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ORIGINAL ARTICLE

# Temporal variation of the cestode, *Cotugnia cuneata* (Meggit, 1924) in their host, domestic pigeons, *Columba livia domestica* (Gmelin, 1789)

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**Abstract** A study of the temporal variation of *Cotugnia cuneata*, on a monthly basis, was carried out from January 2008 to December 2010. The study revealed a similarity in the percentage prevalence and mean intensity of infection with higher values in the beginning of the year that gradually declined towards the middle and rose to moderate values towards the end of the year. The periodicity clearly shows a correlation with the seasonal changes throughout the year and provides important insights to the survival strategies of the parasite as well as its life-cycle.

**Keywords** *Cotugnia cuneata* · Temporal variation · Prevalence · Mean intensity

## Introduction

The study of life-cycles of tapeworms has always been a subject of interest to the biologists since time immemorial. However, unfortunately, there are unsolved mysteries regarding the detailed life-cycles of many helminths till date. Study of the periodic fluctuations of the parasites within their hosts is of immense value as it gives important insights to the life-cycle of the parasite. It also gives an idea about the probable seasons of their dispersal (from prevalence peaks) and hence formulate various deworming programmes by administering effective doses of suitable anthelminthics to the commercially important animals and those that are related to the public health (Natala et al. 2009). These studies are also important as it gives us knowledge about the factor/factors that are responsible for such variability. Studies of Rohde (1994) show that temperature, humidity, rainfall, feeding habit of the host, availability of infective hosts and parasites, as well as parasite maturation are some of the important factors for influencing parasite infections. Pennyuick (1971) reported that feeding activity of the host plays an important factor in the seasonality of the parasite. According to the studies of Mush et al. (2000) the arthropods that form the part of diet in birds usually act as intermediate hosts, thereby the seasonal availability of these intermediate hosts also results in the seasonal variability of the parasites. Literature is replete with information on these aspects of parasitology in different vertebrate hosts.

Pigeons are very close to human beings and live in close association with human dwellings. They are kept as pets by many people and often reared for food. Because of its close interaction with humans and other domestic birds and wild birds it serves as a potential reservoir of zoonotic parasites (Adang et al. 2008). Though, pigeons are not so economically important species, so far as culinary interests are concerned, in certain parts of the world, they obviously serve as reservoirs (Piasecki 2006) for many cestodes including *Cotugnia cuneata* which may become the source of infection to other economically important birds, mainly domestic fowl. *Gallus* sp. has been reported to harbor many members of the genus *Cotugnia* (Nanware et al. 2011). Developing countries may take interest in pigeons and doves in the near future as its flesh has been known to be not only delicious but also nutritive as well and often relished in many parts of the world (Natala et al. 2009). Therefore, works in this field may boost the prospects of livestock production with loses being kept to the minimal.

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However, no data, is available (till date) on the temporal variation of the parasitic cestode *Cotugnia cuneata*, inhabiting the small intestine of domestic pigeons. In fact, literature on *Cotugnia cuneata* is very scarce and its life-cycle still needs to be worked out in detail. The present study deals with the monthly variation of *C. cuneata* in their host, domestic pigeons, *Columba livia domestica* (Gmelin, 1789).

## Materials and methods

Domestic Pigeons (*Columba livia domestica*) were collected from different parts of Burdwan, West Bengal and their guts were examined for the presence of *Cotugnia cuneata* from January 2008 to December 2010. For this purpose, their guts were dissected out, cut open and examined thoroughly. The cestode parasites were collected, washed with normal saline, flattened and fixed in 70 % alcohol. They were then stained with semichon's carmine, observed under the microscope and identified by following Yamaguti (1959). A record of the number of hosts collected, number of infected and uninfected hosts along with the number of parasites (*Cotugnia cuneata*) collected from each infected host were maintained on a monthly basis. From the monthly data, prevalence and mean intensity were calculated following Margolis et al. (1982).

*Prevalence*: Number of hosts infected with the parasite ÷ Total number of hosts examined [infected + uninfected]

*Mean intensity*: Total number of the parasite collected from the sample of hosts ÷ Number of infected host species in the sample.

In the present paper "Prevalence" has been expressed in percentage.

