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Associations between reproductive cycle and occurrence of intestinal helminths infecting the Egyptian lizard, *Chalcides ocellatus*

Hala M. Ebaid
Zoology Department, Faculty of Science, Suez Canal University, Ismailia, Egypt.
Email: halaebaid@yahoo.com

ABSTRACT

Little attention has been given to the association between the host reproductive cycle and the dynamics of parasitic infection in the reptilian model. This relationship was investigated in this study with the common intestinal nematode, *Thelandros schusteri* (Family: pharyngodonidae) infecting the Egyptian lizards, *Chalcides ocelattus*. Fifty three lizards were collected during winter and spring 2009 and were weighted and sexed. The gonads were weighted and gonadosomatic index (GSI) was calculated; both represent measures of the reproductive cycle. The intestinal nematodes were recovered from the intestine by the standard technique. Results showed that the seasonal variation did not affect the infection prevalence in male or female lizards while GSI greatly affected the prevalence in female lizards only. Females with low GSI showed the highest infection prevalence while, those of high GSI showed the highest intensity of infection. Positive or negative correlations between number of follicles/ ovary, gonad mass or GSI and the intensity of infection in female hosts suggested that the investment in reproduction of females is more costly than for males. We interpret the high intensity of infection in females to be an effect of the reproductive cycle and conclude that sex dependent difference is very important in such pattern of host parasite relationship when aspects of reproductive cycle are considered and that the host reproductive investment may be a factor contributing to occurrence of parasitic infection.

Key words: Lizard – intestinal nematodes - gonadosomatic index

INTRODUCTION

One of the most abundant and widespread reptile species in Africa and Egypt is the lizard, *Chalcides ocelattus* where its distribution being primarily attributed to its tolerance of diverse environments ranging from the steppe through agricultural fields to woodland habitats (Al-Shareef & Saber 1995). Mating takes place several times a year and the females are ovoviviparous giving birth to 3-11 young at a time.

Generally, hosts are expected to evolve defense mechanisms aiming at limiting the negative effect of parasitism on their fitness. Hosts have evolved a series of morphological, physiological, and behavioral adaptations to fight off parasitic attacks. On their side, parasites have responded to the selection pressures exerted by their hosts by evolving counter-adaptations to overcome host defenses. These cycles of host–parasite adaptations/counter-adaptations define the so-called coevolutionary process, one of the most prominent characteristics of host–parasite interactions (Sorcia & Garnier 2008).

Parasites and their infections can adversely effect a host's growth, reproduction and survival. A general prediction from evolutionary biology is that hosts suffering from this type of infection should preferentially allocate resources towards reproduction, even if this is at the expense of their growth and survival (Agnew *et al*. 2000). Parasitism has often been discussed in the light of energetic tradeoffs in host investment in different life history traits, and especially that higher investment in reproduction might, decrease energy for investment in immune defense and facilitate parasite infection (Sheldon & Verhulst 1996, Simková *et al.* 2005). Parasites may have complex effects on resource allocation and sexual behaviour both through direct effects on infected hosts and as a criterion for mate choice (Keymer & Read 1991, Dunn 2005). Commonly, parasitism reduces reproductive success and mating vigour. However, some changes in sexual behavior reflect strategies by the host to either avoid infection, or to minimise the fitness costs of parasitism (Dunn 2005).

Primary reproductive investment can be represented by a simple measure of gonadic mass and the gonadosomatic index (GSI), the latter being considered an indicator of somatic and reproductive investment (Mosconi et al. 1991, Chen *et al.* 2004, Malavasi *et al.* 2004). Although fish, gastropdes have been widely studied in this context (Gil de Pertierra & Ostrowski de Nuñez 1990, Minchella *et al*. 1981, 1985, Simková *et al.* 2005) as they used this index in relation to the life cycle of a parasite, since it was intimately related to the life cycle of the host, relatively no information has been given for parasitic infection in reptiles. In addition, the seasonal pattern of host reproduction is an important factor influencing population dynamics of host-parasite interactions (White *et al.* 1996).

The variation in the structure of intestinal helminths community of the Egyptian lizard, *C. ocellatus* (One of the most abundant and widespread reptile species in Africa and Egypt) in relation to seasonal variation , host weight and sex was previously studied (Ibrahim & Soliman 2005). Unfortunately, the possible affect of the host reproductive cycle on the dynamics of infection with such community was not considered. In this work, we predicted that the dynamics of parasite infections may be influenced by multiple factors particularly host reproductive status. Hence, our aim was to investigate the possible affect of the host reproductive cycle on occurrence of one of the most common intestinal nematode (*Thelandros schusteri*; Family: pharyngodonidae)*)* infecting the Egyptian lizard.

