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Research Article

Cockroach Infestation in Some Hospitals in Trabzon, Turkey

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Abstract: The distribution and abundance of cockroaches were investigated in six hospitals in Trabzon. A total of 4756 (692 ♀♀, 652 ♂♂ and 3412 nymphs) cockroaches were caught between 1st October 1999 and 30th January 2000. It was found that three cockroach species were present in hospitals. Of these, *Blattella germanica* was the predominant species with 98.25%, followed by *Blatta orientalis* (1.12%) and *Periplaneta americana* (0.63%). Although the German cockroach, *Blattella germanica*, was found in all areas of the hospitals, *Blatta orientalis* and *Periplaneta americana* were only caught in kitchens.

When comparing the population density of German cockroaches in different places chosen for this study, it was clear that the number of this cockroach per 10 m^2 (102.23) and infestation rate (83.61%) were higher in kitchens than in other places. It was seen that the population density of this species in kitchens is significantly different from that in other places (one-way ANOVA: $F = 54.17$, $P < 0.01$).

Although several stages of *B. germanica* were observed in hospitals, nymphs showed the highest infestation rates (62.50-86.89%). Most of the nymphs were immature (67.28-88.26%). The infestation rate of immature nymphs was higher (88.26%) in kitchens than in other places, namely the patient rooms (67.28%), nurse rooms (76.34%) and doctor rooms (80.04%).

In addition, some ecological parameters, such as humidity and temperature, were measured in the places studied to examine the relationship between the population density of *B. germanica* and these parameters. There seemed to be a very significant correlation between humidity and the population density of German cockroaches ($R = 0.65$, $P < 0.01$), but not for temperature ($R = -0.2$, $P > 0.01$). In conclusion, the population density of *B. germanica* increased over 45% humidity, but did not at lower humidity levels (39-45%).

Key Words: Cockroaches, Population density, Humidity, Temperature, Hospital

Trabzon'un Bazı Hastanelerindeki Hamamböceklerinin İstilası Hakkında Bir Çalışma

Özet: Bu çalışmada, Trabzon'daki 6 değişik hastanedeki hamamböceği türleri ve populasyon yoğunlukları araştırılmıştır. 1 Ekim 1999–30 Ocak 2000 tarihleri arasında toplam 4756 (692 ♀♀, 652 ♂♂ ve 3412 nimf) hamamböceği yakalanmıştır. Araştırma yapılan hastanelerde 3 türün yaşadığı bulunmuştur. Bu türler arasında *Blatella germanica* % 98.25 ile en baskın olup diğer iki türden *Blatella orientalis* % 1.12 ve *Periplaneta americana* ise % 0.63 gibi düşük oranda yaşadığı bulunmuştur. Alman hamamböceği olarak adlandırılan *Blatella germanica* hastanelerin her yerinde bulunmasına rağmen diğer iki tür (*Blatta orientalis Periplaneta americana*) sadece hastanelerinin mutfaklarında yakalanmıştır.

Mutfaklardaki Alman hamamböceğinin yoğunluğunu incelenen diğer yerlerle karşılaştırdığımızda 10 metre kareye düşen birey sayısının (102.23) ve istila oranının yüksek olduğu (% 83.61) belirlenmiştir. Bu türün mutfaklardaki populasyon yoğunluğunun istatistiki acıdan önemli derecede farklı olduğu görülmüştür (one-way ANOVA: $F = 54.17$, $P < 0.01$).

Alman hamam böceğinin birçok hayat evresi yakalanmasına rağmen, nimflerin en fazla istila oranına (% 62.50-86.89) sahip olduğu gözlenmiş, bunlarında büyük bir çoğunluğunun (% 67.28-88.26) genç nimf evresinde olduğu belirlenmiştir.. Diğer taraftan, genç nimflerin en fazla (% 88.26) mutfaklarda bulunduğu görülmüştür.

Ayrıca, *B. germanica*'nın populasyon yoğunluğunun sıcaklık ve nemle ilişkisini göstermek amacıyla incelenen yerlerde yapılan ölçümlerde nem ile Alman hamam böceği yoğunluğu arasında önemli bir ilişki bulunmuştur ($R = 0.65$, $P < 0.01$), fakat populasyon yoğunluğunun sıcaklıkla bir ilişkisi bulunamamıştır ($R = -0.2$, $P>0.01$). Sonuçta, *B. germanica*'nın populasyon yoğunluğunun % 45'in üzerindeki nem değerlerinde belirgin olarak artığı, daha düşük değerlerde (% 39-45) azaldığı görülmüştür.

