FACTORS AFFECTING HELMINTHS COMMUNITY STRUCTURE OF THE EGYPTIAN LIZARD *CHALCIDES OCELLATUS* (FORSKAL, 1775)

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Summary:

The variation in the component community structure of intestinal helminths in the lizard *Chalcides ocellatus* (Forskal, 1775) was studied in relation to the seasonal variation and host weight and sex. 120 lizards were collected seasonally during year 2004, from Al Firdan, Ismailia governorate, Egypt. The helminths community consisted of six species (five nematodes and one cestode). The various helminths differed according to host sex. The prevalence of total helminths infection was 67.6 % while the prevalences of *Thelandros schusteri*, *Pharyngodon mamillatus*, *Parapharyngodon bulbosus*, *Cosmocerca vrcibradici*, *Spauligodon petersi* and *Oochoristica maccoyi* were 43.4 %, 3.9 %, 13.2 %, 5.3 %, 6.6 %, and 14.3 %, respectively. The results showed that the season was the main factor affecting infracommunity species richness and parasite abundance. Moreover, there was interaction between season and host sex on abundance of *P. bulbosus*. The prevalence of intestinal helminths varied significantly in relation to host weight classes and sex in some species. Helminths abundance and intensity were independent from host sex. In addition, correlations were found between total helminths abundance and host weight. In conclusion, the helminths community of *C. ocellatus* was depauperate and the influence of the studied factors varied from species to another one. We cannot say if the low species richness and infection rates observed in the present study are typical of the host species or if they are due to characteristics of the study area, since no available data on parasite assemblages exist for other *C. ocellatus* populations.

KEY WORDS : helminth, parasite community, *Chalcides ocellatus*, sex, weight, season.

Résumé : FACTEURS INTERVENANT SUR LA COMPOSITION DE LA COMMUNAUTÉ DES HELMINTHES DU LÉZARD ÉGYPTIEN, *CHALCIDES OCELLATUS* (FORSKAL, 1775)

La variation de la composition de la communauté des helminthes qui parasitent le lézard Chalcides ocellatus *(Forskal, 1775) a été étudiée selon les saisons, le poids et le sexe de l'hôte. 120 lézards ont été collectés au cours de l'année 2004 à Al Firdan, gouvernorat d'Ismailia, en Égypte. Six espèces d'helminthes ont été observées (cinq nématodes et un cestode). La composition varie selon le sexe de l'hôte. La prévalence totale d'helminthose est de 67,6 % dont* Thelandros schusteri *(43,4 %),* Pharyngodon mamillatus *(3,9 %),* Parapharyngodon bulbosus *(13,2 %),* Cosmocerca vrcibradici *(5,3 %),* Spauligodon petersi *(6,6 %) and* Oochoristica maccoyi *(14,3 %). L'étude montre que la saison est le principal facteur influant sur la variété et l'abondance du parasitisme. De plus, on observe des interactions entre la saison, le sexe de l'hôte et l'abondance de* P. bulbosus. *La prévalence de plusieurs espèces de ces helminthes intestinales varie de façon significative en fonction du poids de l'hôte et de son sexe. L'intensité de l'infection est indépendante du sexe de l'hôte. Mais, des corrélations sont observées entre l'abondance totale d'helminthes et le poids de l'hôte. En définitive, la communauté helminthique de* C. ocellatus *est pauvre, et les facteurs étudiés ont une influence variable selon les espèces qui le parasitent. Et il n'est pas possible de dire si le nombre réduit d'espèces et les taux d'infestation observés dans la présente étude sont caractéristiques de l'hôtes, ou s'ils sont dus aux caractéristiques de la zone géographique, puisque aucune autre donnée de ce type n'existe pour d'autres populations de* C. ocellatus.

MOTS CLÉS : *helminthe, communauté de parasites,* Chalcides ocellatus, *sexe, poids, saison.*

INTRODUCTION

The community structure of vertebrate parasites is a subject that has attracted considerable interest in the last decade, resulting in the development of a conceptual framework for the hierarchical structure of parasite communities (Poulin, 1998). This has enabled hypotheses to be formulated about the key processes that regulate the composition and structure of parasite component communities (Esch *et al.*, 1990). Although fish, birds and mammals have been widely studied in this context, relatively little information is available on the characteristics of helminths communities in reptiles (Aho, 1990; Bush, 1990; Sharpilo *et al.*, 2001; Martin & Roca, 2004).

