Seasonal dynamics of *Thelandros maplestoni* infections in the wall lizard, *Hemidactylus flaviviridis* in Imphal Valley, Manipur, India

R. K. Gambhir · Sonia Oinam · Wahengbam Lakshmiyari

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Abstract The influence of seasons on the population dynamics of the nematode, *Thelandros maplestoni* infection in *Hemidactylus flaviviridis* was studied for one annual cycle in the Imphal Valley, Manipur, India. Various factors like the incidence, intensity, density, index of infection and dominance of this parasite was observed in relation to temperature and rainfall. The incidence, intensity, density, index of infection and dominance of *T. maplestoni* was higher in monsoon season, while lowest during winter. The intensity and density of female *T. maplestoni* was found to be comparatively higher than the male parasites and this observation indicated a shift from the previous studies. The study thus indicated that the temperature and rainfall acts as one of the most favourable extrinsic factors for *T. maplestoni* infections in *H. flaviviridis* in the Imphal Valley, Manipur.

Keywords Seasonality · *Hemidactylus flaviviridis* · *Thelandros maplestoni* · Temperature · Rainfall

Introduction

In India, the parasite fauna of reptiles have been studied by various workers like Chatterjee (1935), Khera (1961), Deshmukh and Ali (1966) and Agarwal (1968). Similarly, the effects of seasons on helminthic infections in reptiles have also been reported by Shinde et al. (2004), Sinha (2005) and Chandra et al. (2006). But rather limited number of investigations have been done on the influence of seasons on the nematode *Thelandros maplestoni* infections in

H. flaviviridis. *T. maplestoni* belongs to the superfamily Oxyuridea wherein the parasites follow a direct life-cycle. Studies on the influence of seasons on the population dynamics of this parasite have been undertaken by Gyaneswori (2007) in Manipur and Bhaskar and Gupta (2008) in Bareilly, Mirzapur and Chandausi. According to these workers, the infection levels of parasites in the hosts not only depend on the intrinsic factors but also on the external ones, such as temperature and rainfall. This is all the more true in the case of poikilothermic hosts which are easily influenced by the climatic factors (Manohar and Rajeshwara 1996). In the present study, the population dynamics of *T. maplestoni* infections in *H. flaviviridis* have been worked out and studied in relation to temperature and rainfall in the Imphal Valley, Manipur.

Materials and methods

The hosts *H. flaviviridis* for the present study were collected from the different localities of Imphal Valley, Manipur during March, 2009 to February, 2010 with more or less at regular periodicity. The annual cycle was divided into four seasons i.e., summer (March–May), monsoon (June–September), autumn (October–November) and winter (December–February). The meteorological data for the study were obtained from the Airport Authority of India Station, Tulihal Airport, Imphal. The collected hosts were brought to the laboratory, dissected and parasites were obtained. The nematodes thus obtained were fixed in warm Alcohol–Formalin–Acetate (AFA). To work out the various study parameters, only the sexually mature nematodes were counted. The data thus obtained were subjected to the following standard formulae as used by Rajendra et al. (2009):

Incidence—It is the frequency of infection of hosts by the parasite expressed in terms of percentage i.e.,

R. K. Gambhir · S. Oinam (✉) · W. Lakshmiyari
Parasitology Laboratory, Life Sciences Department,
Manipur University, Canchipur 795003, Manipur, India
e-mail: soniainmu@gmail.com

$$\text{Incidence} = \frac{\text{Infected host}}{\text{Total hosts examined}} \times 100.$$

Intensity—It is the quotient from the number of parasites divided by the number of infected hosts i.e.,

$$\text{Intensity} = \frac{\text{Number of parasites obtained}}{\text{Number of infected hosts}}.$$

Density—It is the concentration of the parasite in terms of parasite (single host) per unit space i.e.,

$$\text{Density} = \frac{\text{Number of parasites collected}}{\text{Number of hosts examined}}.$$

Index of infection—It is expressed by the formula of Tenoza and Zejda (1974)

$$Z = \frac{A \times B}{C^2},$$

where Z is the Index of infection, A is the Number of parasites collected, B is the Number of hosts infected, C is the Number of hosts examined.