Anahtar Sözcükler: Hamamböceği, Populasyon yoğunluğu, Nem, Sıcaklık, Hastane

Introduction

Cockroaches are the most abundant and important pest insect that inhabit various public places such as hospitals, food manufacturing sites and kitchens (1,2). In hospitals, restaurants and houses, cockroaches feed on a variety of animal products, including meat and grease, starchy food, sweets and other unprotected materials (3). When cockroaches run over food they leave filth and secrete an oily liquid that has an offensive and sickening odour that may ruin food (4). In recent studies, a strong association has been found between the presence of cockroaches and increases in the severity of asthma symptoms in individuals who are sensitive to cockroach allergens (2,5).

Many cockroach species have been described in several parts of the world. Of these, the German cockroach, *Blattella germanica*, is the most troublesome species because of its predominance in houses as well as places of food manufacturing (6,7). Conventional insecticides are often ineffective in controlling wide spread infestations of *B. germanica*. Because of the shortness of its life cycle of three to eight months depending on temperature, it is very difficult to control this species compared with other cockroach species (8-10). This species may easily protect itself and develop resistance to insecticides such as Malathion and Propoxur. In addition, this species shows weak tolerance to Sumithion and Tetramethorin (11). On the other hand, Koçak (12) has stated that boric acid remains effective against German cockroaches for a long time whereever insecticides cannot be used.

In recent years, a number of studies have been carried out to determine the population dynamic of cockroaches in some hospitals and apartments in Turkey (13) and Korea (7,8). In these studies, it was found that among cockroaches caught in hospitals, *B. germanica* was the predominant species (7,8). It was also claimed that the population density of this species correlated with pest control programmes used in hospitals (8). On the other hand, the insecticides used against *B. germanica* have negatively affected the population dynamic of this species in Turkey (13). However, these studies do not provide further information about the population dynamics of cockroaches in hospitals and the influence of temperature and humidity.

The literature review reveals that information about the population dynamic of cockroaches in hospitals is rather scarce, and no comprehensive study has been undertaken. Therefore, the present study was carried out in order to determine cockroach species and their infestation rate, and the influence of some parameters such as humidity and temperature on the population dynamics of German cockroaches in some hospitals in Trabzon.

Materials and Methods

This study was carried out in 84 different sites in six hospitals in Trabzon between 1st October 1999 and 30th January 2000. A total of 4756 (692 ♀♀, 652 ♂♂ and 3412 nymphs) cockroaches were caught in these hospitals

Cockroaches were usually sampled using sticky traps. In addition, some cockroaches in cracks were collected by a vacuum cleaner. In order to determine cockroach population densities, 14 places (five patient rooms , five doctor rooms, two nurse rooms, one furnace and one kitchen) in each hospital were examined. The number of sticky traps used for cockroach sampling was two or five depending on the area of the study sites, resulting in one trap per 10 m^2. The sticky traps were placed where cockroaches were likely to be found, such as under beds and furniture, behind refrigerators, near rubbish bins and cupboards, in drawers and in the corners of rooms. The sticky traps were left in these places for 15 days and they were brought to the laboratory for evaluation along with samples collected by a vacuum cleaner. All of the specimens were examined to determine cockroach species, and then the cockroaches were counted by life stages (young nymph and old nymph) and sex. The nymph stage was determined according to the last segment, as stated before (10,14). The data was analysed (SPSS) using one-way ANOVA for the mean number of cockroaches per 10 m^2 and using a correlation between some ecological parameters (humidity and temperature) and population densities of *B. germanica*. In addition, we used regression analysis to find a regression equation between humidity and density.

Pattern and coloration characteristics were recorded while the animals were alive. In addition, colour slides of some of the specimens were taken and placed in collection boxes. The other cockroaches were fixed in 60% ethanol.

The humidity and temperature in the sampled sites were measured by a Casella B 5 5248 hygro-

thermometer which had two thermometers placed side by side. In order to estimate the population dynamic of German cockroaches, the mean values of humidity and temperature records were compared with the population density of German cockroaches.

Results

Three cockroach species belonging to the two families of Blattidae and Blattellidae were determined. Of these, *Blattella germanica* (4673) was the most common species found in all sites of hospitals chosen for study, when compared to other species such as *Blatta orientalis* (53) and *Periplaneata americana* (30). On the other hand, *B. orientalis* and *P. americana* were only captured in the kitchens of hospitals. The infestation rate of *B. germanica* was higher (98.25%), followed by *B. orientalis* (1.12%) and *P. americana* (0.63%) (Fig. 1). Due to the lower densities of *B. orientalis* and *P. americana,* only the population density of *B. germanica* was given.

