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Some ecological aspects of the genus *Microtus* Schrank, 1798 (Mammalia: Rodentia) in Northwest of Iran

Khalilaria, A.[a*] & Çolak, E.,[b]

[a] *Agricultural and Natural Resources Research Center of Azerbaijan, West Azerbaijan,Iran*
[b] *University of Ankara, Faculty of Science, Department of Biology, Ankara, Turkey*

In order to study the ecology of the genius *Microtus* Schrank, 1798 (Mammalia: Rodentia) in NWof Iran, three regions including Salmas, Marand, and Moghan were selected. The number of active nests of *M. socialis* and *M.* aff. *socialis* (2n=54) were detected during spring and autumn. In this period, detection were made in three blocks of each location (each one 20×50m) with intervals of one week in 2008-2009.
In each blocks, hole colony diameter, slop, length, distance from the other holes, number of rooms in the holes, shape of the tunnels and their connection to each other were measured in the block from the same colony. Meteorological data of each location including temperature (ºC), humidity (%) and rainfall (mm) were obtained from meteorological stations. Decrease in population was found in the first and second blocks of Salmas from 2008 autumn to 2009, but an increase in population was observed after 2009 autumn to September 2010. In spite of appropriate weather conditions, it is agricultural controls that have probably caused changes in population size.
The number of *M. socialis* nesting population in Moghan was higher than Salmas and Marand. The average sizes of diameter and length of the holes were 47.7 mm and 510 mm, and the slope angle was 35.4° in Marand. In Salmas, the average for diameter, length of hole entry, and slope angle degrees were 43 mm, 498 mm and 29.5° respectively. In Moghan, both types of the described colonies were observed.

Key words: Iran, *Microtus,* ecology, nesting population

INTRODUCTION

West Azerbaijan is in the northwest of Iran. This region is neighbor of Azerbaijan and Turkey (It has a common border of 488 km with Turkey) on the north. It is also neighbor of Turkey and Iraq on the west and of Iran's Kurdistan state on the south and of Iran's Zanjan and East Azerbaijan states. The surface measure of this region including Salt Lake is 43660 km^2 and it composes 2,65% of Iran. It has approximately one million hectare utilizable land. (Anonymous, 2010).
The surface measure of Ardabil state is 17953 km^2 and it composes 1.09% of the country. Moghan plain is one of the important regions of this state in terms of agriculture. It has an open land and it is composed of alluvium from the river Aras and alluvium from its branches. There is mountainous terrain on south and south east of Germi region and on the border of Meshkinsehr and the Republic of Azerbaijan but on other parts there is not significant geographical difference. This plain is in the watershed of the Caspian Sea. Moghan plain composes the west extension of Caspian coasts. Its altitude on Aras and Balharud banks is approximately between 50-100 m and the altitude increases to the south with a low inclination. It is one of the important agricultural and stock raising places of Iran. It is possible to see *M. socialis* species belonging to *Microtus* on clover fields and on many other parts of this plain. (Anonymous, 2010).

*Corresponding Author: aria836@gmail.com, a_aria2001@yahoo.com

Surface measure of East Azerbaijan is 45491 km^2 and it is the region where huge mountains of Iran, the Alborz and Zagros meet. The environment of this region consists of seven mountains and the plains among them. Sabalan Mountain with an altitude of 45491 km^2 separates this state from the Ardebil state. The altitude of another high mountain the Sahand is 3707 m. Climate diversity is one of the important characteristics of East Azerbaijan. The climate of this region is under the affect of Mediterranean climate. For this reason some parts are semi-arid and cold and other regions have a warm climate (Anonymous, 2010).

It is known in Europe that field mouse (*M. arvalis*) experiences a multiannual population fluctuation (Frank, 1953). This species, which do not breed in winter, live together in big groups having various ages and genders (Chelkowska, 1978). In the spring, individuals of this group migrate to suitable parts and get a more suitable feeding environment and therefore, a rapid growth occurs in the local population intensity. From summer to the autumn the individuals disperse to adjacent places (Frank, 1953). Their high intensity population can cause huge agricultural loss (Jobsen, 1988).

