INVESTIGATIONS ON SOME MORPHOLOGICAL CHARACTERISTICS OF THE HONEY BEES (*Apis mellifera* L.) OF THE HARRAN PLAIN-TURKEY

Harran Ovası Bal Arılarının (*Apis mellifera* L.) Bazı Morfolojik Karakterleri Üzerine İncelemeler

Recep SIRALI[1]   **Turgay ŞENGÜL[2]**   **İsmail YILDIZ[3]**

[1] Karadeniz Technical University, Agricultural Faculty, 52200 Ordu- Turkey

[2] Harran University, Agricultural Faculty, 63050 Şanlıurfa- Turkey

[3] Harran University, Science and Art Faculty, 63100 Şanlıurfa- Turkey

Abstract: In this study, 16 morphological characteristics were measured according to the methods of several apicultural scientists on worker bee samples collected from 36 colonies of 12 different locations covering the main beekeeping regions of Harran Plain. The morphological data from honeybees of different locations were analysed and identified by variance, factor (principal component) and canonical discriminant analyses. According to analysis of variance results, 15 morphological characteristics were found to be significantly different (P<0.01) between the locations. The tarsal index (TSI) did not vary among locations. All morphological characteristics of local honeybee samples differed from the *Apis mellifera anatoliaca* race. Some morphological characteristics are similar to the *Apis mellifera syriaca* and *Apis mellifera meda* races. In conclusion, it was shown that when all morphological characteristics were considered, honeybee samples from different locations in the Harran Plain formed an intermingled cluster.

Key words: Honey Bee (*Apis mellifera* L.) Morphology, Morphological Characteristics, Harran Plain.

Özet: Bu çalışmada, Harran ovasının başlıca arıcılık yörelerini kapsayan 12 farklı lokasyonuna ait toplam 36 koloniden alınan işçi arı örnekleri üzerinde 16 morfolojik karakter arıcılık konusundaki araştırmacıların bildirişlerine göre ölçülmüştür. Farklı lokasyonlara ait işçi arı örneklerine ilişkin elde edilen morfolojik veriler varyans, faktör (temel bileşenler) ve kanonik diskriminant analizleriyle tanımlanmıştır. Yapılan varyans analizi sonuçlarına göre, ölçülen 15 morfolojik karakter bakımından lokasyonlar arası farklılıklar önemli (P<0.01) bulunmuştur. Metatarsus indeks karakterinde (TSI) lokasyonlar arası varyasyon görülmemiştir. Yerel arı örneklerinin ölçülen tüm morfolojik karakterler bakımından *Apis mellifera anatoliaca* ırkına benzerlik göstermediği, bazı karakterler açısından ise *Apis mellifera syriaca* ve *Apis mellifera meda* ırklarına benzerlik gösterdiği belirlenmiştir. Sonuç olarak; incelenen tüm morfolojik değerlere göre Harran ovasının farklı lokasyonlarına ait bal arısı örnekleri iç içe geçmiş geniş bir küme oluşturmuşlardır.

Anahtar Kelimeler Bal Arısı (*Apis mellifera* L.) Morfolojisi, Morfolojik Karakterler, Harran Ovası.

INTRODUCTION

Turkey has a great beekeeping potential having over 4.3 million bee colonies, many different kinds of topographic and climatic characteristics, rich flora, genetic diversity of honeybee races and ecotypes. Honey production exceeds 67.000 tons per year and the honey yield is about 15.6 kg per hive. Although the colony numbers and honey yield increase every year steadily, this increase is not satisfactory (Güler et al, 1999; Anonymous, 2000; Gökçe, 2001).

As a result of these heterogeneous climatic and ecological conditions, the honeybee has spread widely throughout Turkey, where it has been differentiated into several forms (Yıldız and Asal, 1996). The honeybee populations have been classified in various manners by a number of authors. Maa (1953) made the first taxonomic classification of central Anatolian bees, *Apis mellifera anatoliaca* in 1953. Several authors have corroborated this classification, particularly on the basis of various morphological characteristics (Adam, 1987; Ruttner, 1988). North-east Anatolia is inhabited by the race *Apis mellifera caucasica*, while south-east Anatolia, to the north and north-east of Syria and Iraq, is in the range of *Apis mellifera meda* (Ruttner et al, 1985). In addition, several ecotypes such as Muğla, Gökçeada, Thrace and Karadeniz were described in other regions of Turkey (Güler et al, 1999). Each honeybee race and ecotype of Turkey reflects in its morphology and behaviour the environmental characteristics of its endemic range (Çakmak, 1999).

