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Investigations on the Ecology of Eurasian Water Vole, *Arvicola amphibius* (Rodentia: Mammalia) in Ankara Province

Güliz Yavuz,[1]* Ercüment Çolak[2] and Teoman Kankılıç[3]
[1]*Department of Biology, Faculty of Arts and Sciences, Ahi Evran University, 40100 Kırşehir, Turkey*
[2]*Department of Biology, Faculty of Science, Ankara University, 06100 Ankara, Turkey*
[3]*Department of Biology, Faculty of Arts and Sciences, Niğde University, 51240 Niğde, Turkey*

Abstract.- The population dynamics of *Arvicola amphibius* were investigated in Ayaş (Ankara, Turkey), during the period between August 2005 and July 2006. The method of capture-mark-recapture was used and 123 individuals were marked during the study. For each animal, total body length, body weight, reproductive condition, as well as features of habitat were recorded. The width of the riparian vegetation was measured by ranging from 1 to 5 m. The reproductive period lasted from March to October. In adult females, the total length varied from 306 mm to 321 mm, while in adult males, it varied from 305 mm to 326 mm, it was compared with other populations. Estimated monthly population size of the water voles ranged from 3 in January to 49 in July.

Key words: *Arvicola amphibius*, population size, Eurasian water vole.

INTRODUCTION

Eurasian water vole, *Arvicola amphibius* (Linnaeus, 1758), has a confusion in nomenclature. Some authors use as "*terrestris*" (Ventura and Casado-Cruz, 2011), but the others think that "*amphibius*" has a priority (Musser and Carleton, 2005). Therefore *amphibius* was used in this paper instead of *terrestris*. Eurasian water voles are distributed in the Palaearctic region (Gromov and Erbajeva, 1995; Wilson and Reeder, 2005) and are known to occur in Turkey (Ellerman and Morrison-Scott, 1951; Mursaloğlu, 1975; Harrison and Bates, 1991; Özkurt *et al*., 1999). *Arvicola amphibius* has semiaquatic and fossorial ecological forms (Kratochvil, 1983). Eurasian water voles are semiaquatic and they have a widespread distribution and live near rivers and lakes with a riparian habitat around agricultural areas. Improper usage of water sources threatens animals living in wetland habitats.

Eurasian water voles are important in the ecosystem, serving as an important food source for many predators, as a result of which the population size of water voles reduced. In Britain, a decline in Eurasian water vole population has been observed for many years due to predation by American mink, *Neovison vison* (Jefferies *et al.*, 1989; Strachan and Jefferies, 1993; Woodroffe, 2000). During the overwinter period, the population was reduced in the United Kingdom (Strachan and Moorhouse, 2006). The red fox, *Vulpes vulpes*, generally feeds on microtine rodents, especially *Microtus* voles; however, this species consumes more Eurasian water voles in the winter than in the summer (Dell'arte *et al.*, 2007). Stoats, *Mustela erminea* and weasels, *Mustela nivalis* prefer the same habitat as water voles and they prey on *Arvicola amphibius* and *Microtus* voles (Elmeros, 2006; Sidorovich *et al.*, 2008). The wildcat, *Felis silvestris* mostly feeds on *Apodemus* but they also feed on *Arvicola* in the spring, summer, and autumn (Pineiro and Barja, 2011).

Eurasian water voles can be found throughout Turkey, except in coastal regions. Many anthropogenic activities such as highways, roads, agricultural efforts, and settlements effect the Eurasian water vole populations in Turkey and cause habitat loss and habitat fragmentation. However, many aspects of Eurasian water vole populations in Turkey are unknown.

The aim of this paper was to determine changes in the body weight, sex ratio, population size, and habitat features of *Arvicola amphibius* in Turkey, using the capture-mark-recapture method.