According to ecological data, field mice have a regional social order constituted by the females of them (Frank, 1953; Boyce and Boyce, 1988 a, b). Many young females found a big nest system as 2 up to 6 different groups (on average 4) and share separate food storage and nest units and connected tunnels with from 2 up to 14 nest entrance (Liro, 1974; Goszczynska and Goszczynski, 1977; Boyce and Boyce, 1988b). When the population is at low intensity many female groups breed together concurrently.

Many studies have been carried out on population dynamics of small rodents (Krebs and Myers, 1974; Taitt and Krebs, 1985; Hansson and Henttonen, 1988; Batzli, 1992; Stenseth and Ims, 1993; Norrdahl, 1995; Korpimäki and Krebs, 1996; Krebs, 1996; Stenseth, 1999; Hanski et al., 2001; Turchin and Batzli, 2001) and it is perceived from these that multiannual fluctuation is a significant and common topic of ecological studies.

MATERIAL AND METHODS

Three stations in Salmas, Marand and Moghan regions were chosen from West Azerbaijan, East Azerbaijan and Ardebil respectively between 2008 and 2010 (Fig. 1). These stations are clover fields. As agriculture and stock rising is prominent in these states, clover and other feed types are cultivated in wide areas. At the same time various species of *Microtus* live in these fields. The species of *Microtus* prefer living in fields close to slopes and in fields that are adjacent to the slopes. So that, they can move to the upwards coming out of their nests in case of possible agricultural activities such as irrigation, spraying and others.

1st Station: It was chosen from Salmas region of West Azerbaijan state. The station is a field on the 12th km of Salmas-Orumiyeh motorway just by the road and has the coordinates 38°09'N, 44°55'E and the altitude 1317 m from the sea level. This station is about two hectare and has been cultivated clover for many years and applied spraying against rodents. One side of this station is neighbor to high mountains, another side to motorway and the other two to clover fields.

2nd Station: This station is located on Marand region of East Azerbaijan. It is on the 2nd km of the road between Galleban village and Koshksaray region of Marand and has the coordinates 38°30'N, 45°33'E and 1113 m altitude from sea level. It is a clover field which has been cultivated for 4 years. All neighboring fields are cultivated wheat.

3rd Station: It is located on Moghan region of Ardebil state. This station of 15 hectare on clover fields of Kesht-o Sanat agricultural company has the coordinates 31°36'N, 47°46'E and an altitude of 104 m from sea level. Neighboring fields are cultivated clover.

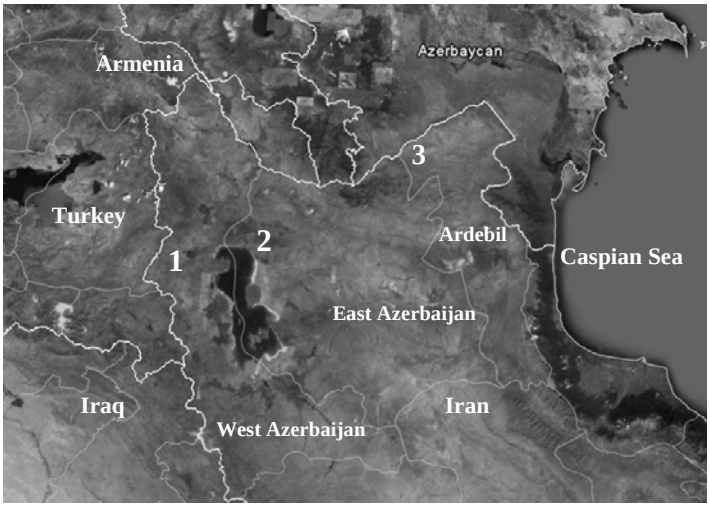

FIGURE 1. The stations (1: Salmas; 2: Marand; 3: Moghan).

