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Comparative study for evaluating pairs of between *Apis mellifera meda* (Iranian race) and two exotic honey bee colonies, *Apis mellifera anatolia* (Turkey race) and Hybrid *Apis mellifera caucasica* (Russian race)

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Abstract
The objective of present work consists of two different experiments conducted in the years 2015-2016 (1) Comparative study for evaluating relative varroa mite levels and colony strengths within pairs of between *Apis mellifera meda* (Iranian race) and two exotic honey bee colonies, *Apis mellifera anatolia* (Turkey race) and *Apis mellifera caucasica* (Russian hybrid race). (2) The fifteen morphological characteristics examined *A. m. meda*, *A. m. anatoliaca* and hybrid *A. m. caucasica*. Results showed that colony mortality was not different between the three stocks (Turkey: 4.80%, Iranian: 5.10%, Russian: 6.12%; χ^2=0.29, p= 0.72) respectively. 96.4% of all sampled colonies were infested by varroa mites during the first season, and there was no significant difference in the incidence of varroa between the three stocks (χ^2=0.63, p=0.70). Iranian and Turkish colonies had significantly greater adult populations (paired *t*-test = 2.54, $p<0.05$), as well as numerically larger comb areas (paired *t*-test = 1.78, p=0.05).

Keywords: *A. m. meda, A. m. anatoliaca, A. m. caucasica*, Varroa mite, Morphometry, discrimination

1. Introduction

The characteristics that differ among the various races of honey bees are subtle, but can make a difference in the success or failure of your hive. All *mellifera* races (*A. m. meda, A. m. anatoliaca, A. m. caucasica*) described below do well when managed well. They all do poorly when they are not managed well. The differences noted are slight. When a race is mentioned as prone to swarm, keep in mind that all bees swarm if crowded [2]. Differences between individual colonies are often greater than the differences between races mentioned here [2]. Honey bee populations from Anatolia were studied extensively by using standard morphometric characters [1, 15, 16]. As a result, colony mortality has dramatically increased for commercial and hobby beekeepers, and entire feral populations of honey bees have been decimated [20]. Subspecies of the Western honey bee, *Apis mellifera*, with different morphological and physiological characteristics presumably arose from variation of the environments in which they evolved. Thus, it is not surprising that distinct subspecies and morpho-types inhabit this region. Avetisyan and Ivanova [3] noted variations in the external characteristics of pure grey and hybrid bees from l8 apiaries in Russia. Neniskiene [28] studied the effect of migration on Caucasian bees. He transferred the bees of Caucasian race from grey mountains to Lithunian area of U.S.S.R. and studied the original bees and their hybrids. Similarly, Gubin [17] moved twenty colonies of Caucasian bees from Abkhaza to Moscow. Some colonies showed no changes in their morphological characters, whereas, in other colonies, tongue length decreased and the width of third tergite increased. According to Ruttner [33], there are at least 24 *Apis mellifera* subspecies grouped in three or four evolutionary branches, based on morphometric data. Huba [19] compared hybrid (Caucasian × Carpathian) bees with local and Carpathian bee᾽s morphometrically. Hybrid worker bees showed higher values for all the characters such as tongue length, width of forewings, body size etc. Ursu and Subbotin [39] made a comparative evaluation of various races of bees and their hybrids in Moldavia. Ftayeh *et al.* [13], reported *A. m. meda* from Syria was clearly distinct from *A. m. meda* samples from Turkey, but very close to *A. m. meda* samples from Iraq. Honey bee populations from several localities of Turkey were investigated extensively by morphometry [9, 10, 14, 15, 16, 20, 22, 23]. The present study was conducted to determine the influence of different bee race on the extent of *Varroa destructor* infestation in *Apis mellifera* bee colonies containing Iranian, Turkey and hybrid Russian (Caucasian) bee races. The comparison was all the more important because in Iran there is no uniform system of queen evaluation and each breeder employs his own standards in bee improvement.