However, the gene pools of the Turkish bee populations are becoming homogenized and genetic variation is getting lost, since techniques of migratory beekeeping have improved in recent years. It is important to identify and quantify genetic variation among Turkish bee populations, in order preserve these genetic resources (Darendelioğlu and Kence, 1992).

Some of morphological studies on the honey bees of different regions of Turkey were carried out by Bodenheimer (1942), Settar (1983), Ruttner (1988), Karacaoğlu (1989), Öztürk (1990), Budak (1992), Kaftanoğlu et al (1993), Gürel (1995), Güler (1995), Gençer (1996), Genç et al (1997), Dülger (1998), Akyol, 1998) and Sıralı (1998). Nowadays, there are several different ideas about the identity of Southeastern Anatolian honeybees in Turkey. Some apicultural scientists describe the honeybees of South-eastern Anatolia as *A. m. syrica* or *A. m. meda*. As no samples of bees from the Harran plain have been analysed up to now, the distribution of these races or ecotypes within south eastern Anatolia and the transitions among is still not clear. Therefore the main aim of the present study was to investigate the morphological characteristics of honeybee samples from different locations of the Harran Plain in Southeastern Anatolia-Turkey.

MATERIALS AND METHODS

The Harran Plain, situated at a 510 m altitude, is one of the hottest regions in the world, with low humidity and low precipitation (falling mostly during winter). There is one period of nectar yield from the cotton. Migratory beekeeping is practised in the lower area of Harran but not in the mountains. Less beekeeping practices take place in the Harran Plain than in any other region in southeastern Anatolia. This area stretches from the east, northward and eastward along the Tektek, Germüş and Fatik mountains, and is limited to the south by the Syrian border.

Sample Collection

Samples of bees with 25 workers each were taken from 36 colonies at 12 locations in Akçakale (Bolatlar, Dorumali, Erdemler, Atatürk Mahallesi, Onortak, Salihler and Zorlu) and Şanlıurfa (Göktepe, Melikören, Perşembe, Uğurlu and Yenice) provinces in the Harran Plain. Details of the collection sites are given in figure 1.

Sample Protection and Measurements

Samples were preserved in 70 % ethanol and bees were dissected according to the methods given by Ruttner et al

(1978). Sixteen morphological characteristics were selected from those studied by investigators of subspecific variation (Alpatov, 1929; Goetze, 1930; Alpatov, 1948; Du-Praw 1965a and 1965b; Ruttner, 1986; Ruttner, 1987).

Morphological measurements were taken from the dissected body parts of worker bees from each colony according to the methods of Alpatov (1929), Daly and Balling (1978), Ruttner et al (1978), Ruttner (1987), Güler (1997), Genç et al (1997).

Sixteen measurements were made on parts of each bee as follows: proboscis length (PRLN); forewing length (FWLN); forewing width (FWWD); forewing index (FWIN); cubital index (CUBI), pigmentation of tergite 2 (PIG2); pigmentation of tergite 3 (PIG3); pigmentation of tergite 4 (PIG4); hair length of tergite 5 (HALN); tomentum width (TOWD); hind leg length (HILN); tarsal index (TSI); 6rd sternum index (STI6); tomentum index (TOMI); body size (T3+T4) and distance between wax mirrors (WXDS).