The number of the active nest entrances for the species *M. socialis* and *M.* aff. *socialis* were determined in 3 blocks with dimension of 20x50 m (1000 m^2) at each location during autumn 2008, spring and, autumn 2009, and spring 2010, , every other week . To achieve this, all of the nests had been closed on the first day. Next day the numbers of the nests opened by the animals were recorded (Eppo, 1975; Zapletal et al., 2000; Lisická et al., 2007) and then their average was calculated. Then, active nest numbers for each block were determined and recorded.

On three blocks for each of the locations (Salmas, Marand and Moghan), diameter, inclination, length and distance between nests in a colony were measured. Then one of the nests was dug and the number of chambers, the form of tunnels and their connections were determined. In fact the fields' borders were a bit higher than the fields around and are under less agricultural activities; help the mouse to hide itself in unsuitable condition. Similarly, the irrigation channels between fields do the same action to prevent the mice to get trapped.

The temperature (ºC), humidity (%) and rainfall (mm) values in these stations were regularly obtained from meteorology stations. To illustrate the values, graphics were drawn on Excel program. The values of similarity among plant species within the stations that are used for sampling were compared and calculated by handling stations two by two.

According to Sorensen (1948); Sorensen=2a / (2a+b+c), where similarity between two different station is considered; a=the number of common species in both stations, b=number of species in station 1 that is different from the one in station 2 and c=number of species in station 2 that is different from the one in station 1, and these are calculated as follows (Krebs, 1989).

Data were analyzed using GLM procedure of SAS 9.3. Mean of the criteria including number of entrances, diameter of entrance, slope angle degree, and length of hole were compared using Fisher's protected least significant difference (LSD) at p=0.05.

RESULTS AND DISCUSSION

In 2008, 2009 and 2010 when the studies were carried out, the climate in the northwest of Iran was relatively warm. Maybe that is because of this air condition that the results obtained are almost similar for each station.

On the clover fields on the stations, other plant species together with clover are available as it is the case with other clover fields in most of the region as shown in Table 3.

The temperature (ºC), humidity (%) and rainfall (mm) of Salmas station in April 2008-September 2008, October 2008-September 2009 and October 2009-September 2010 are illustrated on Fig. 2. As

can be seen on the figure, the temperature was mostly above zero during the winter when studies were carried out on the station and it dropped below zero only a few times in January of October 2008-September 2009 period (Fig. 2). That is, the station was observed during a mild winter, and spring and summer which are not so hot. As it is known, population growth can be observed in the species of *M. arvalis* and *M. socialis* representing *Microtus* during winters that are not much cold and during mild summers. As a result, population explosion was marked in September 2010 in these species.

The temperatures of Moghan station in April 2008-September 2008, October 2008-September 2009 and October 2009-September 2010 (˚C) is illustrated on Fig. 3. As shown in the figure, the temperatures in October 2009-September 2010 rose when compared to the former period (October 2008-September 2009). On this station, temperature does not drop below zero and it is usually over 5˚C even in winters.

The amount of rainfall (mm) and humidity (%) belonging to the periods mentioned, are shown on Fig. 3. As illustrated there, the amount of rainfall (mm) and humidity (%) belonging to the period October 2009-September 2010 rose compared to former period (October 2008-September 2009). When we consider average temperature rise in the station, it can be concluded that suitable air conditions and the softness of the soil provided by the rainfall and growth of lush vegetation as a result quickened the breeding of individuals among population and caused the population growth that was witnessed in the spring. According to the past studies carried out, during the years when the winters were mild and the summers cool, the fertility increased and a remarkable population growth in the species of *Microtus* was observed (Khalilaria et al., 2004).