2. Materials and Methods

The objective of present work consists of two different experiments conducted in the years 2015-2016 (1) Comparative study for evaluating relative varroa mite levels and colony strengths within pairs of between *Apis mellifera meda* (Iranian race) and two exotic honey bee colonies, *Apis mellifera anatolia* (Turkey race) and *Apis mellifera caucasica* (Russian hybrid race). (2) The fifteen morphological characteristics examined *A. m. meda*, *A. m. anatoliaca* and hybrid *A. m. caucasica*. The hybrid Caucasian (Caucasian × Anatolica) colonies (Russian race) were brought from Krasnodar in Southwest Russia, near the border with Georgia. Anatolian colonies were originally from Southeast Turkey.

2.1 Data collection

In June 2015, each participating beekeeper was sent an evaluation form which they were asked to complete and return. Included in the packet were detailed instructions on how to sample their colonies for varroa mite intensity (the percentage of mite infested adult bees) using the ‘sugar shake’ method [8, 24] and for varroa mite load (the number of mites in the hive) using the ‘sticky board’ method [36, 38]. We asked that the participants measure their colonies on the first week of September to minimize temporal variation. Each questionnaire also requested that the participant provide information about the strengths of total colonies and morphological characters for each worker bee races.

2.2 Study area and sample location

Sampling localities (Fig.1) were chosen because they involved traditional and hobby, stationary beekeeping rather than migratory beekeeping, and did not practice queen replacement. Specimens of worker bees were collected for morphometric measurements from hundred colonies in one apiary at each locality (Central district: 35°50′22"N50°50′34"E), (Chaharbagh district: 35°50′20″N50°50′53"E), (Chendar district: 35°50′20″N50°50′40"E) from Savojbolagh apiaries in Iran, (Van: 38°29′39″N43°22′48"E in Southeast Turkey) and (Krasnodar: 45°02′41″ N 38°58′33″ E in Southwest Russia). Young worker bees were collected from the brood areas, killed with chloroform and preserved in 70% ethanol until morphological examinations were carried out. Hundred worker honey bees were selected randomly from each sample and dissected for measurements. The examined body parts were removed and placed on glass slides to measure the lengths and widths (in mm) using a dissecting binocular microscope equipped with a micrometer lens. Body parts (tongue, right forewing and right hind leg) were mounted on projector slides and the morphological characters were measured under a stereomicroscope with ocular micrometer in accordance with [30]. A total of 500 worker bees from 100 colonies at five localities were used for morphometric analysis. Eleven morphological characters were measured for each worker bee. These included: 1. Tongue length (TL), 2. Length of hairs on tergite 5 (HL), 3. Tergite 3, longitudinal (T3), 4. Tergite 4, longitudinal (T4), 5. Femur length (FeL), 6. Tibia length (TiL), 7. Metatarsus length (MetL), 8. Forewing length (FWL), 9. Forewing width (FWW), 10. Length of cubital vein a (CVA), 11. Length of cubital vein b (CVB). Four others were secondary characters calculated from the main characters (index and sum): 12. Cubital index (CI), 13. Forewing index (FWI), 14. T3+T4, longitudinal (T3+T4), and 15. Hind leg length (HLL). The discoidal shift (DS; the position of discoidal joint relative to the lower joint in the radial cell) also was calculated as a qualitative score (–, 0 and +) [1].

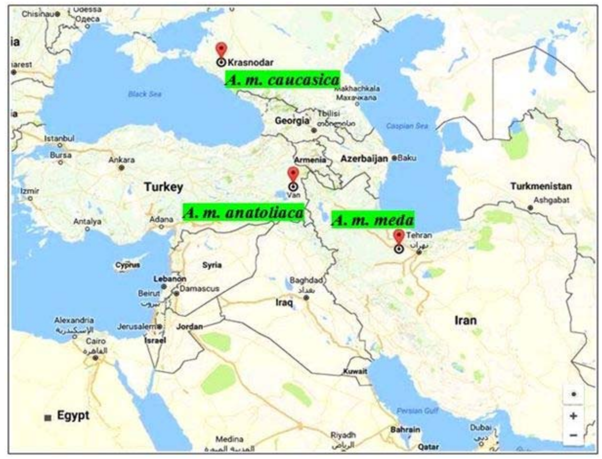

Fig 1: Sampling localities and natural distribution of three honeybee races (*A. mellifera meda*), (*Apis mellifera anatolia*) and hybrid *Apis mellifera caucasica* (southwest Russia).

