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Seasonal variation in prevalence of helminthic infection in captive Asian elephant, *Elephas maximus*

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Abstract

Elephants are the largest land-living animals; face a variety of challenges in both wild and captivity, including the parasitic infestations. This study investigates the effect of season, age-sex class, and management system on the prevalence of helminthic infection in captive elephants managed by temple and private owners. The parasitic prevalence was studied by direct identification of helminth eggs in fecal samples collected in different seasons (post monsoon, summer, pre monsoon and monsoon) of 2009 and 2010 by following sedimentation flotation method. Of the 20 elephants studied, 55% being infected with Strongyloides sp. Seasonal variation study revealed that the parasitic prevalence varied with season; maximum in summer (April-June) and minimum during post monsoon season (Jan-March).The helminthic prevalence in females recorded to be significantly ($P< 0.05$) higher than that of males. The adult animals were sensitive to infection than other age groups. There was no significant ($P>0.05$) variation observed in parasitic prevalence between temple and private owned elephants.

Keywords: *Elephas maximus*, Strongyloides, prevalence, seasonal variation

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1. Introduction

India bears nearly about 50% of the wild elephant population and about 20% of the captive elephant population of Asia. The Asian elephant (*Elephas maximus*) satisfies with the special status in our country, as it has been very closely associated with the religion, myths, history etc, of India (Anon, 1993). Tamil Nadu, a southern state of India, manages approximately 150 captive elephants under three different management systems: private, temple and forest department (Vanitha *et al*., 2010).But they do face a variety of challenges in both wild and captivity. Parasitism is one among them that directly affects both the evolution and ecology of hosts through processes such as sexual selection (Hamilton and Zuk, 1982) or parasite-mediated competition, which can lead to a reduction in population size, or the extinction of one host (Price *et al*., 1986; Freeland, 1983). Parasites can also adversely affect the ecology of their hosts, in terms of health (Arme and Owen, 1967), fertility, foraging and may alter host behaviour to facilitate parasite transmission (Wesenberg-Lund, 1931; Holmes and Bethel, 1972; Moore, 1984).

There are some studies on the prevalence of parasitic infection in captive elephants viz., in natural reserves (Arunachalam *et al*., 2007), zoological gardens (Suresh *et al*., 2001) and Hindu temples (Saseedran *et al*., 2003). This study has been attempted to evaluate the effect of season and age-sex classes on parasitic infection by analyzing fecal samples from 20 captive elephants in Tamil Nadu.

2. Materials and Methods

2.1 Parasitic prevalence

2.1.1 Study animals and sampling method

The faecal samples were collected from 20 captive elephants managed in temples (n=16) and by private owners (n=4) for a period of two years from 2009 to 2010. Totally 160 samples from 20 individuals were collected during the study period at one sample/individual for each season. Based on the age, the following age groups were categorized: juveniles (5-10 years), sub-adults (11-15 years) and adults (>15 years). The elephants were given designated code as TE1 to TE16 for Temple elephants, while PE1 to PE4 for Private owned elephants. Core samples were collected within few hours of defecation from faecal boluses to reduce contamination by soil nematodes and stored in 10% formalin. Each sample was a mix of dung from the outer layers of the different boli of a dung pile, since parasite eggs may not be evenly distributed among the boli of a dung pile or even within a bolus. The age and sex of the captive elephants were recorded by interviewing the caretakers (mahouts) and from register of records. As in the case of animals obtained from other states by temple authorities and private owners, age was calculated by using the shoulder height method (Sukumar *et al*., 1988). For the study of seasonal variation, the year was grouped into four seasons, such as Post monsoon (January to March), Summer (April to June), Pre monsoon (July to September) and Monsoon (October to December).

2.2 Coprologic examination

The prevalence of intestinal parasites among captive elephants was assessed through coprological analysis using direct microscopic examination. One gram of faeces was placed into a plastic tube and 5 ml of saline was added and mixed well. An aliquot of 0.1 ml of the suspension was transferred onto a glass slide using micropipette, then coverslipped and examined under a compound light microscope at high power magnification for the presence of parasitic eggs. The sedimentation floatation methods (Watve, 1992; 1995; Vidya and Sukumar,2002) and the sedimentation technique standardized by Monson-Bhar and Bell (1982) were also used. In this method, known weight of faecal samples (in 10% formalin) was strained via a fine mesh nylon strainer to remove coarse debris and the filtrate was centrifuged for 2 min. While centrifuging 10% formalin faecal mixture, the eggs sink as it is being heavier than water. Supernatant was discarded; the sedimented dung was dissolved in 10 ml of zinc sulphate solution (1.18 specific gravity) and centrifuged again. After the second centrifugation, the nematode eggs float to the surface due to the high specific gravity of zinc sulphate. Using wire loop of 5 mm diameter, the sample from the surface of the solution was transferred onto a microscope slide, coverslipped and examined under the compound light microscope. To get enough material to examine 5 to 7 dips with the wire loop was done. In case of absence of eggs in a sample, 12 more loopfuls of the solution (six at a time) were examined for eggs to confirm the absence of parasitic infection. For data analysis One Way- ANOVA was used.