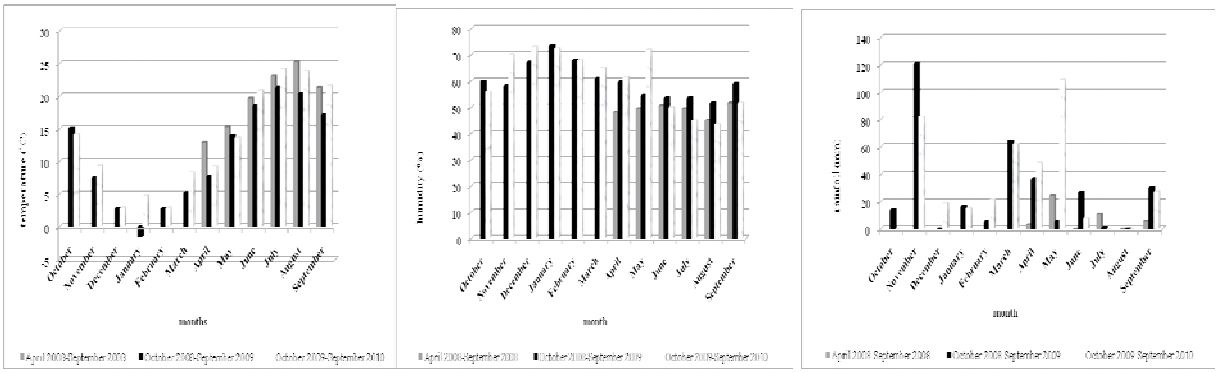

FIGURE 2. The temperature (ºC), humidity (%) and rainfall (mm) of Salmas station.

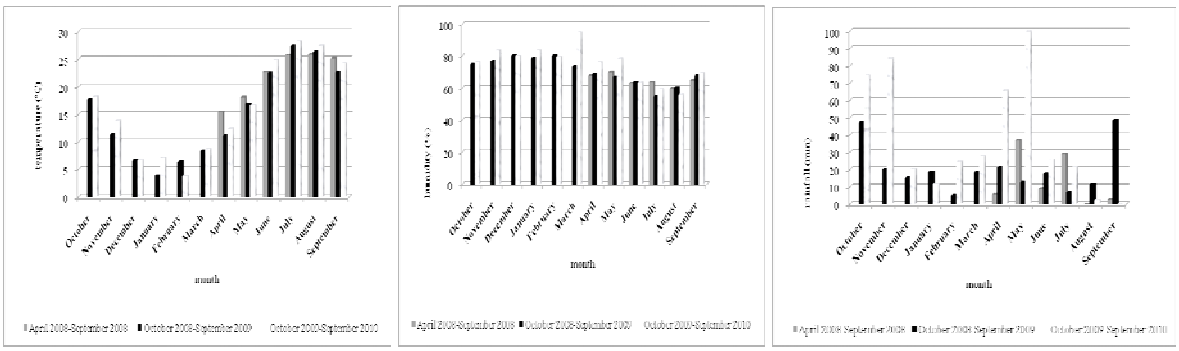

FIGURE 3. The temperature (ºC), humidity (%) and rainfall (mm) of Moghan station.

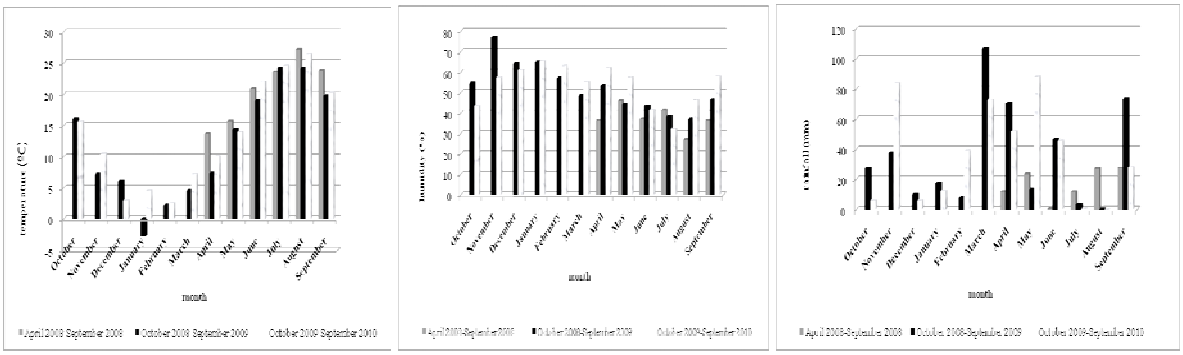

FIGURE 4. The temperature (ºC), humidity (%) and rainfall (mm) of Marand station.

