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Reproductive Characteristics Of Turkish Honeybee (*Apis Mellifera* L.) Genotypes

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Abstract: Queen honeybees from different races such as *Apis mellifera caucasica (*Northeast Anatolian) and *Apis mellifera anatoliaca* (Center Anatolian) and ecotypes Aegean (Muğla), Marmara (Gökçeada), Thrace and Mediterranean (Alata) were raised from April to July to determine some of the reproductive characteristics. Muğla and Central Anatolian queens were bigger than the other genotypes at emergence. The mating ratio were 90.0±7.1 %, 85.0±6.5 %, 80.0±0.0 %, 72.5±7.5 %, 65.0±8.7 and 57.5±11.1 % in the Muğla, Caucasican, Gökçeada, Alata, Central Anatolian and Thrace genotypes respectively. The preoviposition periods were shorter in the Muğla, Gökçeada and Alata bees than the others. The volume of the spermatheca was smaller in the Alata ecotype but there was no significant difference in the number of spermatozoa in the spermatheca among the genotypes. The rearing season also affected the weights of the queens at emergence and after mating, preoviposition period and spermathecal volume. Commercial queen breeders can raise queen bees from April to June in the region; however due to the shortage of nectar and pollen it is not practical in July.

Key words: Turkey/Honeybee (*Apiss mellifera* L.)/ genotypes/ reproductive

Türkiye'nin Önemli Balarısı (*Apis Mellifera* L.) Genotiplerinin Üreme Özellikleri

Özet: Türkiye'nin Kuzeydoğu Anadolu Bölgesinde yetiştirilen Kafkas (*A. m. caucasica*) ve Orta Anadolu Bölgesinde yetiştirilen Anadolu (*A. m. anatoliaca*) ırkları ile Ege, Marmara, Trakya ve Akdeniz Bölgelerinde yetiştirilen arı genotipleri kolonilerinden Nisan, Mayıs, Haziran ve Temmuz 1993 aylarında larva transfer yöntemiyle ana arı yetiştirilmiştir. Arı genotiplerinin üreme özellikleri incelenmiştir. Muğla ve Orta Anadolu ana arıları diğer genotipleri ana arılarından çıkışta daha ağır bulunmuşlardır. Muğla, Kafkas, Gökçeada, Alata, Orta Anadolu ve Trakya genotiplerinin çiftleşme oranları sırasıyla % 90.0±7.1, % 85.0±6.5, % 80.0±0.0, % 72.5±7.5, % 65.0±8.7 ve % 57.5±11.1 olarak saptanmıştır. Muğla, Gökçeada ve Alata genotiplerinde çiftleşme öncesi süre diğerlerinden daha kısa bulunmuştur. En küçük spermatheca hacmine Alata genotipi sahip olurken, spermathecada deoplanan spematozoid miktarı yönünden genotipler arasında önemli bir farklılık belirlenmemiştir. Ayrıca, yetiştirme döneminin çıkış ve çiftleşme sonrası ağırlığı, çiftleşme öncesi süre ve spermatheca hacmi üzerinde etkili olduğu belirlenmiştir. Bölgede Nisan ve Haziran arası dönemde ticari ana arı yetiştirilebileceği bununla birlikte polen ve nektar kaynaklarının yetersizliği sebebiyle Temmuz ayında kaliteli ana arı yetiştirilemeyeceği görülmüştür.

Anahtar sözcükler: Balarısı (*Apis mellifera* L), genotip, üreme özellikleri.

Introduction

Turkey has a great beekeeping potential having over 4.1 million colonies, suitable climate, rich flora, genetic diversity of honeybee races and ecotypes. Honey production

exceeds 65.000 tons per year and the honey yield is about 16 kg per hive (Anonymous, 1996). Although the colony numbers and honey yield increase every year steadily, this increase is not satisfactory (Güler, 1995). One of the main reasons for the low honey yield is the insufficient queen bee production in the country. The production does not fulfil the demand consequently the beekeepers use old and non-productive queens (Kaftanoğlu and Kumova, 1992).