* Corresponding author: glzyvz@gmail.com
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MATERIALS AND METHODS

Study area

All of the field work took place at İlhan Brook (40°04′N, 32°07′E; altitude, 572 m), in Ayaş, which is located 80 km from Ankara, between August 2005 and July 2006. The study was carried out once a month, over 3-4 days, over 1 year period. A total of 40-50 live traps were set in each work station. Number of traps varied depending on signs of voles and habitat conditions. The study area was 450 m in length and 10 m in width. We did not come across the presence of voles beyond this width. Traps measuring 27 × 10.5 × 8 cm were used. The traps were set at intervals of at least 5 m. Figure 1 shows the location of the traps.

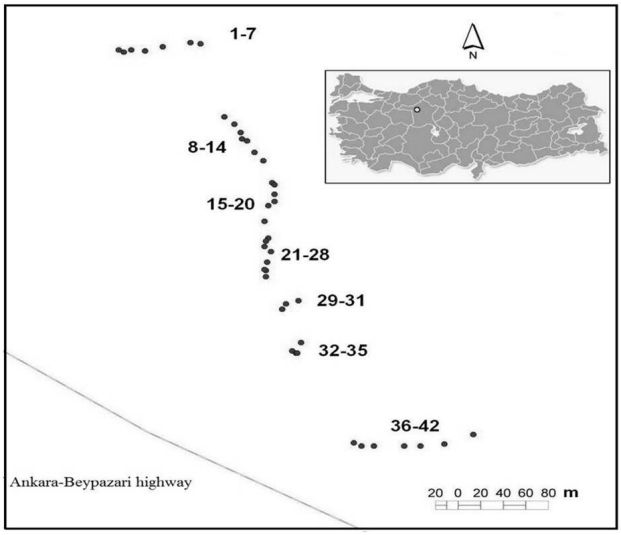

Fig. 1. The study area in Ayaş and the layout of trapping stations.

Methodology

Bread with peanut butter, cucumber, apple, and carrot were used as baits in the live traps. However, Eurasian water voles preferred the traps with fresh carrot as bait. It was observed that the Eurasian water voles fed on the leaves of Gramineae. Some of the traps were placed randomly where there were visible signs of the presence of Eurasian water voles, as well as where there was a habitat suitable for Eurasian water voles. Placement of these traps remained the same during the 3-4 day study each month. In the months that followed, some of the traps were placed in other locations, a few meters away in distance, depending on the condition of the habitat. The traps were checked every 1-3 h, depending on weather conditions and the baits were renewed often during this time. Throughout the summer, the traps were covered with green leaves to protect them from the sunlight. For protection in the cold weather and during the winter, paper was placed into the traps as nesting material and the traps were wrapped with nylon.

Each of the trapped Eurasian water vole was individually weighed (g), body measurements were taken by ruler (mm), and the sex was recorded. Then, each animal was marked on the ear with a metal ring stamped with a special number. Marked animals were released back into the same habitat from where captured. The coordinates of the working area were registered by GPS and then a map of the study area was prepared using ArcView software. The population size was defined using the method of "capture-mark-recapture" (Ford, 1964). A total of 123 specimens were captured throughout the one year period. Dead samples were not used when calculating the population size.

RESULTS

The width of the riparian vegetation measured 1-5 m. The water level changed during the study period, depending on agricultural watering, seasonal rains, and winter conditions. At times during the study period, the riparian vegetation was burned by the villagers causing changes in the vegetation. Some locations in the study area were flooded during February, this also destroyed some plants (reed bed, sedge).

Shorn reeds and feces were found around the nest entrance. In February, it was observed that the stems of the dry reeds under the soil had been eaten by Eurasian water voles. Eurasian water voles were marked while under anesthesia to prevent them from escaping during the process. When they recovered, they dove into the water and disappeared or they got out of the water immediately and walked along the coastline. Eurasian water voles walked along a linear line of 5-10 cm toward the water and dove in immediately to avoid danger.

Figure 2 shows fluctuations in the total body

length of Eurasian water voles. Similar fluctuation can be seen between the adult females and the adult males. The average total body length of the adult females was between 306 mm in February and April and 321 mm in June and July, while the adult males were between 305 mm in August and 326 mm in October and June.

