villa, J.D., 2004. Swarming behavior of honey bees (Hymenoptera: Apidae) in Southeastern Louisiana. *Annls. entomol. Soc. Am*., **97**:111-116.