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A STUDY OF THE EFFECTS OF FIRES ON THE POPULATIONS OF THE GREEN LIZARD *Lacerta viridis* (Laurenti, 1768) IN EASTERN RHODOPES

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Abstract: Due to the high intensity of the fires occurred in the Eastern Rhodopes (South-east Bulgaria) in the period of 2000-2004 large parts of the habitats of the green lizard (*Lacerta viridis*) were damaged. In the current study data concerning the effects, the dynamics and the rates of restoration of the populations of the green lizard due to fires is presented. The blaze destroys a considerable amount of the individuals. During the first year of our study in the burned area the average density (D) was 13,74 specimens per ha and in the samples area D was 57,02 specimens per ha or presented in percentage - 19,42% against 80,58%. Despite the inflicted damage the populations of the green lizard are recovering considerably rapidly in the studied regions. An equilibrium of the average densities was established in the third year after the fire (they were statistically insignificant - p=0.79), the average density at the fire site was D=53,74 specimens per ha and at the samples site it was D=60,01 specimens per ha. The reasons of this are complex: a considerably large amount of the sexually mature animals actually survive the fire using shelters; there are individuals migrating from the burned site to the samples site and vice versa; the populations of the studied species are with high density in the areas around the fire site and etc.

Key words: *Lacerta viridis,* Reptilia, fires, burned area, population dynamics, Eastern Rhodopes, South Bulgaria

INTRODUCTION

The effects of fires on the lizard populations are complex. The blaze can destroy a big amount of the animals in large territories (ELBING, 2000). The influence of fires on the vertebrate fauna can be viewed as direct destruction of animals (TEVIS, 1956; ERWIN & STASIAK, 1979; STUBBS ET AL., 1985; BRAITHWAITE, 1987; CHEYLAN & POITEVIN, 1998; HAILY, 2000) and as indirect destruction or change of the habitat (HOWARD ET AL., 1959; VOGL, 1973; CORBETT, 1989; HAILEY, 2000; STUMPEL, 2004).

The common species are suitable object for studying the effects of fires on the animal populations, such as, for example, some lizard species (BRAITHWAITE, 1987). The green lizard (*Lacerta viridis* Laurenti, 1768) is the most common lizard in Bulgaria, inhabiting various habitats. Almost everywhere in the country the species' populations are dense and numerous (BESHKOV & NANEV, 2002), which makes it suitable indicator species for studying the influence of fires on the herpetofauna in short-term study.

In the European herpetological literature there are only few papers discussing the influence of fires on the populations of the green lizard (MERTENS & SCHNURRE, 1949; PETERS, 1970; ELBING, 2000) and currently there isn't any data on the subject from Bulgaria.

The aim of the current study is to trace the dynamics and the rates of restoration of the populations of the green lizard *Lacerta viridis* (Laurenti, 1768) under the influence of fires in the Eastern Rhodopes Mts.

MATERIAL AND METHODS

For tracing the rates of restoration of the green lizard's populations we chose two fire sites of different age: the fire site at Gorno Bryastovo Village occurred 8 years before the current study (06.08.1996) and the fire site at Kolets Village, occurred a year before the current study (30.08.2003) with adjacent samples sites.

The studied territories are located in Haskovo district and are part of the northwestern part of the Eastern Rhodopes Mts. (fig. 1). The fire sites are near the following settlements – Kolets Village, with coordinates[1] N41 51.930 E25 20.995,400 m a.s.l. and Gorno Bryastovo Village, with coordinates N41.93201 E25.28807,425 m a.s.l. The straight line distance between the two villages is 9.01 km. The studied fire sites at Gorno Bryastovo Village and Kolets Village (burned area/samples area) are with south-east exposure.

The fire site at Kolets Village occurred in 2003 and covered area of 3521 decares. The vegetation in the region is presented with communities of *Paliurus spina-christi, Cornus mas, Quercus cerris, Quercus frainetto, Fraxinus ornus* and

[1] The coordinates are given in WGS 84 geographic system.

Carpinus orientalis. A territory near the fire site with similar vegetation and geographic exposure was chosen for a samples site.

The fire site at Gorno Bryastovo Village occurred in 1996 and covered area of 381 decares. The vegetation in the region is presented with communities of *Paliurus spina-christi, Cornus mas, Quercus cerris, Quercus frainetto, Fraxinus ornus* and *Carpinus orientalis.* A territory near the fire site with similar vegetation and geographic exposure was chosen for a samples site.

