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MUHAMMED İSMAİL VAROL

FARUK KUTBAY

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Investigation of Seasonal Sex Changes and Young Activities in Wolf and Ground Spiders (Araneae: Lycosidae, Gnaphosidae)

Muhammed İsmail VAROL, Faruk KUTBAY
University of Gaziantep, Sciences and Letter Faculty, Department of Biology, 27310
Gaziantep - TURKEY

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Abstract: Seasonal activities of wolf spiders (Lycosidae) and ground spiders (Gnaphosidae) were studied in a meadow in Van between 30.11.1993 and 27.11.1994. Nineteen species belonging to 4 genera in Lycosidae and 11 species belonging to 6 genera in Gnaphosidae were identified by using pitfall traps. It was observed that male and female lycosids were active from February to July, subadult lycosids were active from May to July, female gnaphosids were active from March to October, male gnaphosids were active from February to October and subadult gnaphosids were active from February to November. In Lycosidae, adults comprised 31% of the population, the male to female ratio was 1:1.30, and the adult to subadult ratio was 1:0.46. In Gnaphosidae, adults comprised 51% of the population, the male to female ratio was 1:1.33, and the adult to subadult ratio was 1:1.03.

Key Words: Spider, Lycosidae, Gnaphosidae, seasonal activity

Kurt ve Yer Örümceklerinde (Araneae: Lycosidae, Gnaphosidae) Mevsimsel Eşey Değişimi ve Yavru Aktivitelerinin İncelenmesi

Özet: Bu araştırma 30.11.1993-27.11.1994 döneminde Van'da çayırlık bir alanda yürütülmüş, araştırmada kurt örümcekler (Lycosidae) ve düz karınlı örümceklerin (Gnaphosidae) mevsimsel aktivitesi çalışılmıştır. Araştırmada çukur tuzaklar kullanılarak Lycosidae familyasında 4 cinsten 19 tür ve Gnaphosidae familyasında 6 cinsten 11 tür teşhis edilmiştir. Lycosidae'de erkek ve dişilerin şubat-temmuz, yavruların mayıs-temmuz; Gnaphosidae'de ise dişilerin mart-ekim, erkeklerin şubat-ekim ve yavruların şubat-kasım dönemlerinde aktif oldukları gözlenmiştir. Likosidlerde ergin bulunma oranı % 31, erkek-dişi oranı 1:1,30, ergin-yavru oranı 1:0,46'dir. Gnafosidlerde ise ergin bulunma oranı % 51, erkek-dişi oranı 1:1,33, ergin-yavru oranı 1:1,03'dür.

Anahtar Sözcükler: Örümcek, Lycosidae, Gnaphosidae, mevsimsel aktivite

Introduction

Ecological and faunistic studies in agricultural areas indicate that spiders can be used as effective predators in biological control. Moreover, faunistic studies indicate that a large number of ground arthropods are spiders. Today, the feeding ecology of spiders and their importance in maintaining the natural balance, as well as their usability in the biocontrol of insects, are being widely studied in North American, European and Far East countries.

The first research into spiders in Turkey was carried out by Karol, who described 10 species and prepared the spider list of Turkey (Karol, 1967). Bayram and Allahverdi (1994) compared ground spiders in fields, forests and steppes according to their ecologies. Bayram et al. (1999) studied the fauna of spiders in a sainfoin field in Van, and they indicated that spiders play an important role in maintaining the natural balance because they feed on insects, and that spiders occupy the second place in the food chain. Bayram and Varol (2000) investigated the seasonal activity of ground living spiders using pitfall traps. Bayram (1996) studied seasonal occurrence in spider populations in Van. In Lycosidae and Gnaphosidae the spiders were most widespread within 13 families.

Spiders are important predators which can be used in biological control. It is necessary to study their life cycle in order to use them effectively. In addition, these studies will form a background for further faunistic and phenological studies. The aim of this study was to research annual sex changes and adult-subadult activities and to determine the time when male, female and subadult spiders reach the maximum levels in the population.