The population densities and infestation rates of *B. germanica* caught from different sites in six hospitals are given in Table 1. It was seen that the highest infestation rate of this species was in the kitchens (83.61%), followed by patient rooms (14.28%), nurse rooms (1.50%), doctor rooms (0.53%) and furnace rooms (0.28%). The number of cockroaches per 10 m^2 in the five different places showed very significant differences (one-way ANOVA: $F = 54.17$, $P < 0.01$). Among these places, kitchens had the highest number of German cockroaches per 10 m^2 (102.23 ± 59.9, one-way ANOVA: $P < 0.01$). The other places (patient, doctor, nurse and furnace rooms) showed no significant differences (one-way ANOVA: $P > 0.01$).

Although several stages of *B. germanica* were seen, the nymphal stage showed higher infestation rates in the five places surveyed. Those rates ranged from 62.50% in doctor rooms to 86.89% in kitchens; however, we did not catch any nymphs from furnace rooms. In addition,

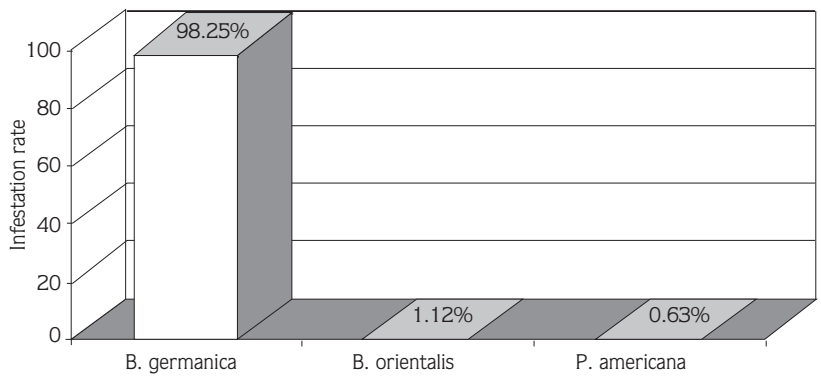

Figure 1. The infestation rates of the three different cockroach species captured from hospitals in Trabzon.

Table 1. The population density and infestation rate of *B. germanica* in the different sites of the hospitals (K: Kitchen, Pr: Patient room, Nr: Nurse room, Dr: Doctor room, Fr: Furnace room, n: number of cockroaches, N: Number of places, F/M: Number of adult females/males).

Places	N	n	Indiv./10 m^2 (Mean ± SE)	Nymphs (%)	Immature Nymphs (%)	F/M	Infestation Rates (%)
K	6	3907	102.23 ± 59.9 *	86.89	88.26	1.32	83.61
Pr	30	658	6.22 ± 8.6	78.06	67.28	0.71	14.28
Nr	12	70	1.92 ± 1.5	67.44	76.34	0.87	1.50
Dr	30	25	0.37 ± 0.4	62.50	80.04	1.09	0.53
Fr	6	13	0.39 ± 0.8	-	-	1.29	0.28
Total	84	4673	111.36 ± 38	-	-	-	100

* The mean difference is significant at the 0.01 level (one-way ANOVA: $F = 54.17$, $P < 0.01$)

the infestation rate of young nymphs was higher (88.26%) in the kitchens than in, patient rooms (67.28%), nurse rooms (76.34%) and doctor rooms (80.04%). When compared to the infestation rate of females/males in kitchens with other sites, a high infestation (1.32) could be easily seen (Table 1). In addition, it was found that 17.03% of adult females were carrying ootheca.

While the mean temperatures measured at different sites in the hospitals were similar to each other (19.83-21.66), the same places had very different humidity values (39.50-54.00%) (Table 2). There was a positive correlation between humidity and the population density of German cockroaches ($R = 0.65$, $P < 0.01$) (Table 3), but not for temperature ($R = -0.2$, $P > 0.01$). The high humidity values were positively associated with the densities of this species (Fig. 2). As a result, the number of specimens belonging to *B. germanica* increased over the 45% humidity value, but not at lower humidity levels (39-45%) (Fig. 2).

Table 2. The average temperature and humidity measured in the different places in the hospitals (N: Number of places examined, Min. and Max: Minimum and Maximum, $\bar{X}$: Mean, SD: Standard Deviation, K: Kitchen, Pr: Patient room, Nr: Nurse room, Dr: Doctor room, Fr.: Furnace room).