There are more than 400 species of reptiles occur in Egypt (Al-Shareef & Saber, 1995). Unfortunately, little attention has been given to their helminths community and few records exist in the literature. Those that do exist are mostly of a taxonomic nature. One of the most abundant and widespread reptile species in Africa and Egypt is the lizard *C. ocellatus* where its distribution is primarily attributed to its tolerance of diverse environments ranging from the steppe through agri-

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cultural fields to woodland habitats (Al-Shareef & Saber, 1995).

In this work, we aimed at studying the helminths infracommunity structure of the lizard *C. ocellatus* and the possible effects of the intrinsic factors (host sex and weight) and extrinsic factor (season) in structuring the infracommunity of intestinal parasites and in influencing both prevalence, abundance and intensity of each of the species involved.

MATERIALS AND METHODS

Our study site located in Al-Firdan area in north of Ismailia governorate, Egypt (northern latitude 30° 6', western longitude 32° 25'). 120 lizards *C. ocellatus* were collected seasonally during year 2004. The lizards were transported alive to the laboratory and then were euthanized, sexed and weighted. The samples were divided into four weight classes (Class 1: 5-10 g; Class 2: 11-15 g; Class 3: 16-20 g; Class 4: 21-40 g). The structure of the sampled host population by the season of captured and host sex is shown in Table I. Digestive tract of the host was examined for parasites using standard techniques and each helminth infracommunity was fully counted. All helminths were identified according to the morphological characters (Hering-Hangenbeck & Boomker, 1998; Hering-Hangenbeck *et al.*, 2002; Bursey & Goldberg, 2004). They were fixed in boiling 70 % ethanol. For detailed light microscopic studies, they were transferred to a 50 % lactophenol-water solution and examined while clearing.

Summary of statistics was presented as mean abundance and intensity ± SE of infection according to Bush *et al.* (1997). The degree of aggression of different species of parasites was calculated by the Index of dispersion (I = the variance to mean ratio) and the Index of discrepancy (D) as described by Poulin (1993): a value of 0 indicates an even distribution of accounts across all hosts, and a value of 1 indicates all parasites aggregated in a single host. Simpson diversity was used to express the biodiversity of helminthes community.

Season	Number of collected lizards		
	Total	Female	Male
Summer	34	22	12
Autumn	29	16	13
Winter	25	16	9
Spring	32	22	10
Total	120	76	44

Table I. – The structure of the sampled host population by the season of captured and host sex.

Testing of effects of both individual and interacted factors (sex and season) on infection was statistically analyzed using the General Linear Interactive Model (GLIM) after normalization of the data by log 10 ($\chi + 1$) transformation (Crawley, 1993; Wilson & Grenfell, 1997; Benhnke *et al.*, 1999). Comparisons of parasite intensity and abundance according to sex and weight were tested using Mann-Whitney test (U-test) and Kruskal Wallis respectively. Correlations between intensity and abundance of infection and weight were examined using the non-parametric, Spearman's rank correlation coefficients (r_s). All the statistical tests were performed by using the software packages SPSS 12.0.0 (USA).

RESULTS

Our results showed that intestinal helminths component community of *C. ocellatus* consisted of six species (five nematodes and one cestode). The nematode species were *Thelandros schusteri*, *Pharyngodon mamillatus, Parapharyngodon bulbosus, Cosmocerca vrcibradici* and *Spauligodon petersi,* while the cestode species was *Oochoristica maccoyi*. *T. schusteri* was the most common species and *P. mamillatus* was the rarest. The overall mean species richness of intestinal parasites harbored per host was 0.79 ± 0.08 (S.E.M.), with a variance to mean ratio 0.62 indicating a positive binomial distribution. Analysis of these data with GLIM (two ways ANOVA in GLIM with normal errors and season and host sex as factors) revealed that only the season played a significant role in determining infracommunity species richness ($F_{3,119}$ =. 10.432; $p < 0.001$) (Fig. 1) and there was no interaction between season and host sex. The diversity of helminths component community differed according to host sex: 0.60 ± 0.2, 0.66 ± 0.03 and 0.57 ± 0.02 for sex combined, male and female respectively. The total prevalence of helminths infection was 67.6 % while the prevalences of *T. schusteri*, *P. mamillatus, P. bulbosus, C. vrcibradici, S. petersi* and *O. maccoyi* were 43.4 %, 3.9 %, 13.2 %, 5.3 %, 6.6 %, and 14.3 %, respectively. Table II shows the prevalence of helminths infection according to host sex. Our results showed that the prevalence of *P. bulbosus* and *S. petersi* in male lizards were more than in female ones. The prevalence of infection of *O. maccoyi* was higher in female lizards than males. On the other hand, the rest of the species were sex independent.