2.3 Statistical Analysis

Categorical data, such as queen acceptance, were analyzed with contingency tables and chi- square analyses. Continuous data, such as mite levels and colony-strength variables, were analyzed with paired *t*-tests. Correlations of the variables were performed with Spearman’s nonparametric tests. All statistics are two-tailed with α=0.05. Also, statistical procedures were done in three phases. First, means and standard deviations of morphological characters for each locality were calculated. Then data were analyzed by analysis of variance (ANOVA) to compare different localities for each character. DS scores were analyzed by a chi-square test to determine whether score (–, 0 and +) distributions differed from one another in localities. Finally, discriminant analysis was done to evaluate differences between localities for the 15 characters measured. Indices and sums that were derived from measured characters and DS were excluded from this analysis. Finally, samples of five areas (Savojbolagh regions; Central district, Chaharbagh district and Chendar district in Iran, Van region in Southeast Turkey and Krasnodar in Southwest Russia) respectively were classified with Canonical variate analysis (CVA) by SPSS ver.18.

3. Results

A total of 500 participants were returned their completed questionnaire, or 65.7% of the total number of those in the cost-sharing program. Table 1. represented the acceptance and supersedure rates of queens from the three stocks. Iranian queens were accepted by the (Turkey) packaged bees 67.4% and also Turkey queens were accepted by the (Iranian) packaged bees 70.3% of the time, whereas Russian queens were accepted by the (Turkey) packaged bees 80.1% of the time (χ^2=5.64, p<0.05). The significantly lower acceptance of the Iranian queens were despite (or arguably because of) the increased time spent in the cage during introduction (it is assumed the participant beekeepers followed the suggested protocol for queen introduction). Moreover, there appeared to be little effect of how long the queens spent within the packages prior to their installation into the hives. In half of the distributed hives, the packages were all queen less and the queens were placed into the packages at the same time the day before they were distributed. In the other half of the distributed hives, the Turkey and hybrid Russian queens (Caucasian × Anatolica) came with the packages from the supplier, while the Iranian queens were introduced into queen less packages the day before distribution. The present study found out to the Russian hybrid, Turkey and Iranian races acceptance rate was 80.1%, 70.3% and 67.4% (χ^2=2.87, p=0.126) respectively. Of the queens that were accepted by the packaged bees, the Russian queens were replaced by the end of the summer 18.6% of the time, compared to the Iranian and Turkey queens had being replaced 12.6% and 10.3% of the time (χ^2=0.87, p=0.48) respectively. Overall, the colony mortality was not different between the three stocks (Turkey: 4.80%, Iranian: 5.10%, Russian: 6.12%; χ^2=0.29, p= 0.72) respectively. Thus, Turkey queens were less likely to be accepted than Iranian and Russian hybrid queens by the Iranian and Russian adult workers in the installed packages, but the supersedure and survival rates of the three stocks were equivalent over the course of the season. Greater than 80% survival of new colonies for first-time beekeepers spoke well of their dedication and abilities as new apiculturists. Only 68% of the returned surveys provided data about mite levels in trio hives of each pair, but the sample size was sufficient to make adequate comparisons. 96.4% of all sampled colonies were infested by varroa mites during the first season, and there was no significant difference in the incidence of varroa between the three stocks (χ^2=0.63, p=0.70). Thus, colonies of three stocks were equally likely to contract varroa, and only 6.4% of the hives were not infested at the time of sampling. Honey bees from the five localities differed for 15 morphological characters according to univariate analysis (P<0.05; Table 4). *A. m. meda* from Savojbolagh areas (Central district, Chaharbagh district and Chendar district) respectively of Alborz in Iran was clearly differentiated from Southeast Anatolian (*A. m. anatoliaca*) and hybrid Caucasian (Caucasian × Anatolica) southwest Russia. Bees from all three sampling sites in Iran were significantly smaller for most morphological characters than hybrid Caucasian bees from Krasnodar in Southwest Russia and smaller than Southeast Anatolian bees from Van region in Turkey. *A. m. meda* had small values relative to the other subspecies for T3, T4, T3+T4, CI, FeL, TiL, MetL and HLL. *A. m. meda* showed high values only for CVA and CI. Samples of Iranian bees differed between localities for T3, T3+T4, TiL, MetL, FWW, CVA and HLL. Bees from Chendar district in Savojbolagh county in Alborz province of Iran showed the lowest values for the T3, T4, T3+T4, FeL, TiL, MetL, HLL and FWL. Hybrid Caucasian (Caucasian × Anatolica) bees from Krasnodar in Southwest Russia were the largest of all samples and had the highest values for HL, FWL, FWW and HLL. Morphological characters of East Anatolian bees (Turkey race) in general were intermediate in size between those of Iranian and hybrid Caucasian bees. *A. m. anatoliaca* from Van region were closest to hybrid Caucasian bees in the body size measures T3, T4 and T3+T4, but had shorter FWL, FWW and HLL. *A. m. anatoliaca* from Van region were similar to hybrid Caucasian bees (Caucasian × Anatolica) in TL, MetL and T3+T4. The distribution of DS scores differed among the five localities ($\chi2$ = 204.247, df = 10, P<0.001; Table 5). There were also significant differences (P<0.001) between localities in the distribution of DS score (0) except the differences between Van and Krasnodar, Van and Central district in Savojbolagh county in Alborz province, and Van and Chendar district. Most individual Iranian bees tended to score (+) for DS, while hybrid Caucasian individuals scored (–). Most East Anatolian bees scored (–) or score (0).