Habitats		N	Min-Max	$\bar{X}$	SD
K	Temperature	6	18-21	19.83	2.136
	Humidity	6	45-65	54.00	7.659
Pr	Temperature	30	18-22	20.83	2.400
	Humidity	30	42-50	45.16	3.920
Nr	Temperature	12	19-22	21.00	1.549
	Humidity	12	36-45	41.00	3.898
Dr	Temperature	30	18-23	20.66	1.751
	Humidity	30	36-41	41.16	3.430
Fr	Temperature	6	14-25	21.66	4.131
	Humidity	6	38-41	39.50	2.429

Table 3. Correlation between the mean humidity values (%) and the densities of *B. germanica*. (N: Number of the places).

Mean Humidity Values (%)	N	Mean ± SD Individuals/10 m^2
54.00	6	102.23 ± 59.9
45.16	30	6.23 ±8.6
41.00	12	1.92 ± 1.5
41.16	30	0.37 ± 0.4
39.50	6	0.39 ± 0.8
R*		0.65

*Significance correlation coefficient at the 99% level.

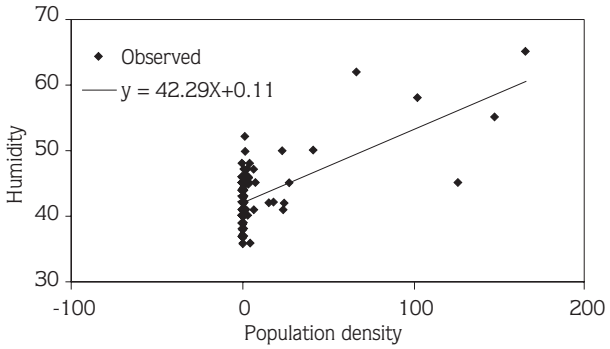

Figure 2. The relationship between humidity and population density (individuals/10 m^2) of *B. germanica*.

It was found that kitchens were suitable places for *B. germaniaca* as they have high humidity levels (45-65%); however, doctor and furnace rooms were not suitable for this cockroach due to the presence of low humidity (39.50-41.16%) (Fig. 2).

Discussion

The results of the present study showed that three cockroach species inhabit the six hospitals. Of these, *Blatta orientalis* was not recorded previously from hospitals, whereas *P. americana* and *B. germanica* were detected from these places earlier (8,15). On the other hand, Dong-Kyu (8) reported another cockroach species, *Peripleneta fluginosa*, in hospitals in Korea. Although Dong-Kyu (8) found *P. americana* in patient rooms and kitchens, no specimen belonging to this species was collected from these places during the present study. All of the specimens of this species were captured from kitchens, such as *B. orientalis*.

Previous studies revealed that *B. germanica* successfully breeds in the kitchens of hospitals, apartments, tea rooms, hotels, private houses and restaurants. Specimens belonging to this cockroach could easily visit other places to find food (7,14). These results were similar to ours. Although the sites in this study were not sufficient in number to allow a definite conclusion about the feeding and breeding of German cockroaches, it was found that hospital kitchens were suitable for German cockroaches because of their suitable temperature and humidity (Table 2). In addition, patient rooms were suitable as well as kitchens for this species (Tables 1,2). This result was similar to previous studies (7,9,12,15) except the study by Dong-Kyu (8), who

captured the highest rates of German cockroaches from patient rooms.

The greatest number of cockroach specimens collected in the patient rooms were old nymphs or adult males, while immature nymphs and females were mostly found in kitchens. It was also observed that females mostly preferred to remain in areas such as kitchens, where food and water were adequate (F/M = 1.32). An alternative explanation of the high occurrence of females in the kitchens would be an migration of females during the breeding period to the kitchens due to adequate humidity (54%), which might have been an important factor for females in the period of carrying the ootheca. As a result, most of the females captured in the kitchens had ootheca. This result was consistent with previous studies (7,14). However, unlike our results, Dong-Kyu (8) observed high numbers of females in patient rooms, but not in kitchens.

Runstrom and Bennet (14) reported that the number of German cockroach nymphs increased between October and February and July and August. The nymph rates (62.50-86.89%) found between October and January in the present study were similar to that result. In addition, our results were similar to the results of Dong-Kyu (8) from Korea (82.7%). However, I captured 75 females with ootheca, and this that seems to be different from the results of Dong-Kyu (8). This difference could arise from the use of a method other than sticky traps, such as a vacuum cleaner, for the collection of specimens.

In conclusion *B. germanica* successfully breeds in general hospitals because of high humidity, high temperature and presence of food. It is essential that further studies be carried out in order to find better control methods for this cockroach in hospitals. Since *B. germanica* still has a high population density in hospitals despite the large amount of insecticide are used, I believe it is necessary to continue work on this matter in order to obtain a more comprehensive solution for this problem.

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