There is a great genetic diversity of bee races and ecotypes due to climatic and ecological conditions in Turkey. Several races *A. m. anatoliaca*, *A. m. caucasica*, *A. m. syriaca*, *A. m. adami*, *A. m. meda* and ecotypes such as Muğla, Gökçeada, Thrace and Karadeniz were described (Bodenheimer, 1941; Ruttner, 1988; Güler, 1995; Smith et al., 1997). All these races and ecotypes are the raw material for breeding studies. Therefore it is of vital importance to know the physiological and reproductive characteristics of the queen bees (Szabo et al., 1987). Therefore the aim of the present study was to investigate the physiological and reproductive characteristics of the queen bees of different genotypes which can be used in selection and breeding programs.

Materials and Methods

The study was carried out in Mediterranean Region between April and July, 1993. The honey bee colonies were obtained from six different regions in Turkey such as North-East Anatolia (Ardahan-Posof), Central Anatolia (Ankara-Beypazarı), Aegean (Muğla-Fethiye), Marmara (Çanakkale-Gökçeada), Thrace (Tekirdağ-Saray) and Mediterranean (Mersin-Erdemli) Regions were the migratory beekeeping have not been practised. From each region, 10 colonies were selected as the representative of the regional genotype. The morphological and physiological characteristics of the colonies were determined (Güler, 1995).

Each month 6 starter and finisher colonies were prepared and total of 1152 one-day old larvae were transferred from 6 genotypes during 4 months period. The grafted cell were placed in the queenless starter colonies for 24 h, and then transferred to the finisher colonies (Laidlaw, 1979; Kaftanoğlu and Peng, 1982). Ten days after grafting the cells were removed from the finisher colonies and 10 queen cells from each genotype were introduced into the 5 frames standard sized nucleus colonies for emergence and open mating. The rest of the queen cells were placed in an incubator and the queens were weighted just after emergence. Seven days after the emergence, the mating colonies were checked daily until the onset of oviposition. Ovipositing queens were weighed and killed in order to measure the diameter of the spermatheca and to count the number of spermatozoa (Woyke and Jasinki, 1973; Kaftanoğlu and Peng, 1982).

The data were analysed in two way ANOVA using SPSS statistical program and the comparisons between genotypes and periods were determined by Duncan's Multiple Range Test.

Results

The weights of the queens at emergence

The weights of the queens at emergence for different genotypes are presented in Table 1.

Table 1. The average weight (mg) of the queens at the emergence

		Periods				
Genotypes	*No Queens*	*April*	*May*	*June*	*July*	*Means*
C. Anatolian	27	177.3±6.7	167.3±5.6	201.0±1.2	186.8±12	178.5 *a*
Caucasican	24	150.9±2.5	147.3±4.4	188.0±4.0	173.0±1.0	156.1 *b*
Muğla	26	204.0±7.2	150.1±5.0	221.0±7.0	172.0±8.1	182.3 *a*
Gökçeada	30	175.9±9.3	162.8±8.8	169.3±10	175.5±13	170.2 *ab*
Thrace	30	146.8±5.9	157.7±7.5	161.7±12	174.3±5.7	157.8 *b*
Alata	29	157.4±8.8	152.8±4.0	182.0±5.0	180.2±4.1	162.6 *b*
Means	176	169.4±3.9 *b**	156.3±2.6 *c*	185.5±5.9*a*	178.0±3.5*b*	167.8

∗Different letters indicate significant differences (P<0.05).

The average weight of the queens at emergence were 169.4±3.9 mg,156.3±2.6 mg, 185.5±5.9 mg and 178.0±3.5 mg for June, July, April and May respectively. Similar queens emerged in June were bigger and heavier than that of others (P<0.05).

The mating ratio

The mating ratios of queen in different months were presented in Table 2.

There were significant differences among genotypes in terms of the mating ratio. The highest value was obtained from Muğla genotype (90.0±0.7 %). Central Anatolian and Thrace had the lowest value (65.0±8.7 and 57.5±11.1 % respectively). There was no significant difference among periods.

Table 2. The average mating ratio (%)

		Periods				
Genotypes	*No. Queens*	*April*	*May*	*June*	*July*	*Means*
C. Anatolian	38	50	80	80	50	65.0±8.7 *c**
Caucasican	40	80	90	70	100	85.0±6.5 *b*
Muğla	40	100	90	70	100	90.0±7.1 *a*
Gökçeada	39	80	80	80	80	80.0±0.0 *b*
Thrace	39	50	70	80	30	57.5±11.1 *c*
Alata	35	60	90	60	80	72.5±7.5 *b*
Means	231	70.0±8.2	83.3±3.3	73.3±3.3	73.3±11.5	75.0±5.0

∗Different letters indicate significant differences (P<0.05).