## Results

The hosts (pigeons) examined during the course of the study (i.e. from January 2008 to December 2010) showed a prevalence percentage of (47.95 ± 1.66) % (Mean of yearly prevalence percentage for 3 years ± S.E.). A total no. of 959 parasites were collected from the infected pigeons, on an average 8 parasites were obtained from each infected pigeon. Figure 1 shows a similar trend in the monthly variation of the percentage of prevalence as well as the mean intensity of infection during the period of study (i.e. for the years 2008, 2009 and 2010) and remains higher towards the beginning of the year, i.e. the months of January, February and March with peak values of percentage of prevalence being the highest in February with a value of 85.71 (Feb'08), 83.33 (Feb'09) and 87.5 (Feb'10), followed by January and March (Table 1). The mean intensity of infection shows peak values in Feb'09 (11.6) and Feb'10 (11.71) with a close to peak value in Feb'08 (9.5) (Table 1). The percentage of prevalence and the intensity of infection gradually decline towards the middle of the year with least values in the months of July and August (Fig. 1; Table 1). The percentage of prevalence values recorded in July are the lowest with 14.28 (July'08), 16.66 (July'09) and 20.00 (July'10), followed by August (Table 1). The mean intensity of infection was however the least in August with values of 5.00 (Aug'08), 5.00 (Aug'09) and 4.5 (Aug'10), followed by July (Table 1). The percentage of prevalence and the mean intensity of infection gradually rise towards the end of the year with moderate values from September to December (Table 1; Fig. 1).

## Discussion

The present study shows high rates of infection which indicates high prevalence of the infective stages and intermediate hosts of the parasite, *C. cuneata*, in and around the area of study. Though there is a scarcity of information regarding the intermediate hosts of *C. cuneata*, mainly beetles and ants mainly act as intermediate hosts as has been reported for other cestodes and forms an important part of the food items consumed by pigeons (Adang 1999). These are found abundantly in this region and thereby form an important source of infection for the birds. Besides these, the pigeons consume other food items as well which include grains, slugs, earthworms and other insects (Adang 1999) which may also carry infective stages of the helminths (Soulsby 1982). The presence of *C. cuneata* infection throughout the year suggests the availability of the intermediate hosts (mainly in the form of ants and beetles) and infective eggs in most parts of the year. Helminth infections affect the pigeons and cause high rates of morbidity and mortality among them (Cheng 1973; Soulsby 1982). The cestodes were present in the small intestine (duodenum and ileum) which forms a site rich in semi-digested food (Dede and Richards 1998) and favour the absorption of nutrients through the body surface. The presence of *C. cuneata* in these sites cause obstruction of the intestine which results in high levels of nutrient depletion that may result in weight loss and decreased egg production in laying pigeons (Soulsby 1982).

Previous reports on the seasonal variability of the helminths in birds show that percentage of prevalence and infection rates vary according to the parasite, the host, as well as the geographical location. Oniye et al. (2000)