MATERIALS AND METHODS

Fifty three Egyptian lizards, C. *ocelattus* were captured from Aborowash area, Giza, Egypt in a systematic field sampling during winter and spring 2009. Each season reflects a different stage of follicle maturation or reproductive cycle of the lizards (Mosconi *et al.* 1991). Lizards were transported alive to the laboratory. Once in the laboratory, they were euthanized, and the total length (in cm) and body weight were recorded. The lizards were divided into three weight classes (Class 1: <15g; Class 2: >15g). Then, they were dissected and sexed. Gonad weight (in g) was recorded for each specimen. GSI was calculated for each individual as gonad weight/body weight X 100. The numbers of follicles in each ovary were counted. The structure of the sampled host population by the season of captured and host sex is shown in Table (1).

Digestive tract of the host was examined for parasites using standard techniques. All helminths were identified according to the morphological characters (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 (Ibrahim & Soliman

2005). *Thelandros schusteri* (Family: pharyngodonidae) was the only nematode considered in this study.

Table 1: The structure of the sampled host population (the Egyptian lizard, *Chalcides ocellatus*) by the season of captured and host sex and weights.

Host Sex	Total Examined	Weight class		Season	
		Class 1 <15g	Class 2 >15g	Winter	Spring
Sex Combined	53	18	35	33	20
Female	31	10	21	19	12
Male	22	8	14	14	8

Epidemiological characteristics including prevalence (percentage of infection in all examined lizards), mean intensity (± SE) of infection (mean number of worms in all infected lizards) were calculated according to Bush *et al.* (1997). For comparison purposes, the effects of individual factors on intensity of infection in analysis of variance was used after normalization of the data by log 10(x+1) transformation (Crawley 1993). The relationships between intensity of infection and GSI, mean number of follicles, mean gonad weight and host size were analyzed using the non-parametric, Spearman's rank correlation. All the statistical tests were performed by using the software packages SPSS 15.0.0 (USA).

RESULTS

Results showed that the total prevalence of the intestinal nematode, *T. schusteri* in the examined lizards was 60.4% (32 of 53). Total prevalence of infection in male and female lizards was 59.1% (13 of 22) and 61.3% (19 of 31), respectively. Variations in infection prevalence of male and female lizards according to seasonal variation, host weight and GSI were shown in Figures (1-3).

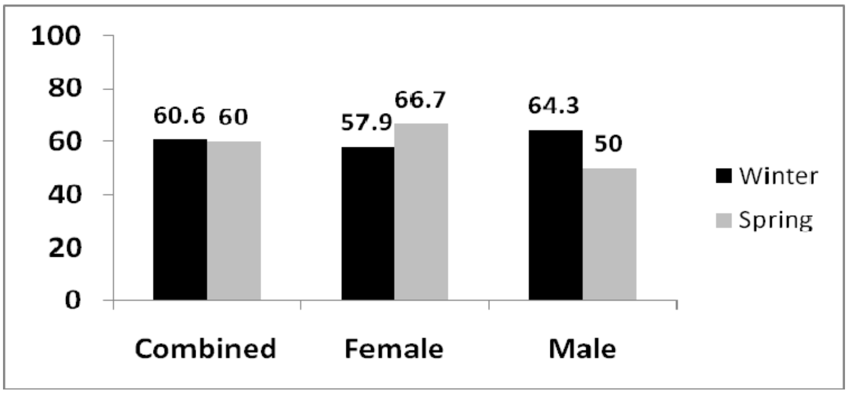

Fig. 1: Prevalence of intestinal nematodes infecting the Egyptian lizard, *C. ocellatus,* according to host sex.

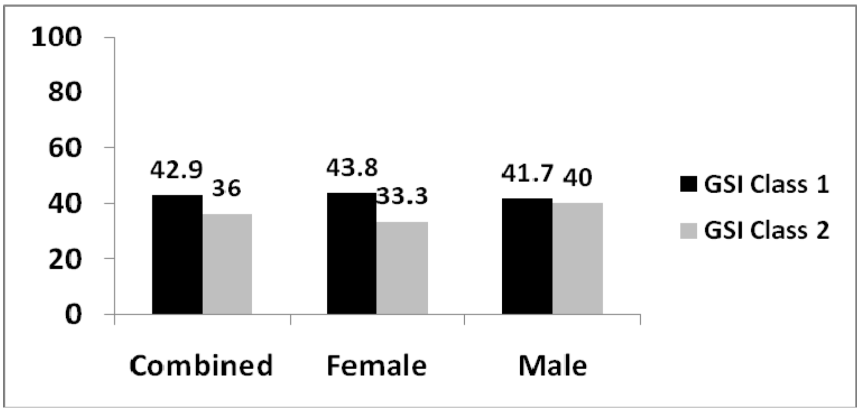

Fig. 2: Prevalence of intestinal nematodes infecting the Egyptian lizard, *C. ocellatus*, according to host GSI class.