The studied areas were visited for a period of three years – from 2004 to 2006 between March to October. For each established specimen we recorded data about the date and the place of observation; surrounding vegetation; approximate altitude and specimens' sex. Based on the body size and the coloration (visually and by capturing) we established three age groups: adult (male and female), subadult and juvenile.

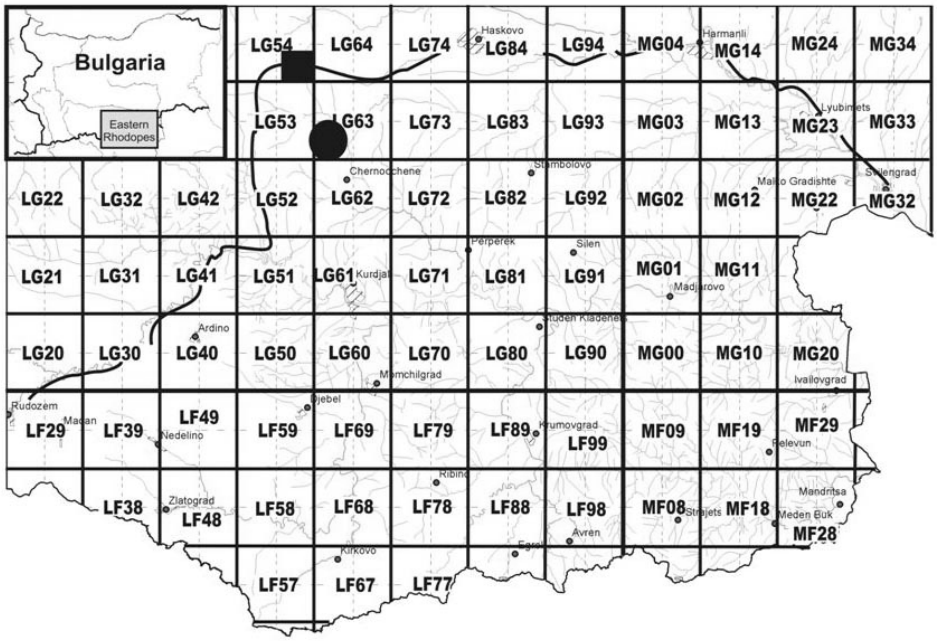

Figure 1. *Map of the studied areas.*
Legend: ■ - Gorno Bryastovo Village; ● - Kolets Village.

For calculating the average density of the populations we used a line transect method (SUTHERLAND, 2000). The width of the line transect was fixed at 5 m (2.5 m for each side from the medial line of observation). The average density was calculated for specimens per 1 ha using the following formula:

$$D = \frac{n}{2rl} \times 10000 \qquad (1)$$

where: **D** – average density in number of specimens per 1 ha; **n** – number of observed specimens; **r** – the distance to the observed object from the medial line; **l** – the length of the transect line. The length of the line transect was measured by means of GPS receiver.

The statistical processing of the data was done using computer software "Statistica for Windows, Release 5.1" (StatSoft Inc., 1996), using descriptive statistics, including the minimal, maximal and the mean values and standard deviation. The data was compared using t-test for independent samples, where for statistically significant results we considered those with $p<0.05$ [α=5%].

RESULTS

Fire site at Kolets Village

The comparison of the mean values of the average density of all age groups in 2004 and 2005, showed a distinguishable higher values at the samples site towards the burned site with a tendency of equilibrium in 2006 (fig. 2, 3).

The t-test of the gathered data showed that for 2004 and 2005 there aren't any statistical significant differences between the mean value of the number of specimens in the samples site and the burned territory (respectively p=0,01 and p=0,02). For 2006 there are differences in the average density in favor of the samples site, but they are not statistically significant (p=0,79) (Table 1). The adult and the juvenile specimens from the samples area showed statistically significant higher average density towards those from the burned area only in 2004, while the differences in 2005 and 2006 are not statistically significant. The sub-adult specimens showed statistically significant higher average density in the samples area towards the burned area only in 2005 (p=0,04).