The results showed that the prevalence varied in relation to season (Fig. 1). The highest prevalence was recorded during summer for *T. Schuster* (73.3 %), *P. mamillatus* (13.3 %), *S. petersi* (13.3 %) and helminths in total (93.9 %), and during spring for *P. bulbosus* (37.5 %) and *O. maccoyi* (37.5 %). *C. vrcibradici*

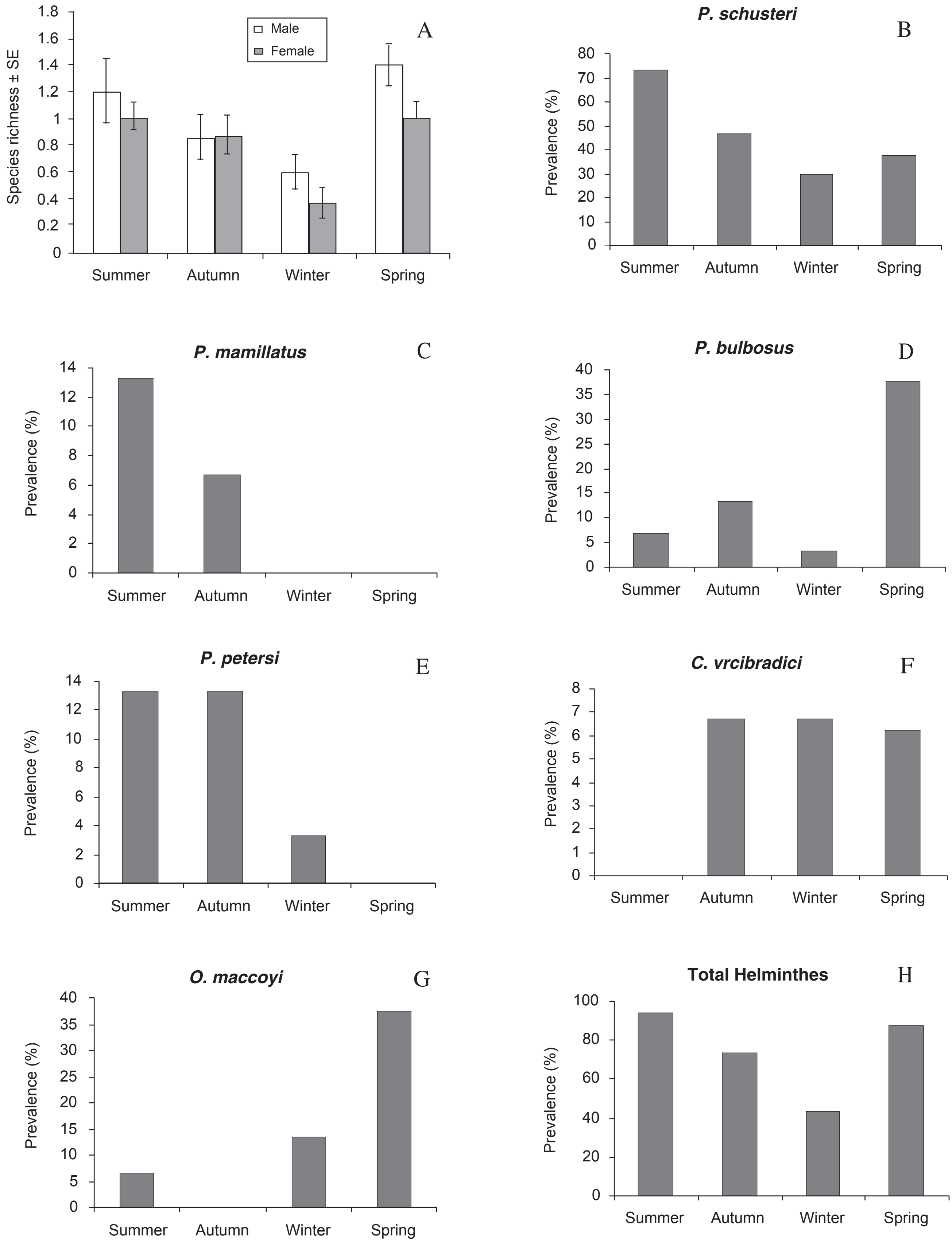

Fig. 1. – A: seasonal changes in mean infracommunity species richness; B-H: prevalence of different helminths related to the four year season.