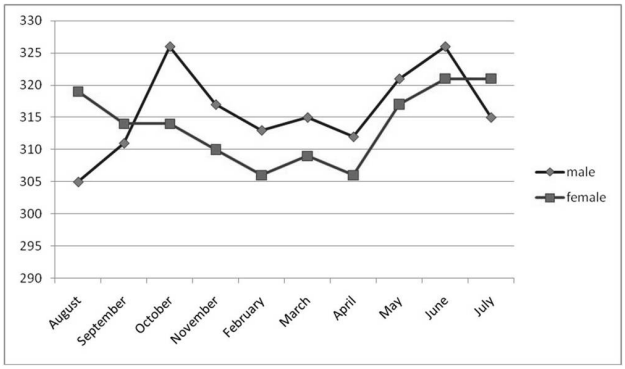

Fig. 2. Fluctuations in the average body lengths of *Arvicola amphibius*.

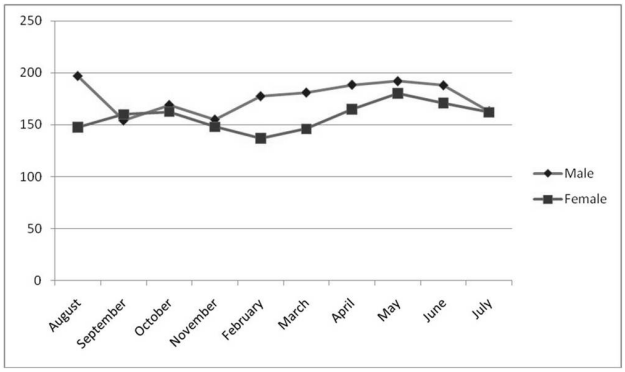

Fig. 3. Changes in the average body weights of *Arvicola amphibius*.

The traps were set for 4 consecutive days and some individuals were caught night after night. The change in the weight of such individuals is given in Table I. Of the water voles captured, 75.6% were caught on consecutive days and showed a loss of their previous body weight (during March, April, May, June, July, August, September, October and November), 20.5% gained weight (during April, May, June, August, September and October), and 5.5% maintained the same weight (during May, June, August and September).

Out of 123 individuals, 15 died in the traps, especially in autumn. Of the water voles caught during September and October, 21% died in the traps, while 15% died in the traps during June and August.

Figure 3 shows the body weight of adult female and male Eurasian water voles. The average body weight of the adult females ranged from 137 g in February to 180 g in May, while the adult males ranged from 154 g in September to 197 g in August.

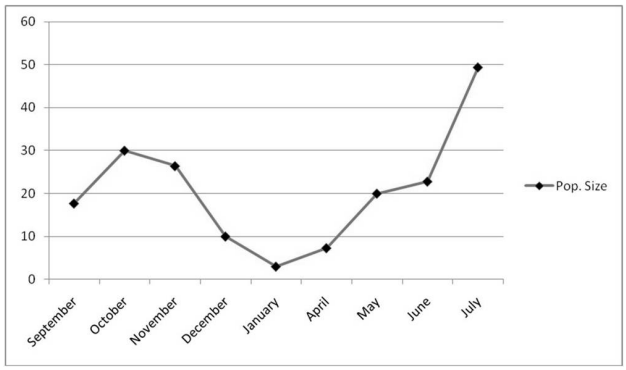

Fig. 4. The estimated population size of Eurasian water voles in the study area.

Figure 4 describes the fluctuations in the number of Eurasian water voles trapped in study area. It also describes the estimated population size using the equation by Ford (1964): $P = MR_{n-1} \times N_n / MR_n$; where P is the estimated population size, MR_{n-1} is the number of marked specimens trapped and released in month n-1 (including all captured specimens without those dead in the traps), MR_n is the number of marked specimens released in month n, and N_n is the total number of specimens caught in month n. The estimated monthly population size of Eurasian water voles ranged from 3 (January) to 49 (July) in the study area and the Ayaş population showed 2 peaks of capture in October 2005 and July 2006, respectively. Because 2 animals were captured in both February and March, data obtained in these months were not included in the analysis to calculate the population size.