Materials and Methods

The research area, approximately 600 m^2, was in the Fidanlık area of the Yüzüncü Yıl University Campus (Van). There is a meteorology station in the research area with a compass rose, and thermometers of different heights and in containers to measure rainfall and snowfall. The research area was a meadow. The grass height was measured as 30 cm in May. Pasturing and harvesting were not being carried out in the area. *Agripiron intermediim, Bromus inermis, Lolium prenne, Festuca rubra* and rarely *Poa* sp. and *Agrotis* sp. groups exist in the area. Ten pitfall traps were set up in 2 rows every 5 m. The locations of the traps were changed weekly from December, 1993, to November, 1994. The average annual precipitation was 350-400 mm. Annual soil surface temperatures and the air temperatures are shown in Figure 1.

The research materials were ground living spiders. Hard plastic lipped containers 11 cm in height and with a 7 cm mouth diameter were used as traps. These were buried in holes dug in the soil and filled with antifreeze up to 3 cm. Their surfaces were covered with large porous woven wire lids 20 x 20 cm in size. Antifreeze was used as protecting and killing solution, and the woven wire was used to prevent damage by moles, voles, birds, leaves, trash etc. to the traps. Woven wires were fixed to the ground by 2 nails. The investigation materials were collected weekly and taken to the laboratory in labelled containers in 70% alcohol. Firstly, insects, myriapods, annelids, molluscs and other arachnids were distinguished. Spiders were identified by using Spinnen von Mitteleuropas (Heimer and Nentwig, 1991), Spiders of Great Britain and Northern Europe (Roberts, 1995), and Identification Key to Spiders of the European USSR (Tyschchenko, 1971). In this work a total of 2891 spiders were studied.

Findings and Discussion

Family lists and percentages of the spiders which were captured by using pitfall traps in the study area from December, 1993, to December, 1994, are shown in Table 1.

Table 1. Numbers and percentages of the captured samples by family.

Family	Specimen number	%
Lycosidae	1322	45,73
Gnaphosidae	868	30,02
Salticidae	181	6,26
Thomisidae	141	4,88
Theridiidae	83	2,87
Philodromidae	69	2,39
Linyphiidae	69	2,39
Amaurobiidae	53	1,83
Araneidae	40	1,38
Agelenidae	23	0,80
Liocranidae	18	0,62
Clubionidae	10	0,35
Tetragnathidae	8	0,28
Zodaridae	3	0,10
Nesticidae	2	0,07
Anyphaenidae	1	0,03
Total	2891	100

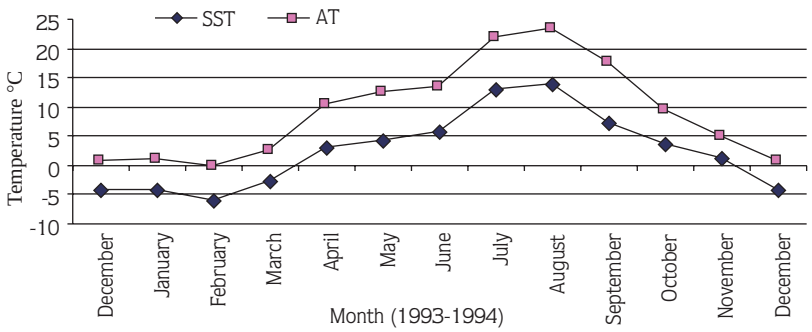

Figure 1. Annual temperature changes (SST: Soil surface temperature, AT: Air temperature).