3. Results

3.1 Parasitic prevalence

A total of 160 faecal samples from twenty elephants were collected and examined for the occurrence of parasitic infection during the study period. Among them, 88 samples (55%) showed the presence of parasitic infection with single species while no parasitic ova in 72 (45%) samples. Digestive disorders observed in elephants affected by parasitic infection included colic, drooling saliva, diarrhea, colon

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impaction, indigestion, anorexia and bloat. The examination of faecal samples revealed only the presence of helminthic parasite, *Strongyloides* sp. in all the positive cases and 5% positive infection was detected to have worms of *Strongyloides* sp. The seasonal variation in prevalence of helminthic infection in captive elephants observed for two years (2009-2010) revealed that they have been changing with the seasons (Fig.1). Invariably parasitic infection was detected in all the seasons, irrespective of sex and age class difference. In general, the captive elephants showed mean higher prevalence during summer (55%), followed by monsoon (37.5%) and pre monsoon (25%). The post monsoon season (22.5%) has recorded a lower helminthic infection. The year 2010 showed higher prevalence of parasitic infection than the year 2009. However it was found to be statistically non significant (P>0.05) represented in Table 1. The female captive elephants (n=16), in general showed a marked seasonal variation during both 2009 and 2010. Higher prevalence was noticed in summer (68.7%) while lower during post-monsoon (18.75%) of 2010 (Fig.2). When compared to male, the parasitic prevalence of female recorded significantly (P< 0.05) more helminthic infection. The age- class wise data (Fig.3) revealed that the adult animals were sensitive to helminthic infection, followed by Juvenile while sub-adults were comparatively resistant to parasitic infection. There was no significant (P>0.05) variation observed in parasitic prevalence between temple and private owned elephants.

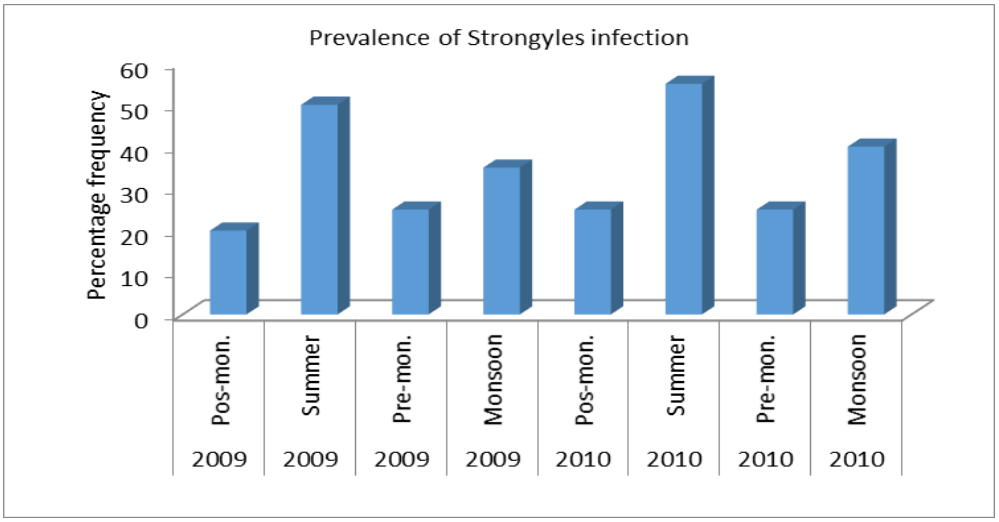

Fig.1: Prevalence of Strongyles infection in captive elephants at different seasons