The sex ratio (female:male) of trapped individuals is shown in Figure 5. The number of females was higher in October, June, and July, whereas the males were higher in August and January.

Table I.- The weight change (% of the previous day's weight) of Eurasian water voles captured on consecutive days.

N	1	4	18	5	64	18	2	1
% weight change	+21-30	+11-20	+1-10	0	-1-10	-11-20	-21-30	-31-40
% of individuals recaptured	1	3.5	16	5.5	56.6	16	2	1

It was determined that Eurasian water voles fed on reed beds throughout the year and they consumed soft parts of the reed beds under the soil in the winter. Although they lived near agricultural areas, they did not damage these areas.

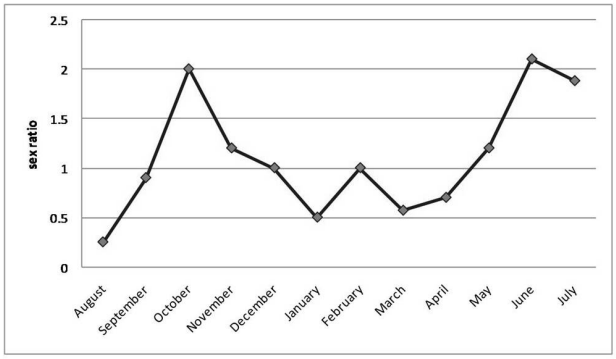

Fig. 5. The sex ratio of *Arvicola amphibius* in the study area.

Males and females with reproductive activity were trapped in March. This shows that the breeding time starts in March. Breeding indications were determined in 9 of 12 males in August, 2 of 6 males in October, 6 of 7 males in March, 5 of 10 males in April, 7 of 9 males in May, 7 of 11 males in June, and 5 of 9 males in July. These indications were also recorded in 4 of 11 females in May, 13 of 19 females in June, and 7 of 16 females in July. Juveniles first appeared in May, and were also observed in June, July, September, and October. In June, 2 pregnant females, each with 5 embryos, were recorded. Therefore, it can be said that the breeding time of *Arvicola amphibius* is seems continuous between March and October.

Eurasian water voles were active during day, but showed the most activity after sunset. These observations remained constant during the study period.

DISCUSSION

Arvicola amphibius live near streams, lakes, ponds, and dams. They prefer abundant vegetation in these areas and generally occur on smooth land (Ognev, 1948; Niethammer, 1990; Nowak, 1991; Gromov and Erbajeva, 1995; Pita *et al.,* 2011a). Contrary to the findings of these researchers, in the present study, it was determined that Eurasian water voles did not leave the shoreline of streams and they burrowed near rivers. The riparian vegetation width was 1-6 m (Moorhouse *et al.,* 2008). Our data (1-5 m) is consistent with that of Moorhouse *et al.* (2008).

Ognev (1948), Mursaloğlu (1975), Özkurt *et al.* (1999), and Anonymous (2002) recorded that the total body length of *A. amphibius* was between 140 and 220 mm and the total tail length of this species was between 95 and 140 mm. Corbet and Southern (1977) determined that the average total body length was 210 mm and the average tail length was 124 mm in males, while the average total body length was 187 mm and the average tail length was 116.5 mm in females. In the present study, these measurements were found to be in unison with literature.

Corbet and Southern (1977) recorded that the average body weight of *A. amphibius* was 263 g in males and 232 g in females. The Mammal Society (2002) determined that the body weight was between 150 and 300 g, and Pita *et al.* (2010) found that the mean body weight was 175.7g (92-261 g). In this study, the values were found to be lower than those presented by Corbet and Southern (1977) and no specimen was recorded as weighting 300 g. Some of the values were between those of Anonymous (2002), while some were outside of these measurements. These differences may be based on disparity of habitat.