The weights of the queens after mating

There was a significant differences among genotype (P<0.05) and period (P<0.001) in terms of the weight of the queen after mating (Table 3). The highest weight were obtained from Gökçeada (200.6±6.3 mg).

Table 3. The average weight of the queens after mating (mg)

		Periods				
Genotypes	*No. Queens*	*April*	*May*	*June*	*July*	*Means*
C Anatolian	19	178.7±1.8	163.2±16	189.8±6.2	183.7±19	178.8±4.7 *b*
Caucasican	16	180.0±5.9	186.7±2.3	198.5±4.1	182.6±1.9	186.9±2.5 *ab*
Muğla	19	189.7±5.4	182.0±5.5	219.4±5.7	176.0±11	191.8±5.3 *ab*
Gökçeada	20	197.2±6.5	189.4±6.7	225.2±15	190.4±15	200.6±6.3 *a*
Thrace	13	193.7±6.3	178.8±3.8	211.8±5.5	143.0±6.0	181.8±6.9 *b*
Alata	15	201.0±5.7	195.0±4.8	193.3±14	170.0±17	189.8±6.1 *ab*
Means	102	190.1±2.4	182.5±3.8	206.3±4.0	174.3±5.1	188.3±2.3
		*b**	*b*	*a*	*b*	

∗Different letters indicate significant differences (P<0.05).

Onset of oviposition

The onset of oviposition in different genotypes and in different months were presented in Table 4. The differences between genotypes, periods and genotype x period interactions were significant (P<0.001). The onset of oviposition was shorter in Muğla, Gökçeada and Alata genotypes (9.9±0.3, 10.2±0.3 and 10.3±0.4 days respectively) than the other genotypes.

Table 4. The onset of oviposition in different genotypes (days after emergence)

		Periods				
Genotypes	*No. Queens*	*April*	*May*	*June*	*July*	*Means*
C Anatolian	21	10.2±0.2	12.2±0.2	12.6±0.4	9.0±0.4	11.2±0.4 *a*
Caucasican	32	9.0±0.3	11.3±0.3	13.0±0.4	13.1±1.1	11.6±0.4 *a*
Muğla	32	9.5±0.3	10.9±0.4	11.5±1.0	8.6±0.2	9.9±0.3 *b*
Gökçeada	30	8.6±0.3	11.6±0.7	11.8±0.4	9.5±0.7	10.2±0.3 *b*
Thrace	17	10.8±0.4	11.6±0.7	11.8±1.0	11.7±1.5	11.4±0.4 *a*
Alata	19	8.6±0.3	11.4±0.7	12.6±0.5	9.0±0.0	10.3±0.4 *b*
Means	151	9.4±0.2	11.4±0.7	12.2±0.3	10.3±0.4	10.7±0.2
		*d**	*b*	*a*	*c*	

∗Different letters indicate significant differences (P<0.05).

The onset of oviposition was also affected by the season. It was shorter in April (9.4±0.2 day) and the longer in June (12.2±0.3 day).

The volume of spermatheca

The volume of spermatheca of the queens in different genotypes and periods were given in Table 5. The highest and lowest values were found to be 0.97±0.03 and 0.85±0.04 mm^3 in Caucasica and Alata genotypes, respectively.

Table 5. The average volume of spermatheca (mm^3)

		Periods				
Genotypes	*No. Queens*	*April*	*May*	*June*	*July*	*Means*
C.Anatolian	19	0.89±0.03	0.88±0.05	0.98±0.10	0.94±0.04	0.91±0.02 *ab*
Caucasican	16	0.91±0.04	1.06±0.04	1.07±0.10	0.90±0.04	0.97±0.03 *a*
Muğla	19	0.90±0.02	0.98±0.04	0.93±0.10	0.84±0.04	0.91±0.02 *ab*
Gökçeada	20	0.93±0.06	0.91±0.07	0.84±0.02	0.80±0.03	0.87±0.03 *ab*
Thrace	13	0.91±0.06	0.88±0.03	1.05±0.03	0.96±0.06	0.95±0.03 *ab*
Alata	15	0.91±0.05	0.94±0.05	0.87±0.09	0.68±0.02	0.85±0.04 *b*
Means	102	0.91±0.02	0.93±0.02	0.95±0.03	0.84±0.02	0.91±0.01
		*ab**	*a*	*a*	*b*	

∗Different letters indicate significant differences (P<0.05).