Table 1: Comparison of queen acceptance between *A. mellifera meda* (Iranian race) and two exotic *Apis mellifera anatolia* (Turkey race) and hybrid Russian race (Caucasian × Anatolica).

	Honey bee races		
Data item	***A. m. meda***	***A. m. anatolia***	***A. m. caucasica***
Total number of queens	158	141	130
Total number colonies from each regions	300 *	100	100
Number queens accepted	125	130	100
Number queens rejected	47	35	30
Number surviving queens	110	98	86
Number surviving colonies	117	126	127
Number superseded queens	45	20	26
Number dead colonies	9	7	5
Percentage of supersedure	12.6%	10.3%	18.6%
Acceptance queen (%)	67.4%	70.3%	80.1%
Percentage mortality	5.10%	4.80%	6.12%
P Value	0.72	0.48	0.126

Note: * For three study districts in Savojbolagh county (Central district, Chaharbagh district and Chendar district) in Alborz province. (Source: Field Survey, 2016).

Table 2. represented the differences in varroa-mite levels between the three honey bee races, as measured by the sugar shake method (mite intensity) and sticky board method (mite load). Russian hybrid colonies had 28.9% fewer phoretic mites on adult bees compared to Iranian and Turkey colonies (paired t-test= -1.64, p<0.05). In general, bees of Iranian bee race were more susceptible to the mite than Turkey honey bee (*A. m. anatolia*) and Russian hybrids (Caucasian × Anatolica). In Iran, honey bee colonies were not treated against the mite, though apparently both climate and bee race influence the mite infestation. This difference was still significant when comparing only those colonies where both hives contained the original queens (paired t-test = -2.67, p<0.05) or were not treated prior to mite sampling (paired t-test = -2.44, p<0.05). Moreover, hybrid Russian colonies (Caucasian × Anatolica) had a 28.9% lower mite drop compared to both Iranian and Turkey colonies, although this difference is not statistically significant (paired t-test = -1.64, p=0.08). When comparing only those colonies where trio hives contained the original queens, the hybrid Russian colonies had significantly lower mite loads (paired t-test = -2.38, p<0.05). Since mite load is an increasing function of colony size, comparisons were also made between the three stocks by independently dividing mite drop by trio colony population and brood area. Mite load was significantly lower in the Russian colonies when controlling for colony population (paired t-test = -2.34, p<0.05) and when controlling for brood area (paired t-test = -2.17, p<0.05). When comparing only those pairs where trio colonies contained the original queens and neither were treated prior to sampling, however, neither measure showed a significant difference between the trio stocks (sugar shake: paired t-test = -2.83, p=1.124; sticky board: paired t-test = -2.46, p=1.148), but this might be an artifact of limited sample sizes (n=78 and 145, respectively). On the other hand, it is possible that the mite levels in the hybrid Russian colonies were