Dominance percentage — It is the monthly burden of a particular species to its annual burden

$$\text{Dominance percentage} = \frac{\text{Monthly burden}}{\text{Annual burden}} \times 100.$$

Results and discussion

The data regarding influence of various factors like the incidence, intensity, density, index of infection and dominance of *T. maplestonei* infections in *H. flaviviridis* in relation to temperature and rainfall in the Imphal Valley, Manipur are presented in Table 1.

The season-wise incidence study indicated that *T. maplestonei* parasitize *H. flaviviridis* throughout the year, though variations do occur in the incidence of its infection during different seasons. The incidence of *T. maplestonei* infection was significantly high during the monsoon, in both the male and female hosts, and lowest during the winter season. The highest intensity of *T. maplestonei* infections in the host was recorded during the monsoon, i.e., 1.80 in July in males and 11.00 in females. On the other hand, the lowest intensity of infection in the host was recorded in the winter season i.e., 1.00 in male and 4.00 in female lizards. Further, the female worms were found to outnumber the males throughout the year.

The highest density of *T. maplestonei* was recorded during monsoon, in both the male and female lizards (1.14 in males and 9.16 in females). In contrast, the lowest density was recorded in winter i.e., 0.33 in male and 1.50 female lizards. Here also, the female parasite density was recorded higher than male density. The study revealed the highest index of infection in the monsoon, in both the sexes

of lizards (0.97 in males and 7.63 in females). Whereas, the lowest index of infection was seen in winter in both the sexes of hosts i.e., 0.08 in males in November and 0.37 in females in December. Again, the highest dominance percentage of *T. maplestonei* was observed during monsoon in both sexes of host i.e., 20.00 % in males and 19.36 % in females in June. The dominance of percentage was low in winter in both males and females of *H. flaviviridis*, i.e. 2.5 % in males and 2.11 % in females in December.

During the study period of 1 year, a total of 193 *H. flaviviridis* (123 males and 70 females) were examined for *T. maplestonei* infection. Of these 49.22 % (47.96 % male and 51.42 % female) were found to be infected by the nematode parasite. The parasite was present in the intestine and rectum of *H. flaviviridis*. Of the various climatic factors, temperature and rainfall plays a significant role in the distribution of hosts and also in the survival of parasites. As these two factors vary in different seasons of the annual cycle, the incidence of parasites is also not uniform in all seasons. Esch et al. (1977) opined that temperature affects a wide variety of growth and development processes, any of which may effectively influence the recruitment, transmission, mortality of parasite and hence could control the regulation of parasite population in the host. The present investigation revealed that temperature bears a direct relationship to the seasonal change of *T. maplestonei* infections in wall lizards. The incidence of infection was higher in the summer and monsoon season when the temperature was high and it was lowest in the winter due to low temperature. The present work supports the observations made by Sinha (2005) and Gyaneswori (2007), as the highest incidence of *T. maplestonei* was recorded in monsoon season. Since lizards breed in summer, a possible cause of high incidence of *T. maplestonei* during rainy season could be due to its heavy production of infected eggs, which may find their way in the younger generation of lizards during rainy season. Fontes et al. (2003) also reported that lizards get more parasitized during the wet season. A few workers, like Crofton (1971) and Boxhall (1974) were of opinion that parasites, especially in poikilothermic hosts, die inside the host during winter months as a result of greater immune reaction responsiveness of the hosts during this period. Similarly, the lower incidence of infection in winter may be due to less chances of fresh infection (Rajeshwari 2005). Sinha (2005) reported that the intensity of nematode to be relatively higher during pre-monsoon while Gyaneswori (2007) recorded highest intensity during monsoon season. The present study supports the observation made by Gyaneswori (2007) with a significant alteration observed in the intensity of male and female nematodes. Gyaneswori (2007) reported higher male intensity compared to females parasite intensity. The present work records comparatively higher female intensity

Table 1 Population dynamics of *Thelandros maplestonei* infection in *Hemidactylus flaviviridis* from March 2009–February 2010