Table 1. *Descriptive statistics data and t-test for independent samples for the area of Kolets Village, burned area/samples area.*

Legend: A – adult; S – sub-adult; J – juvenile; T – total sum of all ages for one year; * - p<0,05 [α=5%]

Burned area					Samples area					p
Age groups	**Mean**	**Min.**	**Max.**	**Std.Dev.**	**Age groups**	**Mean**	**Min.**	**Max.**	**Std.Dev.**	
A, 2004	10,84	1,75	32,52	10,00	**A, 2004**	27,40	4,42	107,61	29,30	0,02*
S, 2004	2,40	0,29	5,41	1,87	**S, 2004**	5,87	1,33	11,98	4,06	0,13
J, 2004	2,20	0,45	6,82	2,04	**J, 2004**	27,89	4,96	112,40	33,25	0,04*
T, 2004	13,74	1,75	41,12	12,55	**T, 2004**	57,02	6,40	231,50	64,06	0,01*
A, 2005	13,76	4,22	40,10	11,11	**A, 2005**	21,22	7,12	60,00	16,62	0,11
S, 2005	2,55	0,89	5,80	1,64	**S, 2005**	6,45	1,79	19,00	5,52	0,04*
J, 2005	12,19	2,07	32,91	9,70	**J, 2005**	18,59	7,55	46,00	12,16	0,23
T, 2005	28,50	10,34	77,63	20,46	**T, 2005**	46,27	19,80	113,82	30,54	0,02*
A, 2006	22,63	3,75	74,78	21,78	**A, 2006**	24,86	7,92	82,50	22,69	0,84
S, 2006	3,48	0,94	8,53	2,51	**S, 2006**	5,67	0,00	13,59	4,33	0,23
J, 2006	27,63	5,91	81,10	24,74	**J, 2006**	29,48	5,79	90,81	27,45	0,89
T, 2006	53,74	24,37	164,41	45,80	**T, 2006**	60,01	23,03	186,90	49,69	0,79

Comparing the average density of each age group annually in the burned area at Kolets Village, the t-test showed statistically significant differences only for the juvenile specimens in 2004 towards 2005 and 2006 (p=0,01). The adult and sub-adult

specimens increased their average density for the three-year period (fig. 2), but they didn't show statistically significant differences for the three-year period (Table 2).

Table 2. *Data from the t-test for each age group for the three-year period of the burned area at Kolets Village.*
Legend: * - p<0,05 [α=5%]

Age groups	Group 1/Group 2	Mean Group 1	Mean Group 2	Std.Dev. Group 1	Std.Dev. Group 2	p
Adults	2004 / 2005	10,84	13,76	10,00	11,11	0,54
	2004 / 2006	10,84	23,19	10,00	20,44	0,09
	2005 / 2006	13,76	23,19	11,11	20,44	0,24
Sub-adults	2004 / 2005	2,40	2,55	1,87	1,64	0,87
	2004 / 2006	2,40	4,18	1,87	3,16	0,24
	2005 / 2006	2,55	4,18	1,64	3,16	0,19
Juveniles	2004 / 2005	2,20	12,19	2,04	9,70	0,01*
	2004 / 2006	2,20	26,32	2,04	23,48	0,01*
	2005 / 2006	12,19	26,32	9,70	23,48	0,11

Burned site at Gorno Bryastovo Village

The descriptive analysis of the mean values of the average density of all age groups between the samples site and the burned site during the three-year period showed close values (fig. 4, 5).

The t-test for all age groups in the samples area compared with the burned area for the three-year study period showed no statistically significant differences (Table3).

Table 3. *Descriptive statistics data and t-test for independent samples for the area of Gorno Bryastovo Village, burned area/samples area.*

Legend: A – adult; S – sub-adult; J – juvenile; T – total sum of all ages for one year;

Burned area					Samples area					p
Age groups	Mean	Min.	Max.	Std.Dev.	Age groups	Mean	Min.	Max.	Std.Dev.	
A, 2004	19,58	6,03	30,64	12,49	**A, 2004**	20,15	5,28	30,70	13,25	0,96
S, 2004	6,29	1,01	11,28	5,14	**S, 2004**	6,13	2,11	8,16	3,48	0,97
J, 2004	17,59	13,73	24,95	6,38	**J, 2004**	19,07	14,45	25,85	6,00	0,78
T, 2004	43,46	21,13	62,16	20,75	**T, 2004**	45,35	24,29	58,49	18,43	0,91
A, 2005	16,56	7,60	23,46	8,13	**A, 2005**	18,30	7,77	26,74	9,66	0,82
S, 2005	5,63	0,01	9,85	5,07	**S, 2005**	6,38	0,01	11,65	5,90	0,88
J, 2005	23,20	19,71	28,15	4,41	**J, 2005**	23,42	21,39	25,56	2,09	0,94
T, 2005	45,39	29,35	58,65	14,85	**T, 2005**	48,09	33,34	55,60	12,77	0,82
A, 2006	18,01	4,89	26,97	11,61	**A, 2006**	18,84	6,51	27,17	10,90	0,93
S, 2006	5,25	0,98	7,89	3,73	**S, 2006**	4,48	0,93	6,79	3,12	0,80
J, 2006	22,07	14,34	27,49	6,87	**J, 2006**	25,36	12,86	36,24	11,77	0,70
T, 2006	49,07	30,26	66,09	17,98	**T, 2006**	48,68	34,42	70,20	18,96	0,98