According to Zejda (1992), the weight of

young specimens increased to 100 or 120 g during their first year, before they became sexually mature, and this weight stayed the same until the following spring. Moorhouse *et al.* (2008) found that Eurasian water voles reached breeding condition at a mean weight of 115 g in males and 112 g in females. In this study, the young males were a maximum of 148 g, while young females were a maximum of 132 g. In the adult females and males, body weight started to decrease after autumn into winter. Potapov *et al.* (2004) found a direct relationship between the increasing of weight in the autumn and food storage. Zejda (1992) recorded that the daily body weight changed by 48 g in 2-5 days in recaptured specimens (11.3 g in males and 13.5 g in females), with the weights changing 39%-41% in some situations. This study recorded body weight fluctuations between 4 and 71g. Zejda (1992) determined that these fluctuations were based on the fullness of the digestive canal, pregnancy, nursing and sexual activity, or difference of habitat. In addition to these explanations, it can be said that these fluctuations may have originated from the stress of being trapped or may be predator related. Due to seasonal factors and differences between females and males, body weights can change.

Giraudoux *et al.* (1995) found 20 individuals/ha in France. In this study, 123 individuals were marked and the monthly population size was between 3 and 49 in an area of 450 m (6-98 individuals/ha). Predator stress, agricultural activity, marked decreasing in water level, and adverse winter conditions may influence the population size. The increased activity of Eurasian water voles in the autumn was probably related to an increase of walking around while collecting food for winter storage. This higher activity may be dependent on searching for food or mating trips. Moreover, 4 adults and 5 young joined the population in the summer. This caused a summer peak in the population size and this peak may explain with new migrants and newborns joined to this population.

The overall sex ratio of the wild populations did not differ significantly from the 1:1 ratio and there was no significant difference among the young (Rogov *et al.,* 1999). The sex ratio did not reflect the true sex ratio due to various factors such as migration rates or reproductive conditions. In this study, the total sex ratio was similar to that reported by Rogov *et al.* (1999). However, the sex ratio varied from month to month. The ratio of females was higher in May, June, July, October, and November. This may be because the females spent more time gathering food for both their offspring and metabolic demands or for winter storage. The ratio of males was higher in January, March, April, and August, which may have resulted from their mating trips to find females that were sexually active.

According to Nowak (1991) and Potapov *et al.* (2004) this species' activity was lower during winter and this situation is likely due to food storage. The young specimens were more active than the adults during the winter, provided that the young had enough food. Corbet and Southern (1977), Niethammer (1990), Nowak (1991), Roman (2007) and Rosario *et al.* (2008) observed that this species fed on plants. Eurasian water voles use riparian vegetation as a food source (Barreto *et al.*, 1998; Macdonald and Strachan, 1999; Strachan and Moorhouse, 2006) and in this study, food pieces cut by Eurasian water voles were found in a vegetation belt of 1 m, as was also found by Moorhouse *et al.* (2008).

We observed the offspring in September, October, May, June, and July. The first offspring joined the population in May. This finding was supported by the study of Ognev (1948). According to Corbet and Harris (1991) Eurasian water voles have a litter of between 3 and 14 offspring and give birth twice in a year. In this study, we also recorded 2 pregnant females in June, both with 5 embryos. Indications of breeding were observed in August, September, October, March, April, May, June, and July. It is known that Eurasian water voles have a gestation of approximately 3 weeks (Ognev, 1948). Based on these results, it can be said that this species gave birth twice during a year in Ayaş.

As in the present study, Ognev (1948) and Corbet and Southern (1977) determined that Eurasian water voles are active during the day, especially after sunset and before sunrise. Fernandez-Salvador *et al.* (2001) and Ventura (2004) reported that they were more active during the day. Pita *et al.* (2011b) observed they were

active at dusk, between May and September, and were diurnal between October-April. Niethammer (1990) and Nowak (1991) found that the life span of this species was 5 months and 12 days. According to Roman (2007), Eurasian water voles rarely survive for more than 12 months. However, we monitored only 1 specimen that survived for 10 months (5-6 months in average). The life span of this species is possibly short in the wild because of predation or high mortality.

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