Seasons	Months	Number of hosts						Total worm burden						Incidence						Intensity						Density						Index of infection						Dominance	% Environmental factors	Environmental factors (meteorological data)	
		Examined			Infected			♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	Min.-max.temp. (°C)	Rainfall (mm)												
		♂	♀		♂	♀																								♂	♀		♂	♀		♂	♀				
Summer	March'09	10	05	04	02	06		15		40.00	40.00	40.00	1.50	7.50	0.60	3.00	0.24	1.20	07.50	05.28	08.9–35.8															98.40					
	April'09	15	06	09	04	10		42		60.00	66.66	66.66	1.11	10.5	0.66	7.00	0.40	4.66	12.50	14.78	12.7–33.2														65.10						
	May'09	10	08	06	04	08		28		60.00	50.00	50.00	1.33	7.00	0.80	3.50	0.48	1.75	10.00	09.85	16.3–35.6														105.3						
Monsoon	June'09	14	06	12	05	16		55		85.71	83.33	83.33	1.33	11.0	1.14	9.16	0.97	7.63	20.00	19.36	18.8–34.7														108.1						
	July'09	09	12	05	07	09		45		55.55	58.33	58.33	1.80	6.42	1.00	3.75	0.55	2.18	11.25	15.84	21.9–35.7														169.7						
	Aug'09	12	09	04	03	07		25		33.33	33.33	33.33	1.75	8.33	0.58	2.77	0.19	0.92	08.75	08.80	21.3–33.5														203.4						
Autumn	Sep'09	15	05	05	03	06		28		33.33	60.00	60.00	1.20	9.33	0.40	5.60	0.13	3.36	07.50	09.85	19.0–33.2														113.9						
	Oct'09	09	03	04	02	05		15		44.44	66.66	66.66	1.25	7.50	0.55	5.00	0.24	3.33	06.25	05.28	13.3–33.4														152.1						
	Nov'09	12	04	03	02	04		08		25.00	50.00	50.00	1.33	4.00	0.33	2.00	0.08	1.00	05.00	02.81	08.0–30.2														11.80						
Winter	Dec'09	06	04	02	01	02		06		33.33	25.00	25.00	1.00	6.00	0.33	1.50	0.11	0.37	02.50	02.11	02.4–25.5														00.00						
	Jan'10	04	04	02	01	03		07		50.00	25.00	25.00	1.50	7.00	0.75	1.75	0.37	0.43	03.75	02.46	02.3–27.0														007.9						
	Feb'10	07	04	03	02	04		10		42.85	50.00	50.00	1.33	5.00	0.57	2.50	0.24	1.25	05.00	03.52	03.7–28.5														007.0						
Total		123	70	59	36	80		284		563.54	608.31	608.31	16.4	89.58	7.71	47.53	5.13	28.08	100.00	99.94																					

than the male parasites. This may be due to an increase in the temperature or some other factors like parthenogenesis as well. Increased temperatures may cause shifts in the timing of reproductive events that counter thermal effects on reproductive parameters, including the sex ratio (Visser et al. 2004). For example, cool thermal conditions lead to more male offspring and warm thermal conditions lead to proportionally more female offspring both in the field study and in laboratory experiments (Wapstra et al. 2004). The scarcity or absence of males also indicates a tendency toward hermaphroditism or parthenogenesis. Hermaphroditism is in fact not uncommon among terrestrial nematodes, especially rhabditoids, as shown by the studies of Maupas (1900), Potts (1910) and Honda (1925). Moreover, intersexes i.e., females having male characters have been frequently reported in nematodes (Steiner 1923) and seem to result from partial sex reversal under environmental influence. Therefore the present authors are of the opinion that intensity and density of male and female parasite population may be related to the environmental influence i.e., elevated temperature conditions which lead to parthenogenesis or sex reversals or sex determination that bring changes to sex ratios. This study also revealed that the index of infection remains high in monsoon and this finding is in conformity with the work of Gyaneswori (2007). The dominance percentage was highest in the monsoon season and lowest in the winter season. The authors think that it may be due to the high infectivity level in monsoon and less infectivity in winter (due to less feeding or hibernation of host). In conclusion, this study indicates that temperature and rainfall have significant influence on the seasonal changes of the population dynamics of *T. maplestonei*. Accordingly, whenever temperature and rainfall is high, the *T. maplestonei* infections are higher and whenever the same is low the incidence also gets low in the Imphal Valley, Manipur.

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