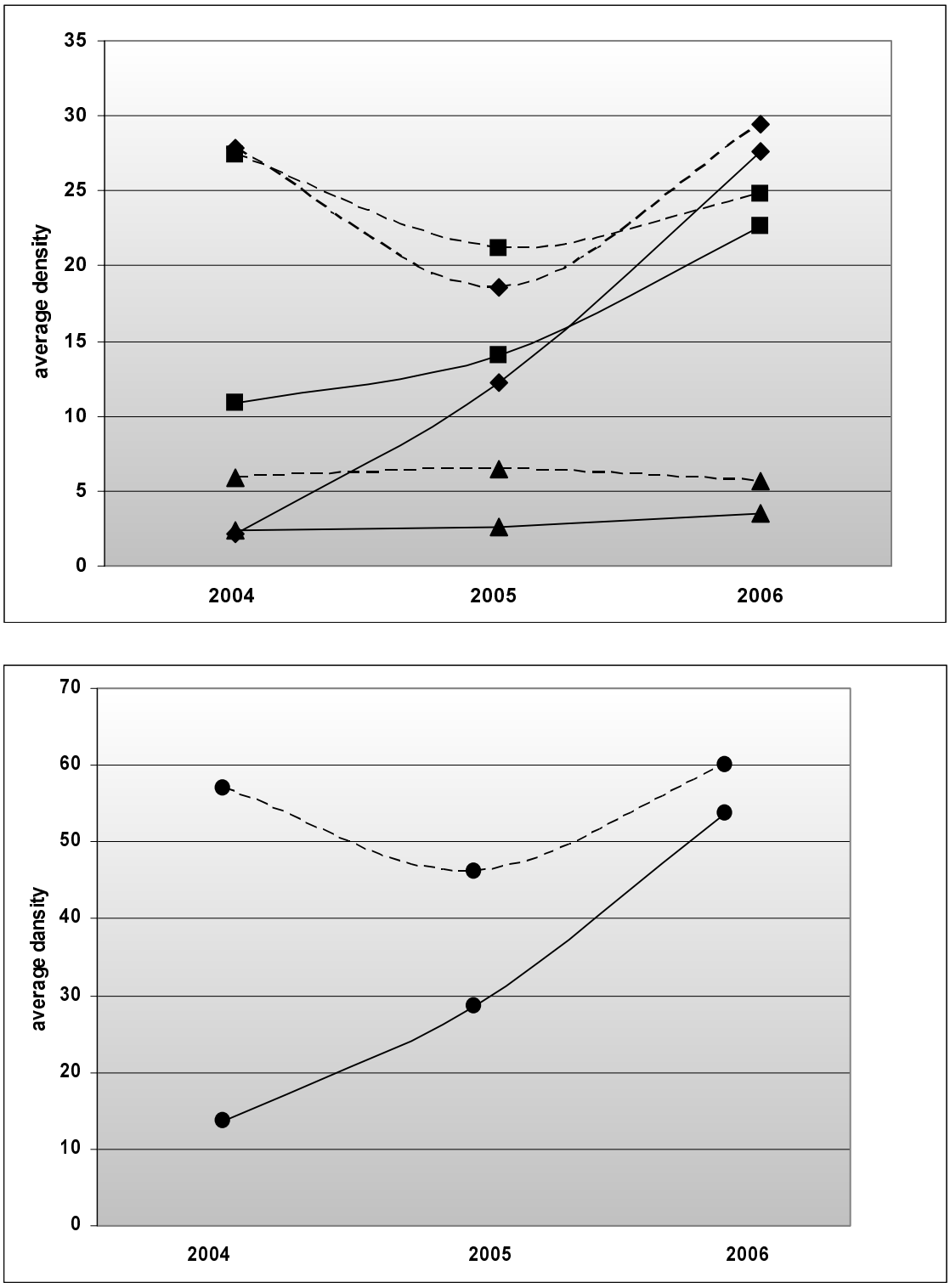

Figure 2. *Average density of the green lizard (Lacerta viridis) populations presented annually in the burned area and the samples area at Kolets Village.*

Legend: ■ - adult; ▲- sub-adult; ◆ - juvenile;
● - total; —— burned area; – – – samples area.