The temperature (ºC), humidity (%) and rainfall (mm) of Marand station in April 2008-September 2008, October 2008-September 2009 and October 2009-September 2010 are illustrated on Fig. 4.

In this study, average of nest entrance numbers which were recorded between 2008 and 2010 are illustrated on Table 1. As seen on Table 1, the population decreases from 2008 autumn to 2009 autumn in Salmas on 1st and 2nd blocks. However, the population increases following 2009 autumn. Although weather conditions were suitable during this term, the change in the population can be attributed to agricultural protection. Because, it can be considered that the weather conditions between 2008 autumn and 2009 spring (Table 1) was suitable for breeding of individuals of *M. socialis*.

Nest numbers in Moghan station belonging to the population in *M. socialis* are greater in number when compared to the two other stations. Thanks to the soil structure and especially suitable climate conditions in Moghan station, population intensity in this station is greater than the others. Looking at the graph (Fig. 5) drawn to examine population intensity of different years and seasons, it can be observed that suitable air conditions are available for the individuals of *M. socialis* to breed as it is in two other stations. But due to some agricultural interventions in some years, changes occur in population.

Nest structures and number of their entrances belonging to *M. arvalis* in Salmas and Orumiyeh-Sero regions are similar. Nonetheless, they usually consist of 3-5 nest entrance. Colonies are generally built on the highest point on fields or gardens (in order to prevent water from filling inside the nest and destroying it during irrigation). In many regions, colonies are found to be connected to the border of another field or garden from a field or garden with a channel (generally in places where agricultural activities are not applied).

Also, it was realized that colonies on the borders of the field are usually connected to the main irrigation channel which runs just by the field. In Salmas locality nests belonging to *M.* aff *socialis*

TABLE 1. -Average of active nest entrance numbers in stations

Stations / Seasons	Salmas			Marand			Moghan		
	1st block	2nd block	3rd block	1st block	2nd block	3rd block	1st block	2nd block	3rd block
2008 autumn	60	33	12	10	9	11	58	70	39
2009 spring	39	10	25	8	13	6	46	39	35
2009 autumn	25	14	15	8	4	6	43	52	37
2010 spring	28	11	12	9	8	9	31	59	28
Average	**38**	**17**	**16**	**8,8**	**8,5**	**8**	**44,5**	**55**	**34,8**

2n=54 and in Marand locality nests belonging to *M. socialis* were dug. In Salmas locality the nest entrances are on average 43 mm in diameter and have 498 mm length and inclination degree of 29,5 (Table 2).

In Marand, the nest entrances are on average 47,7 mm in diameter and have 510 mm length and inclination degree of 35,4 (Fig. 5 and Table 2).

In Orumiyeh-Silvana locality of West Azerbaijan, nest length of *M. socialis* is 400-500 mm on borders and there are 8-15 nest entrances. The inclination of nest entrances range between 27 and 45 degrees. The depth of the tunnel is between 200 and 350 mm. There are nest chambers having diameter of 150 x 220 mm in each of colonies (Fig. 6 and Table 2). In this region, there are differences among soil (the structure of the soil varies from clayish loam to clay and to silty clay), climate, altitude and irrigation periods. Structures and numbers of the nests vary according to soil structure.

TABLE 2. *Microtus* nest and Colony data at the stations.