Characteristics of proboscis length, forewing length and width, hair length, width of tergites, hind leg length, tomentum and sternum parameters and pigmentation were measured by microscopy and with an ocular micrometer. All indexes were calculated from measured characteristics (Güler, 1997; Genç et al 1997).
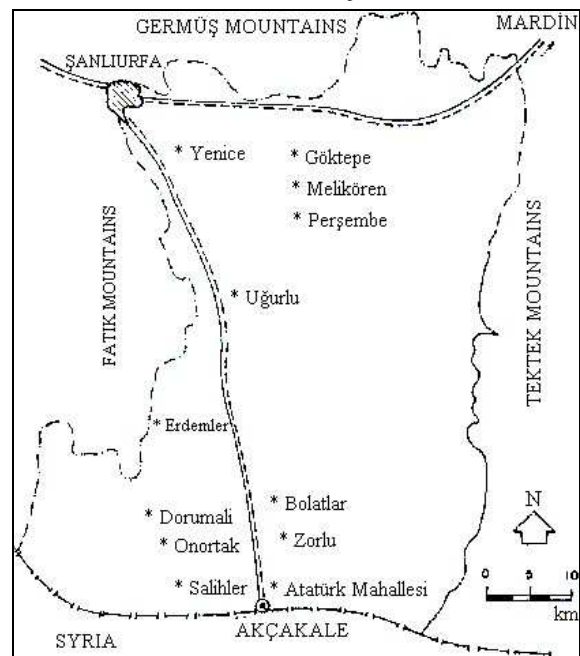
Figure 1.

Map of Harran Plain with locations where bee samples have been collected

Statistical Analyses

Univariate (variance) and multivariate (principal component and canonical discriminant) statistical analyses were conducted for 16 morphological characteristics of worker bee samples from Harran Plain covering one of the main regions of Southeastern Anatolia. Descriptive statistical analyses were carried out via the IBM PC compatible computer programs "Minitab" and "Tarist" and comparisons between locations were determined by Duncan's Studentized Multiple Range Test.

All measurements of morphological characteristics for the colonies from different locations of Harran Plain were analysed by factor (principal component) and canonical discriminant analyses. Heterogeneity among bees from locations in the Harran Plain was investigated using principal component analysis. Both statistical analyses were performed with program package "SPSS/PC" and results of all these analyses were interpreted.

As a reference, discussion of morphological parameters of the honeybee samples from Harran Plain with morphological values for *Apis mellifera anatoliaca, Apis mellifera syriaca* and *Apis mellifera meda,* which is based on the work of Ruttner (1988).

RESULTS

Univariate Statistical Analysis of Morphological Characteristics of Harran Plain Honey Bees

Descriptive statistical values of morphological characteristics of honeybees from different locations in Harran Plain are summarized in Table 1.

Table 1. Means and standard errors of 16 morphological characteristics of Harran Plain honey bees and univariete analyses comparing means.

Locations	PRLN	FWLN	FWWD	FWIN	CUBI	PIG2	PIG3	PIG4
Bolatlar	5.993±0.030 B*	8.945±0.018 BCD	**3.083±0.029** AB	34.487±0.324 ABC	2.054±0.013 B	9.000±0.000 A	7.480±0.249 CDE	**1.640±0.190** D
Dorumali	6.048±0.042 B	8.814±0.032 D	2.911±0.019 B	33.168±0.211 C	2.044±0.013 B	9.000±0.000 A	8.800±0.100 A	5.760±0.176 A
Erdemler	6.028±0.045 B	8.888±0.031 CD	2984±0.019 AB	33.500±0.298 BC	2.046±0.015 B	8.960±0.040 A	8.640±0.098 A	3.920±0.276 ABC
Atatürk Mahallesi	6.037±0.037 B	8.942±0.034 BCD	3.100±0.021 AB	34.912±0.292 AB	2.076±0.016 AB	8.680±0.095 AB	7.400±0.141 DE	2.360±0.432 CD
Onortak	6.032±0.048 B	8.896±0.027 BCD	2.988±0.019 AB	33.682±0.215 ABC	2.062±0.017 B	8.960±0.040 A	8.240±0.176 ABCD	4.600±0.458 AB
Salihler	6.065±0.035 AB	9.092±0.026 AB	3.029±0.024 AB	33.332±0.281 B	2.024±0.012 B	9.000±0.000 A	8.000±0.200 ABCD	3.920±0.490 ABC
Zorlu	6.134±0.042 AB	9.298±0.037 A	3.176±0.024 A	34.176±0.293 ABC	2.089±0.018 AB	8.840±0.075 AB	7.600±0.163 BCDE	1.320±0.150 D
Göktepe	5.998±0.043 B	8.875±0.038 CD	3.162±0.118 A	34.880±0.386 AB	2.096±0.020 AB	8.400±0.163 B	8.320±0.160 ABC	3.960±0.367 ABC
Melikören	5.982±0.036 B	8.998±0.040 ABC	3.035±0.021 AB	33.891±0.236 ABC	2.037±0.0119 B	8.920±0.055 A	8.480±0.117 AB	2.680±0.293 BCD
Perşembe	6.017±0.043 B	8.893±0.012 CD	2.999±0.024 AB	34.392±0.288 ABC	2.178±0.025 A	7.840±0.170 C	7.160±0.094 E	1.200±0.200 D
Uğurlu	6.382±0.053 A	8.836±0.034 CD	2.996±0.022 AB	35.170±0.264 A	2.063±0.010 B	8.840±0.075 AB	8.200±0.163 ABCD	3.800±0.507 ABC
Yenice	5.939±0.045 B	8.908±0.050 BCD	2.999±0.028 AB	33.976±0.303 ABC	2.041±0.012 B	8.760±0.105 AB	8.200±0.183 ABCD	3.800±0.400 ABC
Averages	6.058±0.013	8.949±0.012	3.038±0.012	34.130±0.005	2.067±0.009	8.767±0.031	8.043±0.054	3.247±0.126