Species belonging to Lycosidae and Gnaphosidae were captured more than any others. Other species comprised 24% of those caught. Therefore, only the family Lycosidae and the family Gnaphosidae were studied. The species identified in the study were in Lycosidae: *Pardosa agrestis* (Westring), *P. amentata* (Clerck), *P. ferruginea* (L.Koch), *P. hortensis* (Thorell), *P. lugubris* (Walckenaer), *P. monticola* (Clerck), *P. nigriceps* (Thorell), *P. paludicola* (Clerck), *P. proxima* (C.L.Koch), *Alopecosa accentuata* (Latreille), *A. cursor* (Hahn), *A. cuneata* (Clerck), *A. fabrilis* (Clerck), *A. solitaria* (Herman), *Arctosa fulvolineata* (Lucas), *A. cinera* (Fabricius), *A. leopardus* (Sundevall), *Trochosa ruricola* (Degeer), and *T. terricola* Thorell; in Gnaphosidae: *Zelotes electus* (C. L. Koch), *Z. latreillei* (Simon), *Z. lutetianus* (L.Koch), *Z. longipes* (L.Koch), *Drassodes lapidosus* (Walckenaer), *D. pubescens* (Thorell), *D. signifer* (C. L. Koch), *Micaria albovittata* (Lucas 1846), *Haplodrassus dalmatensis* (L. Koch), *Scotophaeus* sp., and *Gnaphosa* sp.

The numbers of males and females caught by month are shown in Table 2. Ground spiders live for 2 or 3 years. While tarantulas in tropical areas can live up to 20 years, lycosids generally live for 2 years. Species which live for only 1 year have to ovulate in summer. Newly hatched spiderlings moult 6-8 times and then turn into adults. Spring and summer are the mating and reproducing seasons for ground spiders. These spiders are subadults for the first year and turn into adults in the second year.

As Figure 2 reveals, adult populations show an increase in the period between February and July. However, they are stable in the other months. The decrease in the subadult population and the increase in the adult population between March and April indicate that the subadults from the previous year become adult in these months. In Lycosidae, adults comprised 31% of the population and the adult to subadult ratio was 1:0.47.

The decrease in the adult population between May and July was related to males having short lives or being eaten by females after mating and also to the natural deaths of females. A sharp increase was observed in the subadult population between May and July, which indicates that the spiderlings hatched from eggs laid before May. The subadult population decreased due to the effects of predators and the environment. It is clear from the data that adults were active from March to July and subadults were active from May to September.

Table 2. Numbers of subadult, male and female ground living spiders by month.

	Lycosidae				Gnaphosidae			
	Sub-adult	Adult			Sub-adult	Adult		
		Male	Female	Adult Total		Male	Female	Adult Total
December 1993	3	0	2	2	8	3	2	5
January 1994	17	3	4	7	7	0	1	1
February 1994	10	0	2	2	21	1	5	6
March 1994	31	24	6	30	41	15	5	20
April 1994	16	46	12	58	27	51	32	83
May 1994	13	79	35	114	24	50	40	90
June 1994	547	30	47	77	43	41	41	82
July 1994	42	11	18	29	106	58	22	80
August 1994	113	15	19	34	44	19	15	34
September1994	79	12	15	27	49	8	13	21
October 1994	19	8	13	21	40	4	9	13
November 1994	18	6	7	13	18	3	2	5
Total	908	234	180	414	428	253	187	440

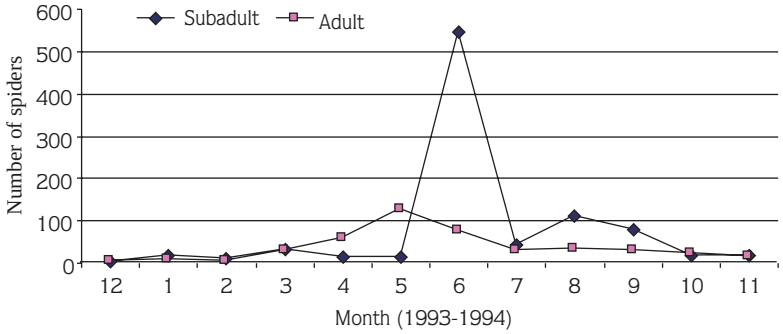

Figure 2. Annual activity of subadult and adult spiders in Lycosidae.