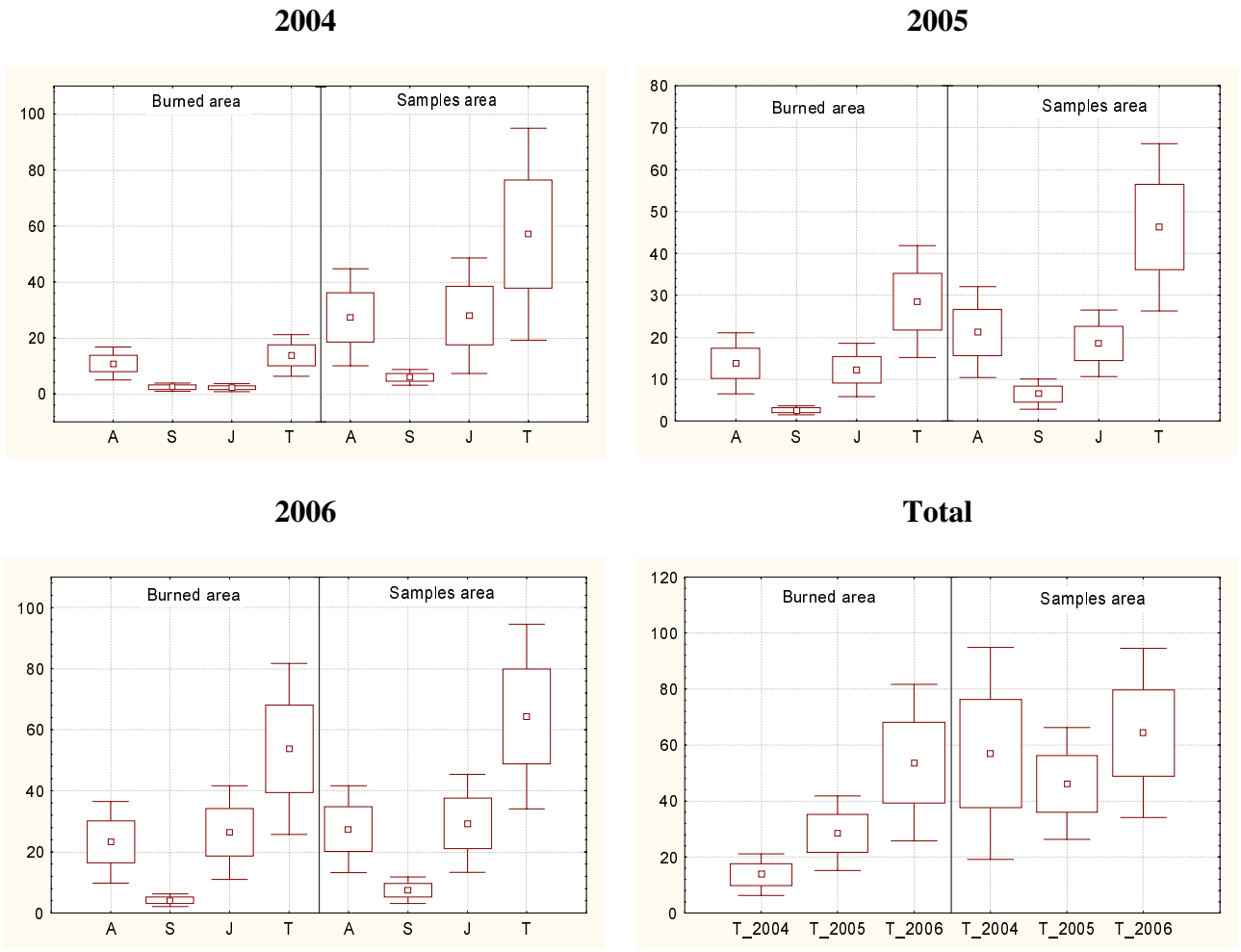

Figure 3. *Average density by age groups presented annually in the burned area and the samples area at Kolets Village.*

Legend: A – adult; S – sub-adult; J – juvenile; T – total sum of all ages for one year; ±1.96*Std.Dev. ±1.00*Std.Err. Mean;