*Means for the same characteristics followed by different letters within locations are significantly different (P<0.01) according to analysis of variance followed by Duncan's Studentized multiple range tests.

Results of variance analysis testing have differences among locations in regards to 16 morphometric characters. Proboscis length (PRLN); forewing length (FWLN); forewing width (FWWD); forewing index (FWIN); cubital index (CUBI), pigmentation of tergite 2 (PIG2); pigmentation of tergite 3 (PIG3); pigmentation of tergite 4 (PIG4); hair length of tergite 5 (HALN); tomentum width (TOWD); hind leg length (HILN); 6rd sternum index (STI6); tomentum index (TOMI); body size (T3+T4) and distance between wax mirrors (WXDS) were found to show significant differences among locations (P<0.01). Tarsal index (TSI) did not differ significantly among locations.

Table 1. continued

Locations	HRLN	TOWD	HILN	TSI	STI6	TOMI	T3+T4	WXDS
Bolatlar	0.211±0.004 ABC*	0.688±0.019 BCD	7.38±0.064 ABC	64.837±1.136 -**	78.955±1.019 AB	2.019±0.009 CD	4.426±0.029 A	0.169±0.004 AB
Dorumali	0.195±0.003 ABC	0.695±0.015 ABCD	6.854±0.055 C	63.683±0.891 -	79.314±0.909 AB	2.069±0.013 BCD	4.300±0.031 AB	0.173±0.005 AB
Erdemler	0.188±0.003 C	0.659±0.012 D	6.906±0.053 ABC	61.934±0.973 -	81.888±0.763 A	2.081±0.013 ABCD	4.249±0.029 AB	0.172±0.005 AB
Atatürk Mahallesi	0.210±0.005 ABC	0.754±0.018 ABC	7.264±0.077 A	64.588±0.931 -	76.698±0.818 B	2.134±0.015 AB	4.460±0.026 A	0.166±0.004 B
Onortak	0.192±0.004 ABC	0.691±0.015 ABCD	6.976±0.061 ABC	62.710±1.051 -	82.447±0.797 A	2.117±0.020 ABC	4.409±0.031 A	0.169±0.005 B
Salihler	0.191±0.004 ABC	0.706±0.016 ABCD	7.012±0.064 ABC	64.854±0.831 -	78.173±1.075 AB	2.118±0.022 AB	4.513±0.041 A	0.168±0.004 B
Zorlu	0.189±0.004 BC	0.702±0.017 ABCD	7.207±0.068 AB	65.646±0.902 -	82.156±0.888 A	2.143±0.016 AB	4.460±0.023 A	0.170±0.005 AB
Göktepe	0.214±0.005 A	0.775±0.015 AB	7.096±0.074 ABC	62.303±1.188 -	80.059±0.988 AB	2.066±0.024 BCD	4.337±0.057 AB	0.196±0.004 A
Melikören	0.212±0.0003 AB	0.677±0.016 CD	7.199±0.074 ABC	63.429±1.281 -	82.150±0.770 A	2.018±0.009 D	4.385±0.031 A	0.164±0.004 B
Perşembe	0.206±0.006 ABC	0.784±0.018 A	6.871±0.064 BC	66.130±1.205 -	80.165±1.191 AB	2.176±0.018 A	4.427±0.030 A	0.186±0.004 AB
Uğurlu	0.201±0.005 ABC	0.704±0.021 ABCD	6.928±0.073 ABC	62.736±1.153 -	81.414±0.675 AB	2.068±0.025 BCD	4.063±0.035 B	0.168±0.004 B
Yenice	0.198±0.005 ABC	0.687±0.015 BCD	7.243±0.069 A	63.147±1.028 -	81.146±0.881 AB	2.091±0.020 ABCD	4.271±0.039 AB	0.175±0.004 AB
Averages	0.201±0.001	0.710±0.005	7.058±0.021	63.833±0.309	80.381±0.276	2.092±0.006	4.358±0.017	0.173±0.001