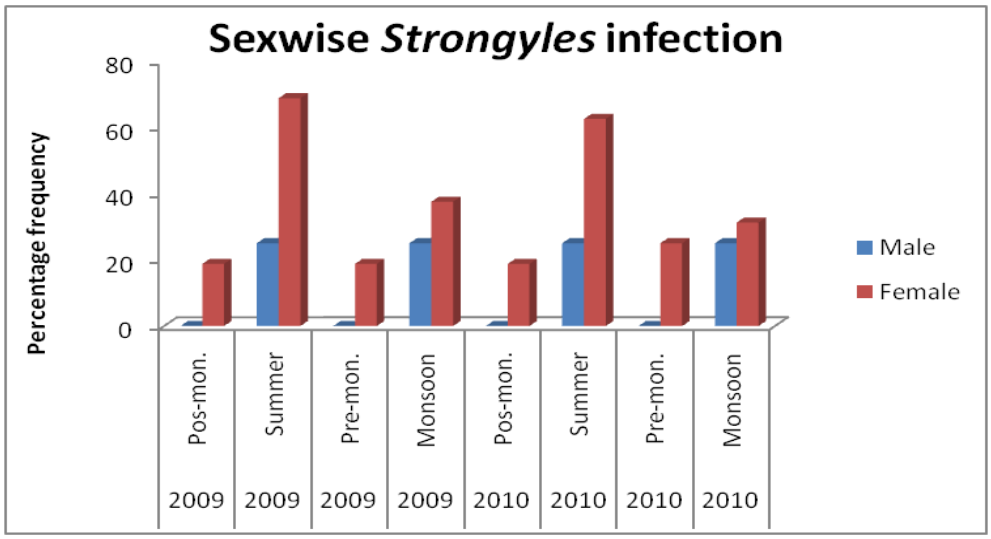

Fig.2: Prevalence of Strongyles infection in male and female captive elephants

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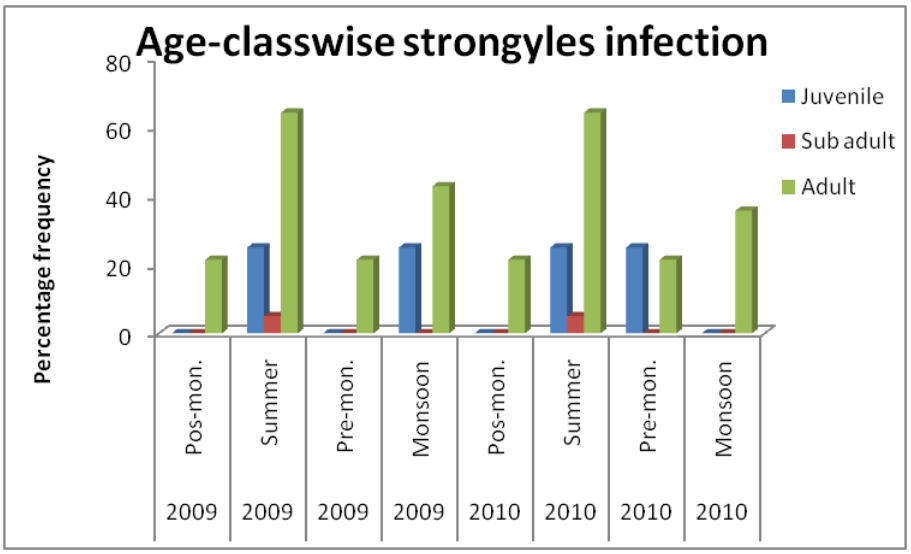

Fig.3: Prevalence of Strongyles infection in different age class of captive elephants

Table 1: One-Way ANOVA for seasonal variation in parasitic prevalence in 2009-10

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*Remarks*
2009 Vs 2010						
Between Years	0.5	1	0.5	0.042254	0.843934	NS
Within Groups	71	6	11.83333			
Total	71.5	7				
Male Vs Female						
Between Groups	144.5	1	144.5	12.90819	0.002436	**
Within Groups	179.1111	16	11.19444			
Total	323.6111	17				
Age-class						
Between Groups	130.5833	2	65.29167	22.71014	5.61E-06	**
Within Groups	60.375	21	2.875			
Total	190.9583	23				

4. Discussion

Endoparasites are ubiquitous in wild and captive elephants. All wild animals harbour parasites of some sort since hosts and parasites have coevolved over millennia, developing complex systems, which can vary from commensal to highly virulent (Anderson and May, 1982; Toft and Karter, 1990; Taylor *et al*., 2013). Prevalence and parasite load are a function of host, parasite and environmental factors. Notably, the prevalence of parasites varies significantly between season and within individuals suggesting that environment and animal health are linked and various factors are associated with altered infection dynamics. Host factors may be numerous including age, gender, individual behaviour, diet and water consumption, daily faecal volume and frequency, reproductive status and overall health. Parasite factors are many and include gender of adult worms, number of adult worms and their fecundity. Significant environmental factors include humidity, rainfall, climate, temperature and the frequency and intensity of external stressors (Stephanie Hing, 2012).