underestimated, whereas the levels comparative with Iranian and Turkey colonies were not, because of the non-blind nature of the study design. The participants were aware *a priori* that the hybrid Russian stock was presumably more tolerant of varroa mites than the Iranian and Turkey stock, and they were fully aware of which hive contained which stock. Thus it is possible that the Russian mite counts were lower because there was an expectation for them to be lower. Though apparently both climate and bee race influence the mite infestation. However, since there was no similar expectation for measures in colony strength. There were also some notable differences between the three stocks for their colony strengths. Iranian and Turkey colonies had significantly greater adult populations (paired *t*-test = 2.54, $p<0.05$), as well as numerically larger comb areas (paired *t*-test = 1.78, p=0.05) and stored honey (paired *t*-test = 1.78, p=0.05). Also Climate and *Apis mellifera* race were found to be important factors that affect the development of this parasite.

Table 2: Comparison of two methods of monitoring *A. mellifera meda*, *A. mellifera anatolia* and hybrid Russian race (Caucasian × Anatolica) infestation level with varroa mite.

	Methods of determining the level of bee infestation									
	Sugar shake (mite intensity)					**Sticky board (mite load)**				
Data item	**No. pairs**	**Iranian**	**Turkey**	**Russian**	**P value**	**No. pairs**	**Iranian**	**Turkey**	**Russian**	**P value**
AH	250	48.23	25.60	14.42	1.036	250	60.84	51.8	37.6	1.080
OQ	100	58.12	36.13	24.41	1.043	150	74.20	56.1	38.8	1.043
UH	90	62.61	44.87	33.76	1.067	160	88.63	68.2	44.6	1.058
OQ, UH	78	44.08	35.32	24.29	1.135	145	68.14	50.4	37.8	1.230
CCP	-	-	-	-	-	156	4.68	2.18	1.58	1.067
CCB	-	-	-	-	-	94	6.54	4.22	2.09	1.138

Note: (AH: All hives); (OQ: Original queens); (UH: untreated hive); (CCP: Controlled for colony population) and (CCB: Controlled for colony brood area).

It should be taken into account that stored honey, as measured in this study, is not necessarily indicative of honey yield. The number of frames of brood was not significantly different between the three stocks (paired *t*-test = 1.086, p=0.78). While the amount of supplemental sugar syrup was significantly correlated with colony population (ρ=1.128, $p<0.001$), comb area (ρ=1.106, $p<0.0001$), and honey stores (ρ=1.069, $p<0.0001$), the three colonies within a pair were provided similar amount of syrup (paired *t*-test = 1.203, p=1.62). Thus differential feeding does not likely explain the observed differences in colony strength between the three stocks. Given that hybrid Russian colonies have been shown to either slow down or cease their brood production in response to the scarcity of local food resources, it is plausible that the differences in between three group (Caucasian × Anatolica) hybrid Russian race, *A. m. meda* (Iranian) and *A. m. anatolica* (Turkish) colonies in the present study may reflect the interaction between stock and environment. In many regions of Savojbolagh in Iran, late summer (July and August) is a dearth period for nectar and pollen resources, the effect of which may have been decreased brood production in the Iranian colonies when measured in early September. Moreover, lower levels of brood may have subsequently slowed the population growth of both bee races (hybrid *A. m. caucasica*) and (*A. m. anatolica*) and varroa mites. Thus, the timing of the colony measurements may potentially explain the observed stock differences in mite levels and colony strengths (Table 3).