*Means for the same characteristics followed by different letters within locations are significantly different (P<0.01) according to analysis of variance followed by Duncan's Studentized multiple range tests.
**It was not significant.

Multivariate Statistical Analysis of Morphological Characteristics of Harran Plain Honey Bees

Heterogeneity among bees from locations in the Harran Plain was investigated using principal component analysis. Results of all samples from 36 colonies of 12 locations are presented in Figure 2, which shows a component plot of the factors in rotated space.

As can be seen, two samples (Erdemler and Onortak) from south Harran, however, are clearly separate and fall into the range of samples from the north of the Harran Plains. One sample (Perşembe) from north Harran falls into the range of samples from the south of the Harran

Plain. Samples from Onortak cluster predominantly near the Erdemler cluster, and samples from Yenice cluster near the Uğurlu cluster, while samples from Salihler for the most part cluster close to Bolatlar samples.

Canonical discriminant analysis shows that all samples from the Harran Plain were grouped together with a probability level of more than 99.84 %. In addition, the canonical discriminant analysis of the measurements of the 16 characteristics showed that significant differences existed among the sample collection sites (Wilks'λ =0.996).
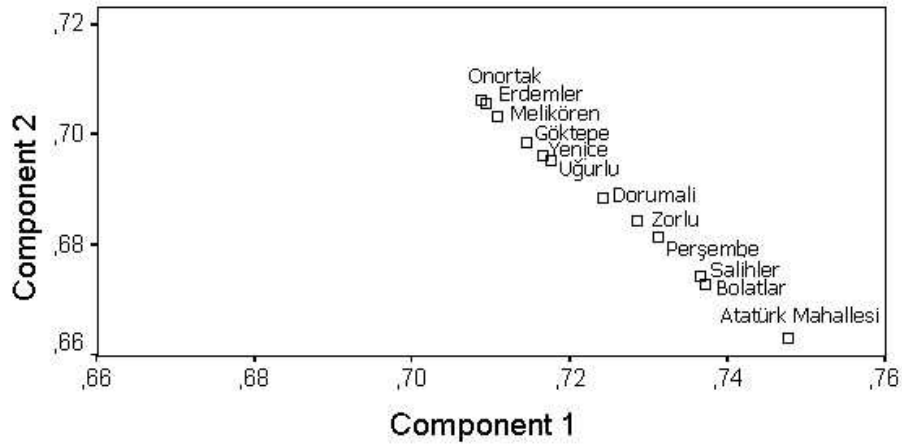
Figure 2.

Factor analysis of morphological characteristics of worker bee samples from Harran plain

Descriptive Statistics of Morphological Characteristics of Harran Plain Honey Bees

Descriptive statistical values of morphological characteristics of honeybees of the all locations of Harran Plain are given in Table 2.