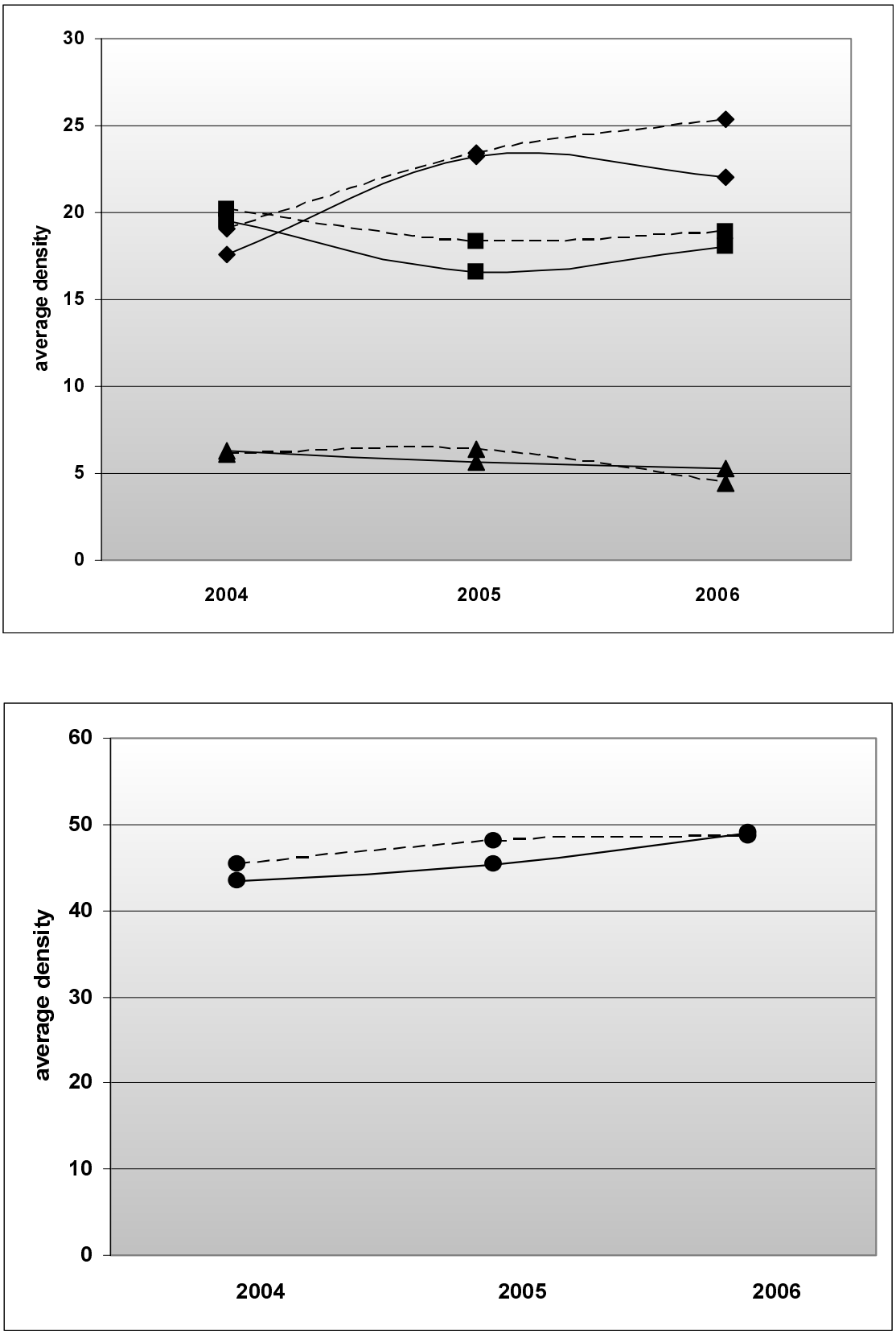

Figure 4. *Average density of the green lizard (Lacerta viridis) populations presented annually in the burned area and the samples area at Gorno Bryastovo Village.*

Legend: ■ - adult; ▲ – sub-adult; ◆ - juvenile;
● - total; —— burned area; – – – samples area.