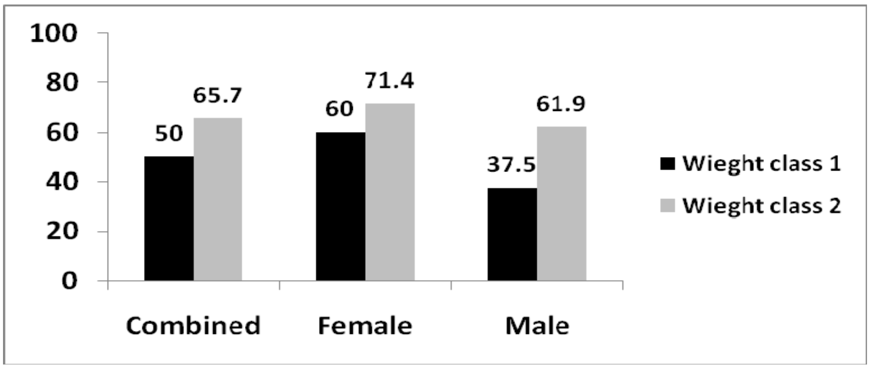

Fig. 3: Prevalence of intestinal nematodes infecting the Egyptian lizard, *C. ocellatus*, according to host weight class.

The highest prevalence of infection was recorded in spring and winter for female (66.7%) and male lizards (50%), respectively. The highest prevalence of infection was recorded in female lizards with a low GSI (43.8%) and the lowest one was recorded in female with a high GSI (33.3%). Prevalence of infection of male lizards did not greatly vary among different GSI classes. Female lizards of weight class 2 showed the highest prevalence of infection (71.4%) as compared to male ones while the lowest prevalence (37.5%) was recorded in males of weight class 1.

Regarding intensity of infection, results showed that the total intensity of infection was significantly very high in female lizards (32.1±9.9) as compared to male ones (4.3±1.2) ($P< 0.000$, $F=15.475$). Total intensity of infection in combined sex (20.8±6.3) was significantly affected by seasonal variation ($P<0.002$; $F=11.232$) and GSI classes ($P< 0.015$; $F=6.631$) while, no significant affect was recorded for host weight (Table, 2).

Regarding female lizards (Table, 2), seasonal variation significantly affected the intensity of infection ($P< 0.003$; $F=5.648$) where it was very high in spring. Interestingly, GSI was found to have a highly significant affect on intensity of infection ($P< 0.006$; $F= 11.638$) being very high in lizards with high GSI. A positive correlation between the intensity of infection and mean gonad weights ($P<0.02$; $r=0.583$), host body weights ($P<0.03$; $r=0.496$) and GSI ($P<.011$; $r=0.568$) was found. Moreover, a negative correlation was found between intensity of infection and number of follicles in the ovary ($P<.025$; $r= -0.512$). On the other hand, no significant affects or correlations were found for all the tested factors on intensity of infection of male lizards.

Table 2: Mean intensity of infection with intestinal nematodes infecting the Egyptian lizard, *Chalcides ocellatus* according factors considered.

Host Sex	Season		GSI class		Weight class	
	Winter	Spring	Class 1 <1	Class 2 >1	Class 1 <15g	Class 1 >15g
Sex Combined	5.2±2.2	41.7±14.8*	9.8±3.8	31.8±11.6*	10.8±4.1	24.7±8.6
Female	12.6±3.8	58.9±19.8*	14.1±6.5	48.3±16.6*	14.8±5.6	40.1±13.8
Male	3±0.8	7.3±3.1	4.3±1.9	4.3±1.4	2.7±0.3	4.8±1.5

* Significantly higher as compared to its corresponding group.

DISCUSSION

The relationship between the host sex and occurrence of intestinal nematodes of the Egyptian lizard was described as a debate issue (Ibrahim & Soliman 2005). In this study, difference between total prevalence of infection in male and female lizards was small while the intensity of infection was the highest in female lizards in the studied seasons. Adeoye & Ogunbanwo (2007) found that male African lizard, *Agama agama*, had a significant higher level of intensity of infection than female while the prevalence was more or least similar. Amo *et al.* (2005) stated that males and females seem to be similarly susceptible to parasite's infection. On the other hand, Roca (1994) reported that the host sex rarely determines either the presence or abundance of parasites in the lizard, *Lacerta schreiberi*, although Lewin (1992 a, b) noted that male lizard, *Lacerta vivipara* or *Lacerta agilis* are generally more heavily infected by the nematodes than female. All theses contradictory findings indirectly reflect the light on the possible role of the host reproductive cycle. Generally, when the host sex dependent intensity is recorded for a certain species, it is greatly being attributed to testosterone levels in male host where males are more susceptible to parasite's infection probably due to the immune suppressive effects of testosterone (Ulter & Olsson 2003, Roberts *et al.* 2004). Since, a little attention has been given to the possible role of the reproductive cycle, especially for the reptilian model, this role is greatly cleared in the present study for the first time especially in female host.