As Figure 3 reveals, male and female lycosids came out of hibernation in February. The number of males was greater than that of females in this family, and the male to female ratio was 1:1.30. The number of males increased in May, and the number of females increased in June. It is clear from the figure that the number of males decreased rapidly from May to June, although the number of females increased rapidly. This supports the assumption that most of the male population were eaten by females. It was observed that female and male spiders were active from February to October.

As Figure 4 reveals, adult populations reached their highest levels between March and July and decreased between August and November. The increase in the numbers of subadults between January and February indicates that species came out of hibernation within this period. The decrease in the numbers of subadults between March and April indicates that the subadults had matured. The sharp increase between June and July indicates that spiderlings hatched within this period. Adults were active from March to July and subadults were active from February to October. In Gnaphosidae, adults comprised 51% of the population and the adult to subadult ratio was 1:1.03.

It is clear from Figure 5 that the males came out of hibernation in February, but that females came out in March when the fluctuations in sex changes of the spiders in Gnaphosidae are evaluated. Decreases occurred in the female population between March and June, but occurred in the male population between February and July. The absence of a decrease in the male population in June, when the female population reached its highest level supports the assumption that females did not prefer males as prey after mating in Gnaphosidae. The number of males was greater than that of females in this family. The male to female ratio was 1:1.33.

Decreases occurred in the male population after July and in the female population after June because of the natural deaths in both populations. The males were active from February to September and the females were active from March to September.

Lycosids (46%) and gnaphosids (30%) were captured more than any other species and they formed the research groups. In Lycosidae, adults comprised 31% of the population, the male to female ratio was 1:1.30 and the adult to subadult ratio was 1:0.46. In Gnaphosidae, adults comprised 51% of the population, the male to female ratio was 1:1.33 and the adult to subadult ratio was 1:1.03.

Nineteen species belonging to 4 genera in Lycosidae, and 11 species belonging to 6 genera in Gnaphosidae (a total of 30 species) were identified. There were no new records for the region.

It was determined that the periods between February and July for adult lycosids, between May and July for subadult lycosids, between February and October for adult gnaphosids and between February and November for subadult gnaphosids were the highest activity periods. It was observed that both males and females were active from February to October in Lycosidae, that males were active from February to September, and females were active from March to September in Gnaphosidae.

When the climatic data between March and October were considered, it was determined that the air temperature averages varied between 5 °C and 24 °C. It was also observed that the subadult spiders prepare themselves for winter in July and August, which are the

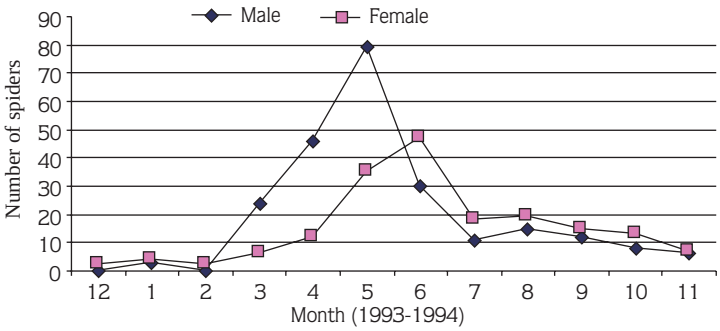

Figure 3. Annual sex changes in Lycosidae.

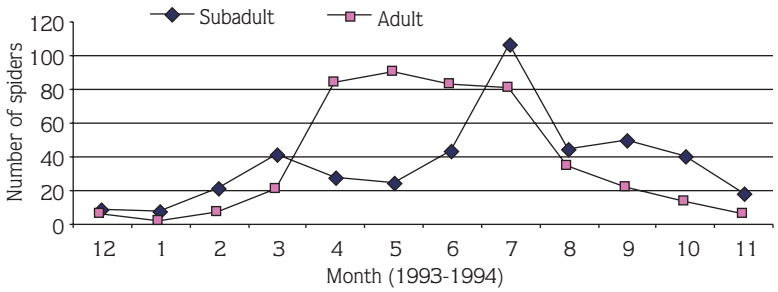

Figure 4. Annual activity of adults and subadults in Gnaphosidae.