Salmas (*M.* aff. *socialis* 2n=54)

Colony	Entrance number	Diameter (mm)	Inclination (Degree)	Nest Length (mm)
1	1	40	30	600
	2	40	30	930
	3	40	30	270
2	1	35	28	140
	2	40	30	600
	3	50	30	260
	4	60	30	360
3	1	40	27	520
	2	40	30	650
	3	35	30	500
	4	50	30	650
Maximum		60	30	930
Minimum		35	27	140
Average		43	29,5	498

Marand (*M. socialis*)

Colony	Entrance number	Diameter (mm)	Inclination (Degree)	Nest Length (mm)
1	1	45	35	56
	2	50	35	60
	3	50	30	38
	4	60	30	85
2	1	40	35	43
	2	40	35	25
	3	50	30	71
	4	50	30	39
	5	45	35	62
3	1	50	45	36
	2	40	60	27
	3	50	30	87
	4	50	30	34
Maximum		60	60	87
Minimum		40	30	25
Average		47,7	35,4	51

Moghan (*M. socialis*)

Colony	Entrance number	Diameter (mm)	Inclination (Degree)	Nest Length (mm)
1	1	70	60	180
	2	60	45	480
	3	65	45	320
	4	60	35	430
	5	70	65	160
	6	80	65	200
	7	50	30	540
	8	40	40	730
	9	50	35	700
	10	60	35	620
	11	70	45	280
2	1	50	45	180
	2	55	45	220
	3	45	45	430
	4	30	30	
	5	30	35	
	6	35	40	480
	7	40	30	450
	8	40	30	270
	9	70	65	200
	10	60	60	230
3	1	40	35	450
	2	40	30	520
	3	30	35	430
	4	50	35	240
	5	30	30	320
	6	30	30	300
	7	60	50	220
	8	75	60	190
	9	35	45	270
	10	40	30	560
	11	50	45	440
	12	30	30	380
	13	40	30	340
	14	40	30	360
Maximum		80	65	920
Minimum		30	30	160
Average		49	41	389

FIGURE 5. *Microtus* nest entrance at Marand station

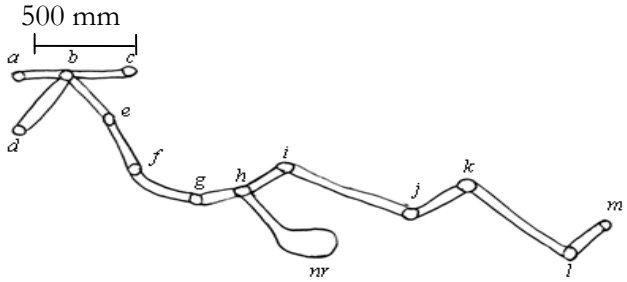

FIGURE 6. Structure of *Microtus* nest at Orumiyeh-Silvana location, a-m: nest entrance, nr: nest room

Significant difference were detected among locations in comparing the number of entrances and slope angle degree at p=0.05. Adversely, no significant differences were observed among locations in comparing diameter of the entrance and hole length of the colonies at p=0.05.

In the studies carried out in station in Moghan region of Ardebil, two types of colonies were observed. The first one covers more space and has more nest entrances (10-14) and this type belongs to reproductive females and their babies. Because of this fact, females were caught from these types of colonies during irrigation. Also it was observed that tens of babies left their nests not to be drowned and they sought higher places on the field where water could not reach. Nest entrance number of second type of colonies was detected as 3-4. During irrigation, mature males were caught from the nests in these colonies. Therefore, the status of nests in the field is different from the ones on the border. Where the place is more flat and wider (inner parts of the field) nesting is affected and more nest entrances are observed and nests cover a wider space on the field. Moreover, in the parts that are higher than other parts of the field, the number of colonies is more. Because, this altitude prevents water from filling inside the nests and therefore helps the newborn babies to stay inside and be secured from the danger of being pray to the predator birds and especially crows which fly over the field during irrigation.

