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POPULATION PARAMETERS OF SYNTOPIC POPULATION
OF THREE SPECIES OF *PODARCIS* IN THE SLOVENIAN ISTRRA
(REPTILIA, LACERTIDAE)

*PARAMETRI POPOLAZIONALI IN POPOLAZIONI SINTOPICHE
DI TRE SPECIE DI PODARCIS NELL'ISTRIA SLOVENA
(REPTILIA, LACERTIDAE)*

Abstract - During July and August 1996, a population of three syntopic lacertid lizards (*P. sicula campestris*, *P. melisellensis fiumana*, *P. muralis maculiventris*) in Lucija near Portorož (45°30' N, 13°36' E, up to 2 m a.s.l.) in Slovene Istra was studied. The total surface of the area is 4.8 ha. The aim of the study was to estimate the population size, population density and sex ratio of the lizards. The population size was calculated using the Petersen estimate index (Chapman's modification) and Triple catch method. The most numerous was *P. sicula campestris*, with density of 0.5 to 0.8 adults per 100 m². The population density of *P. melisellensis fiumana* was 0.13 adults per 100 m² and the density of *P. muralis maculiventris* was 0.06 adults per 100 m². The sex ratio was 1:1 in all three species.

Key words: *Podarcis sicula campestris*, *P. melisellensis fiumana*, *P. muralis maculiventris*, Population parameters, Slovenian Istra.

Riassunto breve - Tre specie di lucertole sintopiche (*P. sicula campestris*, *P. melisellensis fiumana*, *P. muralis maculiventris*) sono state studiate fra luglio e agosto 1996 in Lucija presso Portorož (45°30' N, 13°36' E, m 2 s.l.m.) nell'Istria Slovena. La superficie totale dell'area è di 4.8 ha. Scopo dello studio è stato rilevare la consistenza e la densità di popolazione e il rapporto fra i sessi delle lucertole. La consistenza delle popolazioni è stata calcolata con l'indice di Petersen (come modificato da Chapman) mediante il metodo di cattura di Triple. La più rappresentata è stata *P. sicula campestris*, con densità da 0.5 a 0.8 adulti per 100 m². La densità di popolazione di *P. melisellensis fiumana* è stata di 0.13 adulti per 100 m² e la densità di *P. muralis maculiventris* di 0.06 adulti per 100 m². Il rapporto fra i sessi è stato di 1:1 in tutte e tre le specie.

Parole chiave: *Podarcis sicula campestris*, *P. melisellensis fiumana*, *P. muralis maculiventris*, Parametri popolazionali, Istria Slovena.

Introduction

The Italian Wall Lizard, *Podarcis sicula* (RAFINESQUE - SCHMALTZ, 1810), is an opportunistic lizard (e.g. CAPULA, 1992; RAYNOR, 1989) occurring in peninsular Italy and along the Adriatic coast and several Adriatic islands (e.g. ARNOLD & BURTON, 1983; HENLE &



Fig. 1 - The location of study area (Lucija in Slovenia), scale 1:500.000.

- Localizzazione dell'area di studio (Lucija, Slovenia), scala 1:500.000.

KLAVER, 1986). The Dalmatian Wall Lizard, *Podarcis melisellensis* (BRAUN, 1877), is one of the endemic lizard species of Balkan peninsula (e.g. ARNOLD & BURTON, 1983; TIEDMANN & HENLE, 1986), while the Common Wall Lizard, *Podarcis muralis* (LAURENTI, 1768), is distributed over a wide area in central and southern Europe (e.g. ARNOLD & BURTON, 1983; GRUSCHWITZ & BÖHME, 1986). All three species may co-exist in the same locality, although *P. muralis* and *P. melisellensis* prefer more rocky habitats, especially dry-stone walls, in contrast to *P. sicula*, which prefers vegetated and open land (HENLE & KLAVER, 1986; RAYNOR, 1989).

Surveys of the demography of *Podarcis muralis* were undertaken by e.g. STRIJBOŠCH et al. (1980), BARBOULT & MOU (1986; 1988), ZIMMERMAN (1989), BENDER et al., (1996), BENDER (1997), SCHMIDT-LOSKE (1997), whereas quantitative research about *Podarcis sicula campestris* DE BETTA, 1857, *P. melisellensis fiumana* (WERNER, 1891) and *P. muralis maculiventris* (WERNER, 1891) is still very scarce (e.g. HENLE, 1988; MELLADO & OLMEDO, 1992).