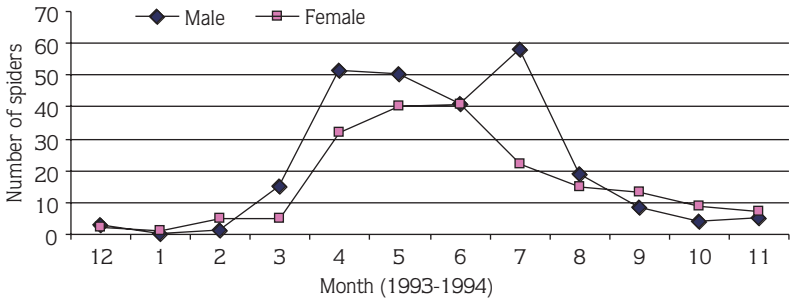

Figure 5. Annual sex changes in Gnaphosidae.

warmest months in the area, and also in September when the vegetation withers. In addition, natural deaths occur after mating in these months. This behavior indicates that spiders use these periods successfully when the climatic factors are optimal.

Pitfall traps are useful for researching the seasonal sex changes and young activities of ground-dwelling spiders.

Lycosidae were established as the dominant family, but Gnaphosidae were the dominant family when only the adults are considered, although Lycosidae were the dominant family when only subadults are considered. The mature-immature and the female-male ratios are consistent with the findings of Duffey (1996), Grastrom (1973), Holender (1971), Bayram and Luff. (1993) and Bayram (1996).

The level of subadult spiders was 61% in the study carried out by Bayram (1996) in the period from March to July. In the present study, the level of subadult spiders was 57.25% in the same period. These 2 results are compatible. In the study carried out by Bayram (1996), adults were first seen at the end of April and subadults after March 27, but the activities of the former could not be observed because the study began in March. In the

present study, adult lycosids were first seen on March 1 and gnaphosids on February 15. Subadult lycosids were first seen on March 1 and subadult gnaphosids on February 1 in this study. These results indicate that gnaphosids emerge from hibernation before lycosids.

Between February and June, the most abundant species belonged to lycosids and gnaphosids according to the study carried out by Bayram and Varol (2000). The increase in the spider population at the beginning of March is parallel to the increase in air temperature. There was an increase in the number of spiderlings in May. These were the first offspring of the individuals which mated in April and May. These results agree with the earlier data. The number of males was greater than that of females until June, after which the number of females was greater. The results in the present study were the same for lycosids until June and for gnaphosids until August. The number of males is greater until a specific time because they look for females in this period. After the copulation period the level of males decreases. This indicates that the end of the copulation period is the turning point in the male-female ratio (Hollander, 1971).

The changes in air temperatures may have caused the fluctuations in the adult-subadult and male-female populations. The increase in air temperature in June and the decrease in August and September support this assumption.

The sharp increase in the population of subadult lycosids between June and August and in the population of the subadult gnaphosids in July indicates that the spiderlings emerged from their cocoons between June and August.

There were only a few active spiders in winter. However, the traps were not adequate to determine these species. These could be studied more effectively by using aspirators and funnels in grass heaps or lumber stacks.

Identifications were performed based on genital structures. Therefore young spiders were studied at the family level. Identification at genera and species levels may be carried out in order to expand the scope of this study.

The same area was studied on 30.11.1993-01.03.1994 (Bayram and Varol, 2000) and on 23.02.1994-29.06.1994 (Varol and Bayram, 1995). This research, between 03.07.1994 and 27.11.1994, added to the 2 previous study periods, gives a total of 1 year in which seasonal sex changes and activities of young wolf and ground spiders were studied.

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