Table 3: Comparison of colony strength measures between Iranian (*A. m. meda*), Turkey (*A. m. anatolia*) and hybrid Russian colonies (*A. m. caucasica*).

Colony measure (No. frames)	**No. pairs**	**Honey bee races**			**P value**
		A. m. meda	***A. m. anatolia***	***A. m. caucasica***	
Colony population	300	14.6	12.8	12.4	1.080
Comb area	210	16.3	13.4	13.1	1.538
Brood area	300	9.85	6.80	6.65	1.848
Stored honey	200	9.32	8.69	7.40	1.487
Supplemental syrup	326	16.08	14.22	14.10	1.689

(< Field Survey, 2016).

The discriminant functions were used to classify the colonies and to determine the percentages of correctly classified colonies and highest posterior probability of each colony being in any cluster was computed. The homogeneity of intercolonial and intracolonial variances at each region was tested using F-statistic. Discriminant analysis separated the bees from these 25 colonies into five clusters. The scatter gram plot of function 1 and function 2 showed Southeast Anatolian (Turkish race), hybrid Caucasian (Russian race) and Iranian bees as distinct populations (Fig. 4). However, *A. m. meda* from the three Iranian localities (Central district, Chaharbagh district and Chendar district) appeared to be not entirely distinct sub-populations as these bees were closely clustered. The bees from Van region in Southeast Turkey were more clearly separate clusters. Bees from Van district also seemed to be a separate cluster but the center of mass was closer to that of Krasnodar in Southwest Russia due to a single distant sample. Populations of five areas based on fifteen morphological characters were classified by canonical variate analysis (CVA). Cross-validation tests based on CVA correctly classified 68.4% of the colonies (Fig. 4). Discriminant analysis showed that the Iranian, Southeast Anatolian (Turkish race) and hybrid Caucasian honey bee (Russian race) populations constituted distinct clusters. Discriminant analysis correctly classified 66.4% of the samples to their actual localities. Iranian honey bee samples from 3 different localities appear not to be entirely distinct sub-populations. The samples from Central, Chaharbagh and Chendar regions overlapped to a large extent; while the samples from Van district in Southeast Turkey and Krasnodar in Southwest Russia formed apparent no overlapping clusters (Fig. 5).

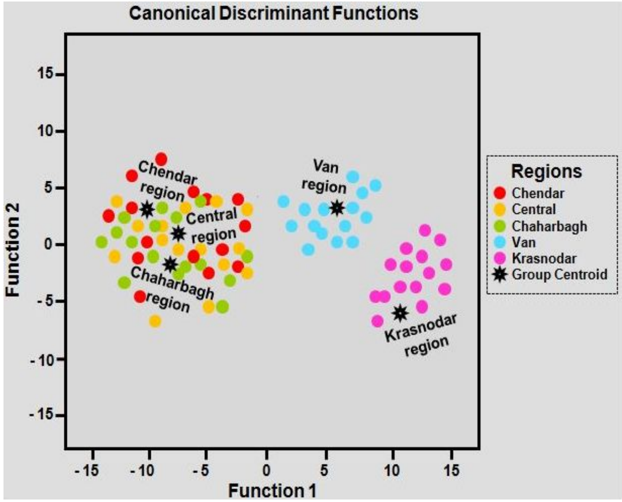

Fig 4: Scatter plot of discriminant analysis based on fifteen morphological characters of three groups bee races; *A. m. meda*, *A. m. anatolia* and hybrid Russian race (Caucasian × Anatolica) in different geographical areas. N=125.