The aim of this paper is to present data on population size, density and sex ratio, obtained using the mark-recapture method, of the *Podarcis sicula campestris*, *P. muralis maculiventris* and *P. melisellensis fiumana* populations of the coastal area in Slovenia.

Study area and methods

This study was carried out on an area with 4.8 ha surface, located in an urban area in Lucija near Portorož (45°30' N, 13°36' E, up to 2 m a.s.l.) on the Adriatic coast (fig. 1). The

habitat consists of an open area with some stones that are important night shelters for lizards (pers. obs.) and a grassy area, mainly on the edges. Some parts of area are partially covered with halophyte vegetation. The climate is typically submediterranean (GAMS, 1972). According to MARINČEK (1987) the area belongs to the submediterranean phytogeographical region.

The field research was carried out between July and August 1996. The lizards were caught by hand or noose and marked by "toe-clipping". Only the first link of the digit was removed. The sex of specimens was determined by their femoral pores (e.g. ARNOLD & BURTON, 1983).

In order to estimate the population size, a capture-recapture method was used. Petersen index (for closed populations), Triple catch and the Jolly-Seber stochastic method (for open populations) were used (e.g. DONNELLY & GUYER, 1994; GREENWOOD, 1996). Because of low capture and recapture rates only the Petersen estimate index - Chapman's modification was used for the estimation of population size of *P. muralis maculiventris* and *P. melisellensis fiumana*.

An index of predation pressure (SHALL & PIANKA, 1980; HENDERSON et al., 1981) was calculated on the basis of the observed frequency of tail regeneration.

All Chi-square test comparisons with 1 d.f. include Yates' correction. All statistic were investigated using SPSS 6.0 for Windows.

Results

During the research work, 95 adults of *Podarcis sicula campestris*, 31 adults of *P. melisellensis fiumana* and 21 adults of *P. muralis maculiventris* were caught, marked and released. Based on the frequency of tail regeneration (tab. I), the predation pressure was estimated to be high.

Podarcis sicula campestris

According to Triple catch method, the population consisted of 400 individuals (SE = 259.2), whereas, according to Jolly-Seber stochastic method, it consisted of 166 specimens (90 % CI 52-287). The survival rate was 0.81. According to the Petersen estimate index - Chapman's modification, the population consisted of 252 individuals (tab. II). The number of adult males of *P. sicula campestris* exceed that of adult females (apparent sex ratio = 1.17 : 1), but the difference was not statistically significant (Chi square test = 0.26, d.f. = 1, P > 0.05). The population density was up to 0.83 adults per 100 m² (tab. III).

Podarcis melisellensis fiumana

According to the Petersen estimate index - Chapman's modification, the population

Species	Nr	Nn	Chi square test
<i>P. sicula campestris</i>	25	70	P < 0.001
<i>P. melisellensis fiumana</i>	13	18	P > 0.05
<i>P. muralis maculiventris</i>	11	10	P > 0.05

Tab. I - The frequency of tail regeneration by *Podarcis sicula campestris*, *P. melisellensis fiumana* and *P. muralis maculiventris*. Nr - number of lizards with regenerated tails, Nn - number of lizards with intact tails.

- *Frequenza nella rigenerazione della coda in Podarcis sicula campestris, P. melisellensis fiumana e P. muralis maculiventris. Nr - numero di lucertole con la coda rigenerata; Nn - numero di lucertole con la coda intatta.*

Date	<i>P. sicula campestris</i>		<i>P. muralis maculiventris</i>		<i>P. melisellensis fiumana</i>	
	N	SE	N	SE	N	SE
10.08.	183	51	15	6	33	18
21.08.	320	114	43	23	87	35
Average	252	-	29	-	60	-

Tab. II - Population sizes of *Podarcis sicula campestris*, *P. melisellensis fiumana* and *P. muralis maculiventris* in Slovenian Istra estimated by Petersen estimate index - Chapman's modification. N = population size; SE = standard error.

- *Consistenza delle popolazioni di Podarcis sicula campestris, P. melisellensis fiumana e P. muralis maculiventris dell'Istria Slovena stimate con l'indice di Petersen, così come modificato da Chapman. N = consistenza di popolazione; SE = errore standard.*

Species	Petersen estimate index	Jolly-Seber method	Triple catch
<i>P. sicula campestris</i>	0.53	0.35	0.83
<i>P. melisellensis fiumana</i>	0.13	-	-
<i>P. muralis maculiventris</i>	0.06	-	-

Tab. III - Density (individuals per 100 m²) of *Podarcis sicula campestris*, *P. melisellensis fiumana* and *P. muralis maculiventris* in Slovenian Istra, estimated by mark-recapture methods.