In this study, the seasonal variation did not affect the infection prevalence in male or female lizards while GSI and the host weight greatly affected the prevalence in female and male lizards, respectively. Although female with low GSI showed the highest infection prevalence as compared to those with high one, the intensity of infection was the highest in females with high GSI. The latter mode indicates that if the parasites succeed in the establishment on the host during a certain stage of the reproductive cycle, its growth and reproduction will be available by the host itself as many parasites reduce their host's investment in reproduction, making more resources available for parasite growth (Read 1990, Keymer & Read 1991). Indeed, the correlations between gonad mass or GSI and the nematode in female hosts found in this study further suggest that the investment in reproduction of females is more costly than for males, and that female lizard are more susceptible to parasite infection in periods of investment in gonad development.

Results showed that the seasonal variation and GSI significantly affected the intensity of infection in female lizards only. As the reproductive cycle is synchronized with the seasonal variation so the effect may be attributed mainly to the difference occurred in GSI during different seasons. Moreover, the positive correlation between gonad mass and parasite intensity and the negative one found between number of follicles in the ovaries and the intensity of infection in females points to a possible relation between them and confirm the role of the reproductive cycle in female hosts. In one of the rare studies on reptilian model made by Dobson *et al.* (1992), the parasite burdens in female Caribbean lizard suggested that the parasite had little effect on host fecundity. Also, the correlation found between host weight and the intensity of infection in female lizards may be indirectly related to GSI which, meanly depend on host weight. Sanchis *et al.* (2000) found that host size is the main factor determining the presence and numbers of the intestinal nematodes, *Oswadocruzia filiforis,* in the intestine of the lizard where this observed variation derived from variation in body size (female larger than male) and seasons as well.

Early in the mating period, males maintain high levels of testosterone hormone (Tokarz *et al.* 1998), which makes them more aggressive, thus more able to obtain and maintain a territory. In pregnant females, the development of eggs requires a great amount of energy and metabolites, which could not be allocated to defense against parasites. Therefore, both sexes seem to invest more in reproduction than in defense against parasites (Amo *et al*. 2005). We interpret the high intensity of infection in females to be an effect of the reproductive cycle. Hence, we conclude that sex dependent difference is very important in such pattern of host parasite relationship when aspects of reproductive cycle are considered. Our results suggest that host reproductive investment may be a factor contributing to parasite infection which is greatly varied between male and female hosts.

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ARABIC SUMMAEY

العلاقة بين دورة التكاثر و الاصابة بالديدان المعوية فى السحلية المصرية ، *Chalcides ocellatus*

هالة محمد عبيد
قسم علم الحيوان ، كلية العلوم ، جامعة قناة السويس ، الإسماعيلية ، مصر.
البريد الإلكتروني halaebaid@yahoo.com

فى هذه العمل تم دراسة العلاقة بين دورة تكاثر السحلية المصرية وبين احد الديدان الخيطية الشائعة والتى تصيب الأمعاء *Thelandros schusteri* . تمت هذه الدراسة على ثلاث وخمسين سحلية تم تجميعها خلال فصلى الشتاء والربيع عام ٢٠٠٩ وقد تم وزنها وتحديد جنسها. وقد تم وزن الغدد التناسلية كما تم حساب مؤشر النضج الجنسي لها ، وكلاهما يمثل مقياس لدورة التكاثر. وتم استرجاع الديدان الخيطية من أمعاء السحالي. وقد أظهرت النتائج أن التغيرات الموسمية لم تؤثر على معدل انتشار الإصابة بالديدان في السحالي ، بينما أثر مؤشر النضج الجنسي بشكل كبير على معدل الانتشار وشدة الإصابة في السحالي الإناث فقط. اما العلاقات الطردية والعكسية التى أوضحتها النتائج بين عددِ حويصلات المبيض ووزن المناسل أو مؤشر النضج الجنسي وكثافة العدوى في الإناث يوضح ان الإناث هى الأكثر تأثرا بدورة التكاثر عن الذكور. ونفسير ارتفاع شدة الإصابة لدى الإناث هو نتاج لتأثير الدورة التناسلية والخلاصة أن نوع الجنس مهم جدا في هذا النمط من العلاقة بين الطفيل و العائل المضيف ، وأن الدورة التناسلية للعائل المضيف قد يكون عاملا مؤثرا في حدوث العدوى الطفيلية.