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Gonocephalum simplex under the Microscope: Influence of seasonal variations on gregarine parasitism

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ABSTRACT

Understanding the complex interplay between host organisms and their parasites is crucial for elucidating ecological and evolutionary dynamics. *Gonocephalum simplex* is a beetle species of significant ecological importance and Gregarines are protozoan parasites commonly found in the intestines of various invertebrates, including beetles, where they can affect host fitness and behaviour. Gregarine parasites naturally infect G. simplex and can influence its population dynamics. Integrated Pest Management (IPM) strategies for controlling *Gonocephalum simplex* can be enhanced by leveraging gregarine parasites as a biological control agent. However, its interaction with gregarine remains relatively unexplored. So, we aimed to investigate the prevalence and distribution of gregarine parasites in *Gonocephalum simplex* population and how seasonal variations influence its susceptibility to gregarine parasites from different regions of Nashik district of Maharashtra. In this study total of 1186 *Gonocephalum simplex* specimens were examined under a microscope for the presence of gregarine parasites. Our findings revealed a significant prevalence of gregarine parasites, with approximately 78.33% of the sampled beetles being infected. Further analysis indicated seasonal variations in infection rates. The implications of these findings on the ecology and health of *Gonocephalum simplex* populations in Nashik are discussed, highlighting the need for further research on the dynamics of gregarine-parasite interactions in this region. Future research should focus on the mechanisms driving these seasonal patterns and the potential impact of climate change on parasite prevalence.

Keywords- *Gonocephalum simplex*, Gregarines, Parasitism, Prevalence, seasonal influence.

INTRODUCTION

The study of host-parasite interactions, particularly in the context of environmental changes, is pivotal for several reasons. Firstly, it provides insights into the adaptive strategies employed by both hosts and parasites. Secondly, it helps predict potential shifts in parasitic infections in response to climate change. Seasonal variations can significantly impact both the prevalence and intensity of parasitism.

Factors such as temperature, humidity, and host availability fluctuate with seasons, potentially altering the lifecycle and transmission dynamics of parasites analysed by Plant wise Plus Knowledge Bank (2022).

Gonocephalum simplex (Fabricius) commonly called a dusty brown beetle serves as an important model organism for various ecological and physiological studies. As larvae and adults of *Gonocephalum species* severely damage both germinating seeds and emerging seedlings by feeding on vital plant parts, with larvae targeting seed coats, kernels, and cotyledons, and adults damaging cotyledon leaves, growing tips, and stems, leading to significant losses in dicotyledonous crops and germinating cereals. In a report from India, it was documented that *Gonocephalum species* caused damage to 5% of groundnut pods in Andhra Pradesh (Reddy et al., 1992). *Gonocephalum species* seem to inflict sporadic damage throughout much of their range. Drinkwater (1999) identified it as the most harmful species of *Gonocephalum* in South Africa. Mlambo (1983) reviews the biology, impact, and control of *Gonocephalum simplex* in Zimbabwe, noting its one-year life-cycle, its role as a pest in various crops, and the prevalence of chemical and cultural control methods.

According to Schrével, Joseph and Michel Philippe (1993) Despite their common presence, the ecological and biological impacts of gregarine parasitism on *Gonocephalum simplex* remain largely unexplored, highlighting a significant gap in our understanding of this host-parasite interaction. The study done by Karuppaiah and Sujayanad (2012) aims to elucidate the relationship between seasonal variations and the incidence of gregarine parasitism in *Gonocephalum simplex*, contributing to a broader understanding of host-parasite interactions and their ecological consequences, which can significantly impact beetle populations, affecting their survival, reproduction, and overall health. Investigation done by Criado-Fornelio et al. (2017) involves examination of *G. simplex* populations across different seasons, employing both field and laboratory methods. By correlating environmental variables with parasitism rates, the study aims to identify key factors driving seasonal fluctuations in gregarine infection.