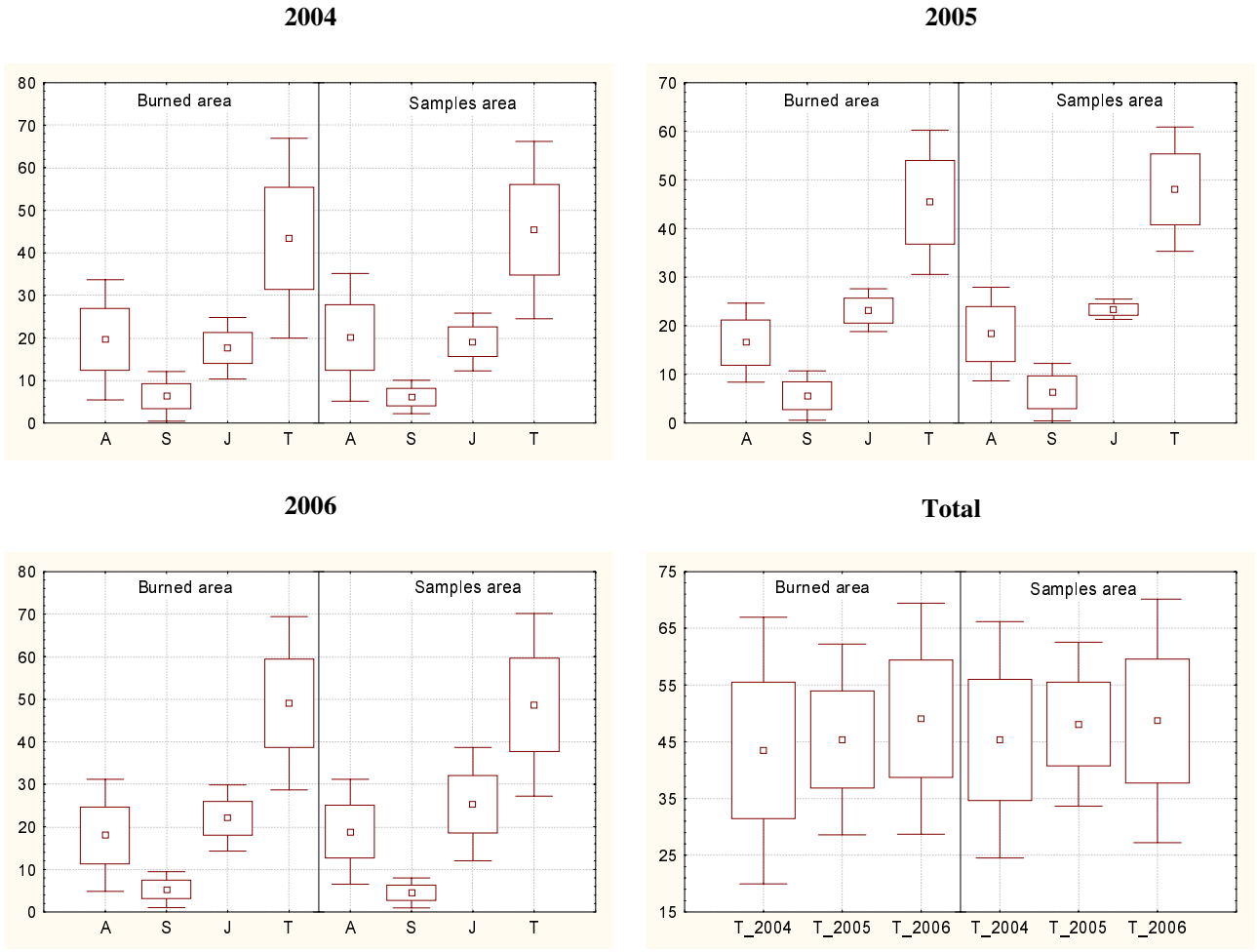

Figure 5. *Average density by age groups presented annually in the burned area and the samples area at Gorno Bryastovo Village.*

Legend: A – adult; S – sub-adult; J – juvenile; T – total sum of all ages for one year; ±1.96*Std.Dev. ±1.00*Std.Err. Mean;

DISCUSSION

Some animals show greater mortality caused by fires, which is due to some aspects of their biology (ERWIN & STASIAK, 1979). Different studies show that some reptiles depending of the habitat structure, the season and the day hour, the fire intensity and its duration are capable of surviving (KAHN, 1960; VOGL, 1973; ERWIN & STASIAK, 1979).

Our study showed that fires influence negatively the populations of the green lizard (*Lacerta viridis*). A proof of this claim is the big differences in the average density of the populations form the samples site compared with those from the burned area during the first two years after the fire at Kolets Village. During the first year after the fire the adult specimens predominated over the juvenile (D=10,84 spec. per ha). This is probably due to the fact that part of the adults escape the fire by moving