recorded the same infection rate in autumn and winter (6.7 %) and no infection in summer. There was no infection in winter and spring with *P. mamillatus* and in autumn with *O. maccoyi*. The prevalence of intestinal helminths also varied significantly in relation to weight class (χ^2 = 11.612; df = 3; p = 0.009). Weight class 4 recorded the highest prevalence for *P. mamillatus* (14.3 %), *P. bulbosus* (42.9 %) and *C. vrcibradici* (14.3 %). On the other hand, no infection was recorded for S. *petersi* and *O. maccoyi* in this weight class. *T. schusteri* (58.1 %) and *S. petersi* (12.9 %) recorded the highest prevalence in weight class 2 (Fig. 2).

Helminths	Habitat	Sex of host	Prevalence (%)	Abundance			Indices of aggregation	
				Mean	± SE	Range	I*	D**
		Sexes combined	43.4	3.78	0.89	0-40		
T. schusteri	Small & large intestine	Male lizard	44.4	3.3	1.42	0-32	15.83	0.66
		Female lizard	42.9	4	1.14	0-40		
		Sexes combined	3.9	1.04	0.72	0-45		
P. mamillatus	Large intestine	Male lizard	3.7	1.2	1.19	0-32	38.11	0.95
		Female lizard	4.1	0.96	0.92	0-45		
		Sexes combined	13.2	2.02	0.23	0-11		
P. bulbosus	Large intestine	Male lizard	18.5	0.81	0.44	0-11	6.45	0.89
		Female lizard	10.2	0.53	0.26	0-10		
		Sexes combined	5.3	0.14	0.07	0-3		
C. vrcibradici	Large intestine	Male lizard	7.4	0.2	0.13	0-3	2.71	0.93
		Female lizard	4.1	0.12	0.09	0-3		
		Sexes combined	6.6	0.14	0.06	0-3		
S. petersi	Large intestine	Male lizard	11.1	0.3	0.15	0-3	2.1	0.92
		Female lizard	4.1	0.08	0.06	0-2		
		Sexes combined	14.4	0.61	0.29	0-8		
O. maccoyi	Small intestine	Male lizard	7.4	0.45	0.45	0-8	7.46	0.89
		Female lizard	18.4	0.71	0.38	0-8		

* Index of dispersion; ** Index of discrepancy.

Table II. – Prevalence, abundance and indices of aggregation of intestinal helminths of *Chalcides ocellatus* collected from Egypt.

Helminths	Factor considered	SS	df	χ^2	F	p
	Sex	0.061	1	0.061	0.306	0.582
T. schusteri	Season	2.253	3	0.751	3.764	0.015
	Sex & season	0.239	3	0.080	0.400	0.754
	Sex	0.006	1	0.006	0.090	0.765
P. mamillatus	Season	0.563	3	0.188	2.816	0.046
	Sex & season	0.073	3	0.024	0.365	0.778
	Sex	0.101	1	0.101	2.109	0.151
P. bulbosus	Season	1.215	3	0.405	8.494	0.000
	Sex & season	0.734	3	0.245	5.134	0.003
	Sex	0.016	1	0.016	1.024	0.315
S. petersi	Season	0.063	3	0.021	1.312	0.278
	Sex & season	0.013	3	0.004	0.262	0.853
	Sex	0.002	1	0.002	0.107	0.745
C. vrcibradici	Season	0.018	3	0.006	0.350	0.789
	Sex & season	0.030	3	0.010	0.560	0.643
	Sex	0.003	1	0.045	0.003	0.832
O. maccoyi	Season	0.580	3	3.321	0.193	0.025
	Sex & season	0.149	3	0.855	0.050	0.469
	Sex	0.014	1	0.014	0.071	0.791
Total helminths	Season	3.511	3	1.170	6.076	0.001
	Sex & season	0.670	3	0.223	1.160	0.331

Table III. – Test of interaction (general linear model) between factors affecting abundance of intestinal helminths infracommunity of the Egyptian lizard, *C. ocellatus*.