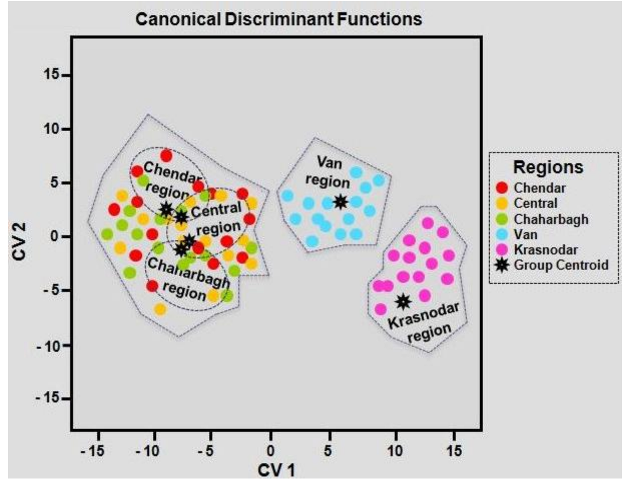

Fig 5: Canonical discriminant analysis scatter plot based upon fifteen morphological characters showed five regions in Iran, Southeast Turkey and Southwest Russia. Only the Savojbolagh groups (Central district, Chaharbagh district and Chendar district) overlapped on scatter plot.

Table 4: Means and standard deviations (sd) of 15 morphological characters of 100 worker bees each from (n) colonies from 5 localities in Turkey (Van), Russia (Krasnodar) and 3 districts (Central, Chaharbagh and Chendar) in Savojbolagh county in Alborz province of Iran.; Measurements are in mm.

>Morphological Indicators	***Apis. mellifera meda***			***Apis. mellifera anatolia***	***Apis. mellifera caucasica***
	Central (n=100)	Chaharbagh (n=100)	Chendar (n=100)	Van (n=100)	Krasnodar (n=100)
Tongue length (TL)	5.65 a (0.36)	5.68 a (0.33)	5.74 ab (0.23)	5.86 b (0.38)	5.83 b (0.45)
Length of hairs on tergite	0.43 cd (0.07)	0.39 a (0.06)	0.41 ab (0.08)	0.44 d (0.07)	0.47 c (0.09)
Tergite longitudinal (T3)	2.05 b (0.06)	2.08 c (0.05)	2.04 a (0.06)	2.13 e (0.05)	2.14 e (0.05)
Tergite longitudinal(T4)	2.10 b (0.07)	2.13 c (0.06)	2.08 a (0.07)	2.18 d (0.07)	2.15 e (0.07)
Femur length (FeL)	2.73 b (0.07)	2.76 b (0.09)	2.70 a (0.07)	2.80 c (0.08)	2.78 d (0.09)
Tibia length (TiL)	3.05 b (0.08)	3.09 c (0.09)	3.02 a (0.08)	3.14d (0.11)	3.12e (0.10)
Metatarsus length	2.06 b (0.06)	2.09 c (0.07)	2.03 a (0.05)	2.13 d (0.07)	2.12 d (0.06)
Forewing length (FWL)	8.07 a (0.19)	8.24 bc (0.18)	8.05 a (0.17)	8.64 c (0.15)	8.82d (0.16)
Forewing width (FWW)	3.11 a (0.09)	3.18 c (0.09)	3.16 b (0.09)	3.21d (0.09)	3.27e (0.08)
Length of cubital vein a	0.656 d (0.053)	0.670 e (0.066)	0.623 c (0.046)	0.600 a (0.046)	0.634 c (0.036)
Length of cubital vein b	0.324 a (0.032)	0.326 a (0.034)	0.336 b (0.034)	0.366 bc (0.038)	0.371c (0.035)
Cubital index (CI)	2.456 d (0.62)	2.492 d (0.84)	2.247 c (0.80)	1.764 a (0.69)	2.163 b (0.39)
Forewing index (FWI)	23.68 ab (0.77)	23.79 bc (1.08)	24.30 d (0.83)	23.58 a (0.64)	23.16 c (0.74)
T3+T4	4.18 b (0.08)	4.22 c (0.06)	4.20 a (0.08)	4.34 d (0.07)	4.37 d (0.07)
Hind leg length (HLL)	7.64 b (0.17)	7.75 c (0.17)	7.54 a (0.15)	8.02 de (0.18)	8.04e (0.16)

Note: The mean values for each morphological character within a row followed by different letters are significantly different ($P<0.05$) according to post-ANOVA Duncan's multiple range test. (Source: Field Survey, 2016).