into the neighbor unburned territories. A similar tendency was established by KAHN (1960) for *Sceloporus occidentilis* in the USA. Another part of the lizards survived the fire using various shelters. Damp places are used for safe shelters, as well as the space under big rocks, deep burrows, made by small mammals, which are present in abundant amounts (KAHN, 1960; ELBING, 2000). An interesting fact is that during the fire the temperature of the substrate drops considerably with the depth. So when at the surface the temperature is 1000°C, at 3 cm below the surface it is no more than 100°C (KAHN, 1960; LAWRENCE, 1966; CHRISTENSEN, 1995). Similar results were presented by RUDOLPH ET AL. (1998) from the telemetric data for *Pituophis melanoleucus ruthveni*. Hidden in burrows at 15-20 cm in depth in the soil, the temperature there is less than 20°C and the animals survive the blaze above them. Our observations established that the green lizard uses as shelter the higher parts of the trees, but only in the cases where the fire is with low intensity. According to KAHN (1960) the young lizards are more vulnerable to the blaze because they use unsuitable and impermanent shelters. Probably due to this reason the average density of the juvenile and the sub-adult specimens during the first year in the burned area near Kolets Village is considerably lower than the average density of the adults and in comparison of that of the juvenile and the sub-adults in the samples area.

According to the same author the reproduction of the lizards seems unaffected seriously by the fires, which has been confirmed in our study as well. The average density of the juvenile lizards during the second year of the fire at Kolets Village is considerably higher than the first year (p=0,01; Table 2), which means that the lizards are reproducing normally.

In the studied territory by ELBING (2000), located near Brandenburg (Germany), the fire had destroyed the green lizard's population there at 100% and one year later the author observed recolonization only by one specimen at the same site. Our study, however, didn't confirm this data. During the first year after the fire at Kolets Village the average density of all age groups was 13,74 specimens per ha, which is 19,42% compared the samples site (80,58%) and forms a correlation 0,24 : 1. This confirms the fact that one large part of the individuals succeed to survive.

For the restoration of the density of populations of the green lizard in the burned areas of great importance is the migration of specimens from the neighbor unburned areas (ELBING, 2000). Our observations established moving of specimens at the border between the fire site and the samples site. The rates of restoration of the populations in the burned territories are favored by the fact that the neighbor unburned areas are densely inhabited by green lizards.

The average density of the populations of the green lizard is restoring considerably rapidly in the areas studied by us. This statement is supported by the established close values between the burned area and the samples area from the third year after the fire at Kolets Village and the absence of differences between the samples area and the burned area in the eight, ninth and the tenth year after the fire at Gorno Bryastovo Village. Similar results were established by ELBING (2000) for populations of the green lizard in Germany where the restoration processes took place with at lower rates. The equilibrium of the average densities between the fire site and

samples site was established at the fifth year after the fire. This is probably due to a complex of factors as well as the different geographic location of the studied territory.

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ПРОУЧВАНЕ ВЛИЯНИЕТО НА ПОЖАРИТЕ ВЪРХУ ПОПУЛАЦИИТЕ НА ЗЕЛЕНИЯ ГУЩЕР *Lacerta viridis* (Laurenti, 1768) В ИЗТОЧНИТЕ РОДОПИ

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(Резюме)

Поради високата интензивност на пожарите в Източни Родопи в периода от 2000 г. до 2004 г. една голяма част от местообитанията на зеления гущер (*Lacerta viridis*) са увредени. В настоящата разработка са представени данни за влиянието, динамиката и темповете на възстановяване на популациите на зеления гущер след въздействие на пожарите. За изпълнение на поставените цели са подбрани два разновъзрастови пожара със сходна растителност и изложение: при с. Горно Брястово, горял 8 години преди настоящото изследване (06.08.1996 г.) и при с. Колец, горял една година преди нашето изследване (30.08.2003 г.) с прилежащи контроли. Териториите са посещавани последователно пролет, лято и есен в рамките на три години от 2004 до 2006 г.

Пламъците унищожават значителна част от индивидите. През първата година в опожарената територия средната плътност (D) е 13,74 екз. на ha а в контролата D=57,02 екз. на ha изразено в проценти 19,42% спрямо 80,58 %. Най-значими загуби претърпяват младите екземпляри, като през първата година след пожара D=2,20 екз. на ha (7,31%) при контролата D=27,89 екз. на ha (92,69%), наред с това средните плътности са и статистически различими (p=0,04).

Въпреки нанесените щети популациите на зеления гущер се възстановяват със сравнително бързи темпове в изследваните от нас райони. Изравняване на средните плътности започва да се наблюдава още при третата година (те не са статистически различими p=0.79), като при пожара D=53,74 екз. на ha а при контролата D=60,01 екз. на ha. Причините за това са комплексни: оцеляване на една не малка част от половозрелите екземпляри; предвижването на екземпляри пожар/контрола и обратно; високата плътност на изследвания вид в околните райони и др.