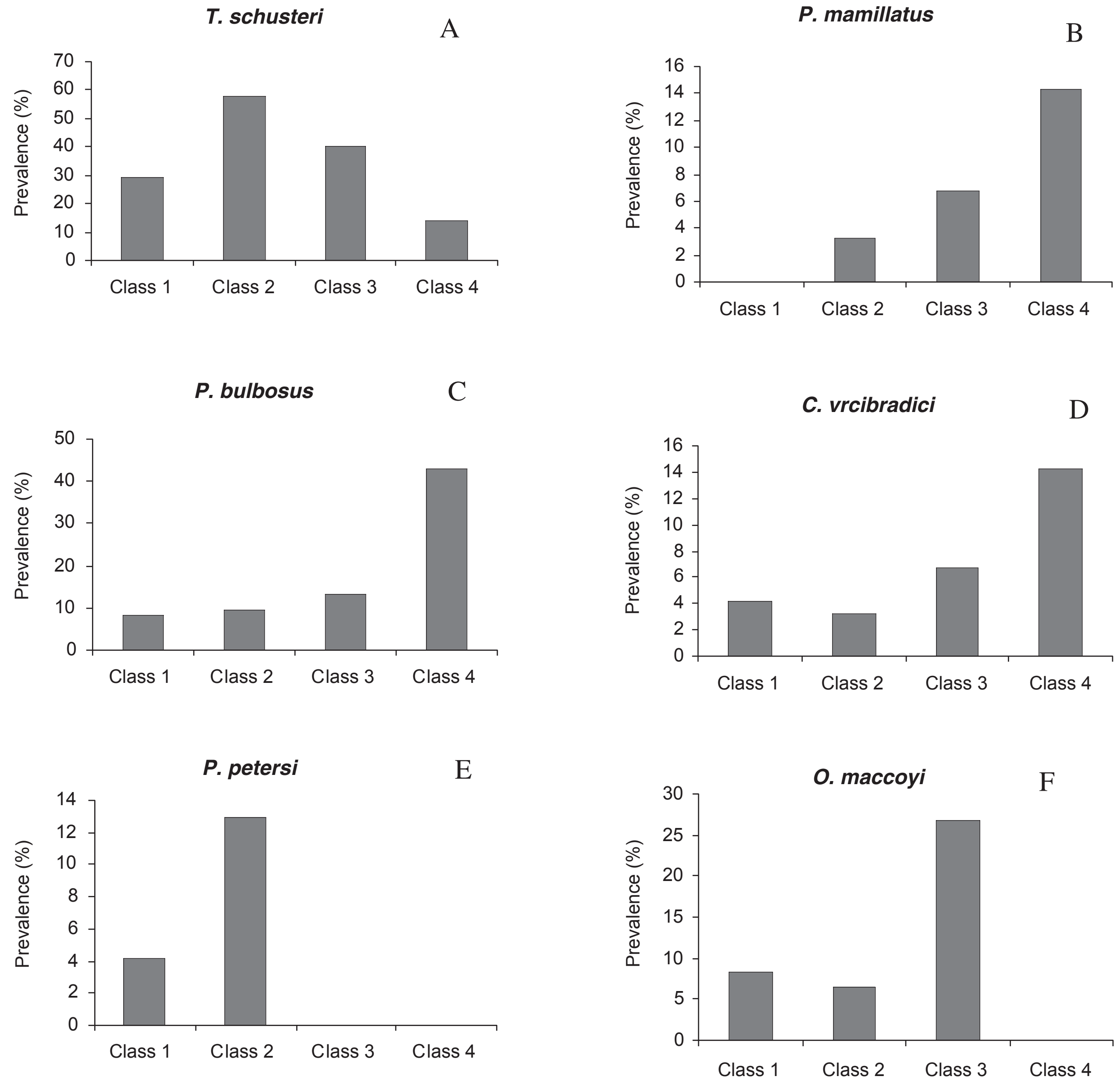

Fig. 2 . – A-F: prevalence of different helminths related to host weight class.

The frequency distribution of helminths abundance was overdispersed. Table II shows the degree of aggression of helminths. Helminths abundance and intensity were independent from host sex, since we found no significant differences between male and female for all helminth species. We analyzed the data after normalization (by log 10 [X + 1] transformation) by 2-way ANOVA in GLIM. This showed that the main effect in parasite abundance was season, but there was also interaction between season and sex in *P. bulbosus* (Table III). A positive association was found between weight and intensity of *T. schusteri* (r_s = 0.34; p = 0.023). On the other hand, a negative correlation was found between weight and intensity of *P. mamillatus* (r_s = – 9.34; p = 0.001). Also a positive correlation was found between total parasite abundance and weight (r_s = 0.26; p = 0.02).

DISCUSSION

Relatively little information is available on the characteristics of helminths communities in reptiles (Aho, 1990; Bush, 1990; Sharpilo *et al.*, 2001; Martin & Roca, 2004). Therefore, this work aimed at studying the possible effects of the intrinsic factors (host sex and weight) and extrinsic factor (season) in structuring the infracommunity of intestinal parasites of *C. ocellatus* and the influence of these factors on species richness, prevalence, abundance and intensity of helminths infection.