Table 5: The distribution of discoidal shift (DS) score (-, 0, +) of worker bees from 5 localities.

		Score		
Localities	**Number (n)**	**(-)**	**0**	**(+)**
Central area in savojbolagh county in Alborz province	100	18	29	20
Chaharbagh area in savojbolagh in Alborz province	100	30	31	42
Chendar area in savojbolagh county in Alborz province	100	19	22	16
Van region in Southeast Turkey	100	60	35	22
Krasnodar region in Southwest Russia	100	78	40	38
Total	500	205	157	138

(**Source:** Field Survey, 2016).

4. Discussion

Most attempts to differentiate honey bee groups based on morphological data have used multiple body characteristics, including (worker) body size, hair length, wing length and width, pigmentation, and proboscis length [6, 7, 13, 29, 32, 33, 35] such studies require time-consuming mounting and measuring of various body parts. The present study objective was to compare morphometric features of neighboring honey bee subspecies that converge in Southeast Turkey (Van) and Southwest Russia (Krasnodar). Two exotic honey bees from Southeast Turkey and hybrid Russian race (Caucasian × Anatolica) from the Caucasus of Southwest Russia and Iran have been classified previously by biometrical studies as *A. m. anatoliaca*, *A. m. caucasica* and *A. m. meda*, respectively [1, 4, 13, 27, 34]. The present study morphometric analyses of bees from these areas agree with these findings. In general, body parts were largest in hybrid Russian bees (Caucasian × Anatolica), intermediate in Southeast Anatolian bees and smallest in Iranian bees' *A. m. meda*. Hybrid Caucasian bees from (Krasnodar) in Southwest Russia were similar to previous findings for TL, T3, T4, FWW [1, 14, 15], FeL, TiL, MetL, HLL, FWI [1, 18], T3+T4 [1, 30], CVA, CVB and CI [1, 22]. The mean FWL of our samples, however, was greater than reported in these previous studies. Bees from Southeast Anatolia were similar to previous findings for T3, T4, FeL, TiL, MetL and HLL [1, 16, 17]. Iranian samples mainly fell within the range previously published for *A. m. meda*. The mean TL of honey bees from Central, Chaharbagh and Chendar accorded with the findings of [1, 13]. HL of bees from Chaharbagh was similar to that found by Adl *et al*. [1], Ftayeh *et al*. [13] and Ruttner *et al*. [34]. Nevertheless, FWL and FWW of bees from Chaharbagh were similar to Iranian bees from Mazandaran as reported by Adl *et al*. [1] and Ruttner *et al*. [30] but HL of bees from Central and Chendar was greater than the range reported by Adl *et al*. [1] and Ftayeh *et al*. [13] and Ruttner *et al*. [34]. CVA, CVB, CI, FWI and HLL of Iranian samples accorded with previous reports. However, Iranian bees we sampled at Central, Chaharbagh and Chendar had greater FWL and FWW than bees reported by Adl *et al*. [1] and Ruttner *et al*. [34] and Ftayeh *et al*. [12]. Ruttner [34] reported that the morphometric distances are approximately equal between all pairs of the three subspecies and data, however, indicate that *A. m. anatoliaca* and *A. m. caucasica* are closer morphometrically than either of these two subspecies is to *A. m. meda*. Unfortunately, few scientific papers are done in this matter under the inspection area. However these present finding are in agreement with the findings [1, 4, 13, 15, 16, 21, 27, 33, 34] and other important factors include supplementary feeding for *A. m. caucasica* in consistent with Güler [14].

5. Conclusion

The present study concludes that measurements of a small part of the entire bee body can be sufficient to discriminate among honey bee racial groups. Bee differences can be used to advantage by beekeepers, depending on what traits interest them, so using different stocks can be a powerful tool at the beekeeper's disposal. Thus, it is best for each beekeeper to experience the characteristics of the different bee strains first hand and then form an opinion about which stock best fits his or her situation. These results indicate success of future programming for breeding Iranian honeybees in terms of resistance characteristics against diseases and *Varroa destructor* mite.

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