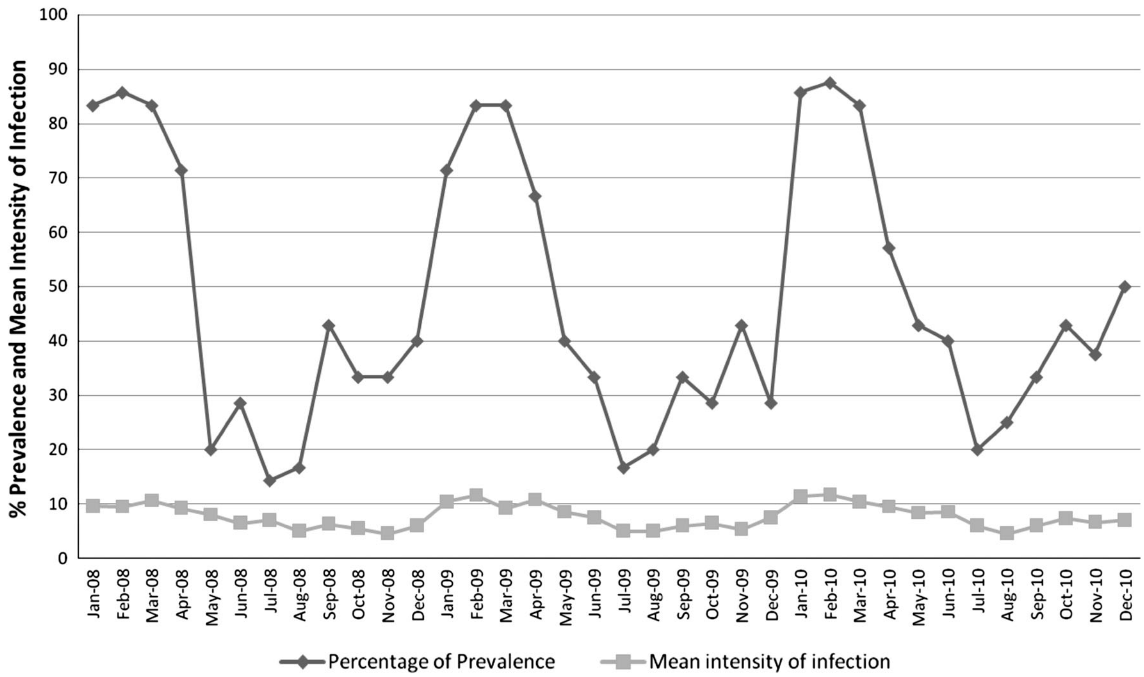


**Fig. 1** Graphical representation of monthly variation of *Cotugnia cuneata* (Meggit, 1924) infecting domestic pigeons. (Period of study: January 2008 to December 2010)

**Table 1** Monthly variation of *Cotugnia cuneata* (Meggit, 1924) infecting domestic pigeons

| Month/year | Jan-08 | Feb-08 | Mar-08 | Apr-08 | May-08 | Jun-08 | Jul-08 | Aug-08 | Sep-08 | Oct-08 | Nov-08 | Dec-08 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage of prevalence | 83.33 | 85.71 | 83.33 | 71.42 | 20 | 28.57 | 14.28 | 16.66 | 42.85 | 33.33 | 33.33 | 40 |
| Mean intensity of infection | 9.6 | 9.5 | 10.6 | 9.2 | 8 | 6.5 | 7 | 5 | 6.33 | 5.5 | 4.5 | 6 |
| Month/year | Jan-09 | Feb-09 | Mar-09 | Apr-09 | May-09 | Jun-09 | Jul-09 | Aug-09 | Sep-09 | Oct-09 | Nov-09 | Dec-09 |
| Percentage of prevalence | 71.42 | 83.33 | 83.33 | 66.66 | 40 | 33.33 | 16.66 | 20 | 33.33 | 28.57 | 42.85 | 28.57 |
| Mean intensity of infection | 10.4 | 11.6 | 9.2 | 10.75 | 8.5 | 7.5 | 5 | 5 | 6 | 6.5 | 5.33 | 7.5 |
| Month/year | Jan-10 | Feb-10 | Mar-10 | Apr-10 | May-10 | Jun-10 | Jul-10 | Aug-10 | Sep-10 | Oct-10 | Nov-10 | Dec-10 |
| Percentage of prevalence | 85.71 | 87.5 | 83.33 | 57.14 | 42.85 | 40 | 20 | 25 | 33.33 | 42.85 | 37.5 | 50 |
| Mean intensity of infection | 11.33 | 11.71 | 10.4 | 9.5 | 8.33 | 8.5 | 6 | 4.5 | 6 | 7.33 | 6.66 | 7 |

Period of study: January 2008 to December 2010

reported prevalence peaks of *Raillietina tetragona* in June and August, Fakae et al. (1991) also reported similarly with the highest prevalence of the worm in the rainy season, Shukla et al. (2012) carried out a study on the seasonality of *Raillietina tetragona* (from the host, *Gallus domesticus*) and reported the highest prevalence in Winter, followed by Rainy and Summer months respectively. Salam et al. (2010) reported a high prevalence of *Raillietina cesticillus* (from indigenous chicken) in the months of July to September, the prevalence of the worm was highest in the summer season followed by Autumn, Spring and Winter respectively. Tambe et al. (2011) reported high rates of helmithiasis from *Capra hircus* in monsoon followed by winter and summer seasons. Pawade et al. (2011), however, reported that the prevalence of *Monieza* sp. (from *Capra hircus*) was highest in winter followed by rainy and summer seasons. Padwal et al. (2011) had stated that the infection rates of *Trichuris* sp. (from sheeps and goats) where highest in winter followed by summer and rainy seasons. The present study shows that the prevalence percentage of the parasites are higher in the late winter months and early summer months which gradually decrease in the wet months. It was noted that a greater number of mature helminths were obtained in the late winter months whereas, the helminths obtained during the wet months of the year (July, August) were mostly immature forms. This may be closely linked to the life-cycle pattern and maturation-cycle of *C. cuneata*.