This study showed that nematodes were the most common in the infracommunities of *C. ocellatus* which are the members of family Pharyngodonidae, Travassos, 1919 (*T. schusteri*, *P. mamillatus, P. bulbosus* and *S. petersi)* and family Cosmocercidae, Travassos, 1925 (*C. vrcibradici*). A characteristic feature of helminths component communities was the large proportion of heteroxeneous helminths species for which *C. ocellatus* (as in many reptile species, Sharpilo, 1983; Martin & Roca, 2004) serves as a paratenic host, and to a much lesser degree, as an intermediate host. Another interesting feature of the helminths component communities of lizards was the absence of strict host specificity (Aho, 1990) since all the helminths recovered in this study were species which sand lizards share either with other reptile hosts or with amphibians. This feature was also noticed by Sharpilo *et al.* (2001). Moreover, the present results confirm the conclusion from study on another European lacertid host, *Lacerta viridis*, those communities from marginal habitats are dominated by host generalist species while those from typical habitats are dominated by lizard specialist (Biserkov & Kostadinova, 1998; Sharpilo *et al.*, 2001). Whilst total species richness in *C. ocellatus* was six, mean infracommunity species richness was 0.79. The low values of helminths richness and abundance indicate that many members of the helminths infracommunities occurred only irregularly and occasionally. This agrees with the typical pattern of helminths infection in many reptiles, i.e. few species occur frequently, few species occur with moderate prevalence, and many species are rare (Roca & Hornero, 1994; Martin & Roca, 2004). These results contrast with considerably higher species richness values recorded from reptiles living in other warm climates (Martin & Huffman, 1980). Sex did not influence mean species richness but seasonal variation was the main factor.

The study showed high infection rates for *T. schusteri*, *P. mamillatus*, *S. petersi* and for the total infection in summer. The reason of higher parasite prevalence in summer as a common phenomenon is still not clear (Soliman & Zalat, 2003) although this factor was attributed to reasons like uneven sampling across age classes, sexes, body condition and specifically to diet (Vidya & Sukumar, 2002). But diet (contaminated food) is unlikely to give rise to the high parasite prevalence in summer (Soliman & Zalat, 2003) because the survival of most infective stage is higher under moist conditions (Rogers & Sommerville, 1963). The intestinal nematodes dominated the helminths fauna of Lizard and these were all either arthropod transmitted species or dependent on direct transmission via eggs. This predominance of arthropod transmitted nematodes does not support Dobson's hypothesis that xeric hosts should be dominated by monoxenic helminths (Dobson, 1989).

Our results showed that the prevalence of infection of *P. bulbosus* and *S. petersi* in male lizards was more than in female ones. Ulter & Olsson (2003) showed that, under controlled laboratory conditions, prenatal exposure to high testosterone levels not only increased offspring growth rate, but also susceptibility to a common ectoparasite in the common lizard, *Lacerta vivipara*. Testosterone has been shown to have a negative impact on immune response in some vertebrates (Olsson *et al.*, 2000; Peters, 2000; Casto *et al.*, 2001; Hughes & Randolph, 2001). There are at least two potential pathways in which increased steroid levels can influence parasite load in free-ranging animals. First, testosterone may increase movement, display rates and aggression, which can lead to higher exposure to parasites (Klein, 2000). Second, testosterone may increase susceptibility to infection or infestation by directly lowering the immunocompetence of the individual, via suppression of the immune system (Hillgarth & Wingfield, 1997; Ulter & Olsson, 2003). In contrary, the prevalence of infection of *O. maccoyi* was higher in female lizards than males. On the other hand, the rest of the species were sex independent. Therefore, the relationship between host sex and parasite load is a debate issue.

This study showed that total helminths abundance was directly correlated with host weight. In addition, intensity of infection was either directly or negatively correlated with host weight in *T. schusteri* and *P. mamillatus*, respectively. Behnke *et al.* (1999) found a significant increase in the abundance of *S. stroma* with increasing age (directly reflected by host weight) of wood mice.

In conclusion, the helminths community of *C. ocellatus* was depauperate and the influence of the studied factors varied from species to another one. We cannot say if the low species richness and infection rates observed in the present study are typical of the host species or if they are due to characteristics of the study area, since no available data on parasite assemblages exist for other *C. ocellatus* populations.

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