**Table 2. Descriptive Statistical Values of 16 morphological
characteristics of Harran Plain honey bees.**

Morphological Characteristics	N	X±Sx	S.D.	Minimum	Maximum	C.V.
PRLN (L)	900	6.058±0.014*	0.233	5.37	6.87	3.85
FWLN (L)	900	8.949±0.012	0.208	8.09	9.05	2.32
FWWD (W)	900	3.038±0.012	0.212	2.78	3.30	6.98
FWIN (I)	900	34.130±0.005	0.086	30.571	35.269	0.25
CUBI (I)	900	2.067±0.008	0.359	1.9048	2.6667	17.36
PIG2 (P)	900	8.767±0.031	0.541	6	9	6.17
PIG3 (P)	900	8.043±0.054	0.936	7	9	11.63
PIG4 (P)	900	3.247±0.126	0.889	3	7	27.37
HALN (L)	900	0.20±0.001	0.023	0.16	0.26	11.51
TOWD (W)	900	0.710±0.005	0.090	0.62	0.92	12.67
HILN (L)	900	7.058±0.020	0.358	6.36	8.15	5.07
TSI (TI)	900	63.833±0.308	5.345	51.339	65.429	7.76
STI6 (SI)	900	80.381±0.276	4.787	65.046	90.645	5.96
TOMI (I)	900	2.092±0.005	0.099	1.8788	2.3939	4.73
T3+T4 (L)	900	4.358±0.017	0.298	4.04	4.96	6.84
WXDS (D)	900	0.173±0.001	0.023	0.16	0.22	13.29

*Values are means (X) and standard errors (Sx) of colony sample means, N=number of honeybee samples, S.D.= standard deviations, C.V.= Coefficient of variation, L=length (mm); W=width (mm); I=index; P=pigmentation (0=completely dark, 9 completely bright); TI=tarsal index (length/width of basitarsus); SI=sternum index (length/width of sternite 6); D=distance (mm).

Results show that pigmentation of tergite 4, tomentum width, tomentum index, 6rd sternum index, distance between wax mirrors, hind leg length, hair length on tergite 5, forewing index, cubital index and proboscis length of Harran plain bees are smaller than those of *Apis mellifera anatoliaca*, *Apis mellifera syriaca* and *Apis mellifera meda* races reported by Ruttner (1988). Pigmentation of tergite 2 and tarsal index characteristics are larger than the other 3 races. Forewing length is similar to the *Apis mellifera syriaca* and *Apis mellifera meda*, but shorter than *Apis mellifera anatoliaca*. Forewing width is similar to the *Apis mellifera meda*, larger than *Apis mellifera syriaca* and shorter than *Apis mellifera anatoliaca*. Body size is larger than *Apis mellifera syriaca* and *Apis mellifera meda*, but shorter than *Apis mellifera anatoliaca*. Pigmentation of tergite 3 is shorter than *Apis mellifera meda*, larger than *Apis mellifera syriaca* and *Apis mellifera anatoliaca* reported by Ruttner (1988).

In conclusion, all morphological characteristics of honeybee samples of Harran Plain differed from the *Apis mellifera anatoliaca* race. Some morphological characteristics are similar to the *Apis mellifera syriaca* and *Apis mellifera meda* races.

DISCUSSION

The morphological measurements of samples show no clear predominance of *A. m. meda* in the southeast of Turkey. According to the morphological characteristics, the local honeybee samples of southeastern part of Turkey were clearly distinct from the *A. m. meda* parameters. This is likely to reflect a north-south and west-east biogeographical variation *of A. m. meda* from the high Anatolian mountains to the lower areas of northern Syria and Iraq (Ftayeh at al, 1994)

It was concluded that some of these locations give rise to different distribution. The finding of differences between locations in the same place shows the increasing tendency of most beekeepers to obscure the original distribution of the domestic races and ecotypes by transport of colonies at the flowering periods of cotton, which is increasingly obscured by increased mobility in modern beekeeping.

Our results show a great deal of variation among bees collected from different locations in the Harran Plain. This probably reflects the mixing of bees from different regions, resulting from transport of colonies at the flowering periods of cotton. As migratory beekeeping becomes more common, differences among domestic races and ecotypes are increasingly obscured.

In the Harran Plain region, the morphological characteristics of honeybee samples show generally intermediate between the *A. m. syriaca* and *A. m. meda* races, some characteristics may indicate the effects of hybridization, while others point to local variation of the bee races or ecotypes specific to south eastern Anatolia. However, all morphological characteristics of the honeybees of Harran Plain are smaller than *A. m. anatoliaca*. In addition, few morphological characteristics of the honeybees of Harran Plain are similar to the *A. m. syriaca* and *A. m. meda* races. It thus seems that bees of Harran Plain are not clearly distinct from the *A. m. meda* and *A. m. syriaca* races.

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