- *Densità di popolazione (individui per 100 m²) di Podarcis sicula campestris, P. melisellensis fiumana e P. muralis maculiventris dell'Istria Slovena, calcolata mediante il metodo marcatura-ricattura.*

consisted of 60 adults (tab. II). The population density was 0.13 individuals per 100 m² (tab. III). The number of males of *P. melisellensis fiumana* exceed that of adult females (apparent sex ratio = 1.33 : 1), but the difference was not statistically significant (Chi square test = 0.52, d.f. = 1, P > 0.05).

Podarcis muralis maculiventris

According to the Petersen estimate index - Chapman's modification, the population consisted of 29 adults (tab. II), and the population density was 0.06 individuals per 100 m² (tab. III). The apparent sex ratio was 1.38 : 1 in favour of males of *P. muralis maculiventris*, but the difference was not statistically significant (Chi square test = 0.2, d.f. = 1, P > 0.05).

Discussion

The estimated population density of *P. sicula campestris* was much lower than that suggested by HENLE (1988) - tab. IV. I assume that the low density of all three species can be explained by several factors:

- the large study area. The general rule - the smaller is the habitat, the higher the bird density (e.g. SUHONNEN & JOKIMÄKI, 1988; LOMAN & SCANTZ, 1991; SOLONEN, 1996) seems to hold true also in lizards. Taking into account the results from TURNER (1977) and OUTBOTER (1981), our conclusions corroborate the findings of HENLE (1988). Nevertheless the density on large areas is much more realistic (see also ROBERTS, 1991).
- the northern range of the species. The region of Slovenian coast examined represents part of the northern border of *P. sicula*, as well for *P. melisellensis fiumana* (e.g. CORTI et al., 1997; TIEDMANN, 1997).
- the unsuitable habitat. *P. sicula* prefers the habitats with well developed vegetation, stones and ruins (e.g. OUTBOTER, 1981; HENLE & KLAVAR, 1986; RAYNOR, 1989; CAPULA, 1992). According to RAYNOR (1989) *P. melisellensis* shows a marked preference for stone walls, which are rare on my study area, in contrast to *P. sicula*, which is much more diverse in its choice of microhabitat.

Locality	Season	Density	Area (m ²)	Source
Figarola	Spring	27.9	265	HENLE, 1988
Figarola	August	32.8	265	HENLE, 1988
Rovinj	Spring	17.5	200	HENLE, 1988
Rovinj	August	18.0	200	HENLE, 1988
Omiš	Spring	63.6	195	HENLE, 1988
Omiš	August	69.7	295	HENLE, 1988
Lucija	August	0.5 - 0.8	48000	this work

Tab. IV - Density (individuals per 100 m²) of the population of *Podarcis sicula campestris* in Slovenian Istra, estimated by mark-recapture method, compared with density in some other localities. - *Densità di popolazione (individui per 100 m²) di Podarcis sicula campestris dell'Istria Slovena, calcolata mediante il metodo marcatura-ricattura, confrontata con la densità di alcune altre località.*

- the presence of the people and domestic animals (which may be functioning as predators) could be also a factor limiting the greater density of lizards in the study area (see also HENLE, 1988).

An additional reason for low densities of *P. muralis maculiventris* and *P. melisellensis fiumana* is probably also strong competition from *P. sicula campestris* (see HENLE & KLAVER, 1986; RAYNOR, 1989 and references therein). The index of predation pressure differs significantly between the three species (see tab. I). The lowest frequency of tail regeneration was observed among the specimens of *P. sicula campestris*, the largest and the most numerous species inhabiting the study area.

The sex ratio of *P. sicula campestris* does not differ significantly from 1 : 1, the same results obtained also by HENLE (1988).

The comparison among the average densities of *P. muralis* established by other authors in different localities (e.g. Germany: 0.5 specimens per 100 m² (JAHNKE et al., 1980), one specimen per 100 m² (HAESE, 1981; DEXEL, 1984), France: 5.3 to 5.6 specimens per 100 m² (BARBOULT & MOU, 1986, 1988) and Slovenia: up to 6 specimens per 100 m², VOGRIN, 1997) shows that the established density of *P. muralis maculiventris* is much lower. The sex ratio was similar to those observed in Germany (e.g. GÜNTHER et al., 1996; SCHMIDT-LOSKE, 1997) and in Slovenia (VOGRIN, 1997).

I have not found any data on population density of *P. melisellensis fiumana* in the literature (see also TIEDEMANN, 1997).

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