This present study revealed the remarkable prevalence of Strongyle infection in both temple and private owned elephant in all the seasons. Strongyle nematodes are perhaps the most widely reported genera of endoparasites in Asian elephants. Strongyles reside in the stomach, caecum or intestines. Transmission is by faecal-oral spread. Eggs are passed in faeces and under warm humid conditions, hatching would be expected within one to two days. Larvae moult through two life stages in the faeces to become infective in four to six days. Larvae crawl onto vegetation and are consumed by the host. In this study, the overall high prevalence of strongyles (55%) indicates that there is a high potential for direct faecal transmission of parasites and infectious disease in captive elephants. The poor hygienic practices and environmental condition in captivity may favour the

transmission and development of parasites. In wild, high definitive host population density facilitates the success of parasite reproduction and increases faecal oral transmission (Anderson and May, 1979). Extensive research in numerous taxa has established that host density is a key factor contributing to prevalence, load and diversity of nematodes (Wiegertjes and Flik, 2004 in avians; Takemoto, 2005 in fish; Sutherland and Scott, 2009 in sheep and cattle; Suzan *et al.*, 2012; Trejo-Macias and Estrada, in primates).

The recorded mean parasite infection rate (55%) in summer is comparable with some reports viz., Vanitha *et al*., (2011) reported that the intestinal parasite *Strongyle* sp. was prevalent among 37% of the captive elephants monitored across three management systems in Tamil Nadu during 2003-2005. Similarly lower prevalence rate of 36% reported for Mudumalai timber camp elephants by Arunachalam *et al*., (2007). However, the observed level was lower to the study of Suresh *et al*., (2001) who recorded 63.64% and 87.5 % Strongylosis in captive elephants from the Nehru Zoological Park, Hyderabad that contradicted to this observation. In addition, Watve (1993) reported a prevalence of 87 to 98% in 207 captive and wild Indian elephants over three seasons and Vidya and Sukumar (2002) also found a prevalence of 84% in 320 free ranging wild Indian elephants in Mudumulai Wildlife Sanctuary. Moreover, Chandrasekharan *et al*., (1995) recorded Strongyle prevalence of 91.27% among the captive elephants maintained by the forest department in Kerala. The current observed prevalence was substantially higher than the 10% parasitic infection reported in Guruvayoor Temple elephants (Saseedaran *et al*., 2004). Such differences among different elephant populations could be attributed to husbandry practices, variable treatment levels, sampling season, and age-sex classes.

In the seasonal variation study, the helminthic infection has been recorded to be high during summer in both the year followed by monsoon, pre-monsoon and post-monsoon seasons. The observed results can be correlated and corroborated with the observation of Vanitha *et al*., (2011), they recorded similar higher helminthic prevalence during summer and monsoon. In addition, in a survey of over 200 captive and wild Indian elephants, Watve (1993) reported higher parasitic load during dry season and Vidya and Sukumar (2002) also recorded similar finding of higher parasitic load in dry season. The higher prevalence of parasitic infection during summer was ascribed to the prevalence of ideal climatic conditions (temperature &humidity) for faster rates of egg hatching and rapid development to the infective stage as reported elsewhere (English, 1979), and due to poor hygienic conditions of the resources such as shelter, food and water. Differences in parasitic prevalence may be associated with differences in individual and host population immunity. However, studies on immune regulation and helminthic parasites in free living wildlife are rare (Schad *et al.*, 2005). Stress affects host immunity and predisposes animals to parasite infection (Agarwal and Marshall, 2001; Benjamin, 2011). Further, the nutritional stress such as limited food availability and deficiencies in dietary components, particularly protein and energy, influence susceptibility to parasites and pathogens (Chapman *et al*., 2006) by affecting immuno-competence (Rolston 1992; Lyles and Dobson, 1993). When rainy season progresses, the increased vegetation growth could reduce nutritional stress and thus improve overall resistance to helminth infection (Dharmarajan *et al*., 2005). Furthermore, this present study and that of Vanitha *et al*., (2011) and from the Nehru Zoological Park, Hyderabad (Suresh *et al*., 2001) showed the higher prevalence of intestinal parasites in females than males, contradicting the general trend reported for mammals.

5. Conclusion

The examination of faecal samples or Asian elephant, *Elephas maximus* revealed only the presence of helminthic parasite, Strongyloides sp. in all the positive cases. The helminthic prevalence was found to be high (55%). Seasonal variation study revealed the effect of season in parasitic prevalence, with higher in summer and lower during post monsoon season. The female captive elephants in general showed significant seasonal variation ($P< 0.05$) than male. The adult animals were sensitive to helminthic whereas the sub-adults were comparatively resistant to parasitic infection. There was no significant ($P>0.05$) variation observed in parasitic prevalence between temple and private owned elephants. Regular vaccination and de-worming practices, proper veterinary care and hygienic environment are needed to ensure the health of elephants in captivity.

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