In case of vector-borne diseases, the transmission depends on the relative size of the vector population as well as the development of parasites within the vectors (Macdonald 1957; Hoshen and Morse 2004; Smith et al. 2004). Temperature and other weather conditions like humidity, rainfall, etc. often determine the abundance of the vector population, both adults and other stages (Altizer et al. 2006). This is both directly and indirectly related to the ability of the parasite to develop in the body of the vectors. It is only under favourable conditions that the parasites are able to survive and develop in the body of the hosts (Focks et al. 1995). Thus, the variability of the helminth may also be closely linked to the variation in availability of the intermediate hosts throughout the year. Ants belonging to the genera *Pheidole* sp. and *Tetramorium* sp. have been reported to act as vectors for the cysticercoids of *Raillietina* spp. (Soulsby 1982). Though, there is a dearth of data on this field from this part of Bengal, the view is supported by the reports of Shukla and Rastogi (2012) who stated that the colony size of *Pheidole* sp., a dimorphic ant was significantly greater during the winter season as compared to that of the summer season. According to the reports of Kennedy (1977), cestode parasites of fishes and birds survive for greater periods at low temperature. Seasonal changes in the social behavior of the host and their aggregation can also account for seasonal dynamics of parasitic infections (Hosseini et al. 2004). Studies have shown that closer proximity of the hosts and higher rates of contacts with members belonging to the same or different species have important implications on seasonality of the parasites (Gremillion-Smith and Woolf 1988; Swinton et al. 1998). This report is very important as it points out to the fact that close associations or sharing of a common resource may spread the parasite to many other hosts belonging to different species. In case of intestinal parasites where the infectious stages are passed out to the environment, the stages have to overcome environmental hazards before they reach their appropriate hosts (Gillett 1974). Thus, the effective transmission of the parasites requires favourable environmental conditions (Smith 1990). In case of the cestodes where the gravid proglottids are released to the exterior through the faeces of the host, the survival and further development of the external stages requires appropriate temperature, moisture and other environmental conditions. High temperatures may affect survivability of the larvae within the eggs. Similarly, heavy rains may wash off the eggs and other infectious stages (Stromberg 1997) and they are no longer available to the vectors for their successful transmission. Studies have shown that hosts exhibit annual rhythms that affect their immune functions (Dowell 2001; Nelson et al. 2002). It has been reported in some recent studies that the immune systems of rodents, birds and humans are weakened during the winter season (Dowell 2001), as well as by rough conditions of the weather, malnutrition or investment in reproduction (Lloyd 1995; Nelson et al. 2002). Under such conditions of reduced immunity, the hosts become more susceptible to infections (Hillgarth and Wingfield 1997). During the breeding season of birds low antibody production and cell-mediated immunity often correlates with higher rates of parasitic infections (Hillgarth and Wingfield 1997; Moreno et al. 2001). Thus, seasonal changes in immunity play an important role in the seasonal variability of the parasites. Studies on the hormonal changes during the breeding season in birds shows correlation with lowered immunity making them vulnerable to infections (Festa-Bianchet 1989; Nelson and Demas 1996; Padgett and Glaser 2003). Annual reproductive cycle of the host is another factor that has co-relation with the host-parasite dynamics in many of the host species (White et al. 1996). Periodic births of new individuals of a host species during the year (in correlation to the breeding period) has bee shown to correlate with higher rates of incidence of parasitic diseases (Altizer et al. 2006). This is because; the young and the juvenile forms are immunologically naïve making them vulnerable to parasites. Social behavior of the birds during the breeding season, i.e. higher rates of contact may also act as an important factor in the seasonal host-parasite dynamics. Pigeons lay eggs throughout the year with a peak of breeding in the spring season and maximum number of eggs is laid in early April (Johnsgard 2009). According to reports of Madhu et al. (2010) there are two breeding periods in pigeons, the primary one being in the months of March, April and May, while the secondary breeding periods have been reported as September and October, however, months of June, July and August are non-breeding periods. Long photoperiod and warm temperature of the summer season results in the increase in concentrations of the gonadal steroids that induces the reproductive activities and suppresses the functions of the immune system in birds (Sing and Haldar 2005; Weil et al. 2006). The graph (Fig. 1) shows that the prevalence rates are higher in the breeding periods and lower in the non-breeding periods of the year. Studies on social behavior of birds have shown that the main factors that trigger the flocking behavior of these birds are cold temperature (Beer and Tibbitts 1950) and drought conditions (Leopold 1936). Pigeons are no exception to this pattern. However, the flocks tend to disintegrate during the breeding season (Carpenter 1932; Emlen and Lorenz 1942). Parenting behavior in birds also make the females avoid flocks (Emlen 1952). Thus, the winter season may play a key role in seasonal peaks of transmission of the parasite (*C. cuneata*) and higher prevalence percentage. These informations may be used for registering suitable dose of anthelminthics to the pigeons and successful eradication of the parasites.

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