Throughout the study it was determined as a result of regular observations that individuals of *Microtus* adapt to the various habitats of northwest regions of Iran (primarily pastureland, clover fields and various fields, gardens and grassy parts along irrigation channels next to the crop fields) and live there. These animals generally prefer living in orchards and in the places where Germaine plants exist. They have nutritional varieties which depend on the season and habitat characteristics. They build their nests in the form of colonies. The actual place where the animal lives is in the depth close to the surface but sometimes it can be a depth of 300-500 mm. Generally, these animals come

out of their nests for a short time during the day for feeding. They can breed almost every season. When their population grows they migrate to find a more suitable place.
In 2010, it was observed that their population grew and so they caused many damages to cultivated land. For this reason, the Ministry of Agriculture applied control methods by spraying and they provided control over the population. Nevertheless, it is considered that a few years later the population may grow again to due to suitable weather conditions and habitat. Therefore, species belonging to *Microtus* are dominant rodents which generally live in clover fields, gardens, on the slopes around fields and on the borders of fields in northwest regions of Iran.
The observation made during this study in Moghan region of northwest of Iran showed that the breeding period of *M. socialis* is very long. The individuals of this species generally come out of their nests in the evenings and feed themselves. During the cool and dark hours of the day, they come out of their nests; feed themselves and they have the habit of acquiring new nests. They build nests and tunnels in different forms. Sometimes the colonies they build may have 46 nest entrances. The depth of nests is between 15-20 cm and each nest contains a few food chamber and storage. They stay inside during the nights and do not come out.
On the clover fields in the station there are also other plant species together with clover belonging to families *Poaceae*, *Brassicaceae*, *Onvolvulaceae*, *Cuscutaceae*, *Geraniaceae*, *Asteraceae*, *Labiatae*, *Leguminosae*, *Iridaceae*, *Plantaginaceae*, as it is the case in most of the
clover fields in the regions. The species belonging to these families are illustrated on Table 3.

TABLE 3. -The list of plant species together with clover in the stations.

Plant	1th station (Salmas)	2th station (Marand)	3th station (Moghan)
Alopecurus myosuroides	+	-	-
Bromus spp.	+	+	+
Capsella bursa	-	+	-
Cichorium inytbus	+	-	+
Convolvulus arvensis	+	+	+
Cynodon dactylon	-	+	-
Cuscuta spp.	+	+	-
Dactylis glomerata	+	-	+
Descurainia sophia	+	+	+
Erodium cicutarium	-	+	+
Lactuca serriola	+	+	-
Lamium amplexicaule	+	-	+
Melilotus officinalis	+	+	+
Muscari botryoides	+	+	+
Plantago lanceolata	-	+	-
Setaria viridis	+	+	+
Sisymbrium irio	+	-	+
Sonchus arvensis	+	+	+
Sorghum halepense	+	+	+
Taraxacum officinalis	+	+	-

(+) present, (-) absent

Tkadlec and Stenseth (2001) derived two models in the population dynamics of *M. arvalis* that they examined in Central Europe. The first is that autoregressive model, which is much referred, causes fluctuations in Central Europe. The second one is the dynamic model which refers to stable

populations (only seasonal fluctuation) which varies geographically and exist in north parts of Central Europe, and to the unstable populations (multiannual fluctuation) in south region. Huitu et al (2003) suggest that population fluctuations in agricultural habitats are not so stable. This study also reached a similar conclusion. Accordingly, seasonal fluctuations in the number of active nests belonging to the individuals of *Microtus* were recorded in all of three stations that were examined. Although the amount of fluctuation differs with respect to three blocks in each of the stations, it was determined that the number of active nests in each of them has up-and-down pattern.

Getz, et al (2006) suggested when they examined the population of field mouse in clover fields in Illinois (US) that seasonal changes are the primary factors in population growth. Furthermore, according to these researchers the degree of survival of young individuals and mature ones differs due to seasons during the years when population fluctuation occurs but the difference is less in the period from August to February. During the years when population fluctuation does not occur, breeding activeness rate of mature females in clover fields in autumn is remarkably higher than it is in winter (Getz et al, 2006). In this study, 23 individuals were collected from Salmas locality and it was determined that 13 of them were male and the rest were female and no much difference was observed in the number of young individuals and mature ones (19 mature, 4 young). Also, sex ratio of individuals (56,5% male and 53,5% female) collected from this region in late summer (last week of August) shows similarity to each other.