The number of spermatozoa per spermatheca

The number of spermatozoa in the spermatheca of the queen were summarised in Table 6. The number of spermatozoa ranged between 3.16-4.06 millions among the genotypes and no significant difference was observed among them (P<0.05). However, the number of spermatozoa were different in different months (P<0.001). Queen reared in July had significantly fewer spermatozoa than the queens reared in June, May and April.

Table 6. The average number of spermatozoa in spermatheca (million)

		Periods				
Genotypes	*No. Queens*	*April*	*May*	*June*	*July*	*Means*
C.Anatolian	19	3.26±0.27	2.69±0.92	4.34±0.50	1.97±1.05	3.16±0.32
Caucasican	16	3.29±0.38	4.20±0.58	4.39±0.29	1.90±0.38	3.30±0.32
Muğla	19	3.92±0.29	4.07±0.32	4.36±0.75	3.64±0.53	3.99±0.25
Gökçeada	20	4.29±0.28	4.69±0.34	4.09±0.58	3.18±0.85	4.06±0.29
Thrace	13	4.03±0.25	4.20±0.45	3.79±0.32	1.88±0.78	3.68±0.29
Alata	15	3.79±0.60	3.58±0.39	4.08±0.07	3.61±0.69	3.74±0.77
Means	102	3.71±0.15	3.92±0.24	4.18±0.20	2.82±0.69	3.66±0.12
		a*	a	a	b	

∗Different letters indicate significant differences (P<0.05).

Discussion

Commercial queen rearing has recently started in Turkey. The production does not meet the demand and there is a shortage of queen bees especially in the spring season. The beekeepers tend to buy any queens available in the market. The government and the private companies started queen rearing projects to supply queens to the beekeepers. Therefore we compared the queen production parameters and some of the reproductive characteristics of queens coming from different regions in the Mediterranean climate in order to help the queen breeding industry.

There were significant differences on the weight of the queens at emergence in different ecotypes. Muğla, Central Anatolian and Gökçeada queens were heavier and bigger than the Caucasican, Thrace and Alata Genotype queens.

The average preoviposition period was found to be 10.7±0.2 days. Muğla, Gökçeada and Alata bees that were adapted to mild climate had shorter preoviposition period than the C. Anatolian, Thrace and Caucasian queens that were adapted to the temperate climate.

The average volume of the spermatheca was found to be 0.91±0.01 mm^3; that was bigger than the volume (0.819±0.022 mm^3) reported by Kaftanoğlu and Kumova (1992). The Caucasian queens had the biggest and the Alata queens had the smallest spermatheca among the ecotypes. There were no significant differences in the number of spermatozoa among the ecotypes. The average number of spermatozoa was found to be 3.66±0.12 millions which was lower than the numbers (4.455±0.123 millions) reported by Kaftanoğlu and Kumova (1992). This difference was the result of the low spermatozoa counts in July when there was a shortage of pollen and nectar. As a result the worker bees killed most of the drones in this month.

Queen rearing season affected the queens' weight, preoviposition period, volume of spermatheca and the number of spermatozoa in the spermatheca. The acceptance rate was highest in June and lowest in May. However, Kaftanoğlu and Kumova (1992) studied the effects of rearing season on the quality of the queen bees in the same region in 1988 and found that the acceptance rates ranged between 81.7 % and 91.4 % from April to July, but they were lower in August (60.0 %) and in September (58.3 %). The acceptance rates were found to be satisfactory for commercial queen rearing in the region in both studies.

In this study the weight of the queen and the number of spermatozoids in Per spermatheca were lower compared to the other studied (Woyke, 1973; Kaftanoğlu and Peng, 1988). This result was attributed to using the non-breeding material. Therefore, we can infer from the study that these genotypes needs breeding. As a result Muğla and Gökçeada genotypes were found to be more productive genotypes than the others in the Mediterranean climate. They are also more adaptable to different ecological conditions and more economical for migratory beekeeping.

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