In Moghan region, 20 individuals were collected in late summer (first week of September) and 6 and 14 of them were determined to be male and female respectively. 23 and 15 of 30 individuals collected in spring (in June) were determined to be male and female respectively. It was observed that necessary conditions were available to enable *M. socialis* to breed, and since it is below zero on few days and this is scarce in the region in winter, population growth in almost every season is observed. In Marand locality, 13 individuals were collected in spring (in June), and five and eight of them were determined to be male and female respectively. That in Marand locality summer heat did not start to occur in abovementioned season and the amount of humidity in the habitat was convenient, and sufficient food was available to feed newborn individuals and required number of females was also existent, cause population growth.

It can be suggested that Moghan's climate is warmer than Salmas' and almost the temperatures in Moghan in September correspond to the temperature in late August in Salmas. The fact that the number of female individuals collected from both localities is high and pregnant individuals were encountered during the study reveals that the time was one of the apparent times of breeding. As it is known, individuals belonging to *Microtus* can be active in breeding throughout the year as suggested by many researchers. However, sometimes the number of mature males increases (when temperatures, humidity and food amount is sufficient) and fertility rate becomes high and as a result population grows.

In late summer of 2010 (from the beginning of September) in states of West Azerbaijan, especially in Orumiyeh, Salmas provinces and northern parts of the state an apparent population growth was recorded. Because of this growth, individuals of *Microtus* exhibit feeding behaviors that are uncharacteristic of them. Some of these behaviors are climbing on trees in apple orchards, vineyards and other fruit orchards and eating the fruits on them. They can climb on vine trees in cordon vineyards and feed there. This type of behavior which is found interesting by local people suggests that in order to accommodate to the population growth and find sufficient food for individuals, they can exhibit different feeding behaviors. According to the vine growers, individuals of *Microtus* which are not afraid of mankind and can approach and come to places where there are people in order to feed themselves exhibit same kind of behavior.

During the field study carried out in first few days of 2010 winter, the growth in the population was witnessed. When the clover fields where the study was underway could not suffice to feed the population, the animals had to find closest apple orchard or vineyard or move to a close slope in

order to find food to survive. As stated before, the fact that the animals had to adapt to the new population growth drove them to exhibit behaviors that are unusual of them.

Yiğit and Çolak (1988) by their study which they carried out in Turkey suggested that rodents which live in similar habitats in different localities differs remarkably in terms of species composition and as a result of this similarity coefficient among localities ranges between 1 and 0,18. These researchers showed that vegetation structure, climate and altitude are the actual factors which effect scatter of rodents in Asiatic Turkey. Also in this study, different rodent species were not encountered because the stations are similar in terms of climate and vegetation, and also they are within the limit of certain altitude. The species observed during this study were determined to be matching *Microtus* species.

Dobly and Rozenfeld (2000) after examining nest forms of field mice in Belgium concluded that characteristics of the nests are that they are covered above with hillock as it is with water vole, and they are built in a way to enable reach to food source areas. Similarly, in this study, when we dug and examined the nests in the stations, we observed that many nest entrances and tunnels extend to irrigation channels and food sources.

According to Dobly and Rozenfeld (2000), field mouse piles the soil which has been dug, in front of their nests which are repeated until food sources. Similarly, in this study we observed after examining nest structures in stations that the dug soil was piled in front of nest entrances and this method repeated until food sources.

Together with clover plant, 16 plant species in Salmas station, 15 in Marand station and 13 in Moghan station were recorded (Table 3). There are 11 similar plant species between Salmas and Marand stations (grass, field bindweed, love vine, kochia, thorny acrid lettuce, melilot, catnip, wild oat grass, gand flower, wild garlic and dandelion). The number of similar plant species between Marand and Moghan stations is 12 (grass, endive, field bindweed, *Dactylis glomerata*, kochia, red deadnettle, melilot, catnip, wild garlic, sisymbrium and wild oat grass). Number of similar species that are common to the three stations were determined as 7 (grass, field bindweed, kochia, melilot, catnip, wild oat grass, gand flower and wild garlic) (Table 4).

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