According to Modak & Haldar (2006) Previous research has highlighted the role of environmental factors in modulating parasitic infections in various hosts. However, there remains a gap in understanding the specific effects of seasonal changes on the parasitism of *Gonocephalum simplex* by gregarines. This study aims to fill this gap by providing a detailed analysis of parasitism across different seasons, utilizing microscopic examination to quantify and compare the infection rates and parasite loads. By examining the influence of seasonal variations on gregarine parasitism in *Gonocephalum simplex*, this research contributes to a broader understanding of parasitic ecology and its environmental dependencies. Such knowledge is vital for developing predictive models of parasitism under changing climatic conditions and for implementing effective conservation strategies for beetle populations and other invertebrate hosts. Through meticulous microscopic examination and detailed seasonal analysis, we aim to shed light on the complex interplay between *Gonocephalum simplex* and gregarine parasites in the Nashik district.

METHODS AND MATERIALS

Insects are collected time to time during morning period from their natural habitats, like farms (different crop plants), grasslands and gardens of different localities at Yeola, Niphad and Manmad tehsil from Nashik district of Maharashtra. As they are easily available in the upper layer and on the surface of soil infecting roots and decaying dead organic remains and sometimes on the leaves of crop plants hand peaking method is mostly preferred to collect the insects by bulk. Insects are collected in plastic tubes maintaining their natural environment in lab feeding with their natural food source to keep them alive for subsequent investigation.

Further inspection for infection of gregarine parasite is done under light microscope with the help of standard method designed by Kanse and Chondekar, 2018) for inspection of *Gregarina havanuri* (Apicomplexa: Eugregarinida: Gregarinidae) Reported from *Gonocephalum simplex* (coleoptera: Tenebrionidae), from Jalna District M.S. India

The host is dissected and its gut is removed carefully. This fresh material placed on clean glass with a drop of 0.6 % NaCl solution. A thin film or smear was taken on slide covered with cover slip for examination of live protozoans under the light microscope. Live digital photography of observed parasites is done to record the prevalence of infection.

RESULTS & DISCUSSIONS:

Dusty brown beetles were analysed in groups of 15-30 insects each time. Analysis was conducted once a week (interval of 7 days) i.e. four times within a month. One year study period was undertaken from February 2023 to January 2024 to observe the influence of seasonal variations on gregarine prevalence in the host.

Yearly Prevalence: (February 2023- January 2024):

- Total examined: 1186 *Gonocephalum simplex*
- Positive for gregarine infection: 929
- Prevalence rate: 78.33%

During the period of 12 months i.e. from February 2023 to January 2024 month wise analysis of the prevalence in *Gonocephalum simplex,* showed the maximum percentage of prevalence during September 2023 (90.83%) followed by October 2023, December 2023, November 2023, January 2024, July 2023, February 2023, August 2023, June 2023, March 2023, May 2023 (86.44%, 83.51%, 82.39%, 80.61%, 78.57%, 76.74%, 73.07%, 71.57%, 70.32%, 67.46% respectively) and the minimum percentage of prevalence is in April 2023 (66.23%).

Seasonal variations in occurrence of Gregarines in *Gonocephalum simplex* -

Summer (February-May 2023):

- Total number of hosts examined: 337
- Number of hosts infected with gregarines: 237
- Prevalence: 70.32%

Monsoon (June-September 2023):

- Total number of hosts examined: 400
- Number of hosts infected with gregarines: 318
- Prevalence: 79.50%

Winter (October 2023-January 2024):

- Total number of hosts examined: 449
- Number of hosts infected with gregarines: 374
- Prevalence: 83.29%

The prevalence of gregarines in the hosts increased from Summer (70.32%) to Monsoon (79.50%), reaching its peak during Winter (83.29%). The highest prevalence was observed in September 2023 with 90.83%, followed closely by October 2023 with 86.44%. The lowest prevalence was observed in April 2023 with 66.23%. It indicates the effect of season on infection of gregarines in the hosts, with the highest prevalence occurring during the Winter months and the lowest during the summer months.

Monthly Breakdown for Feb. 2023- Jan. 2024:

Table 1: showing the prevalence of gregarine parasites in Summer, Monsoon & Winter season (from February 2023 to January 2024) in *Gonocephalum simplex.*

Season	Duration (month wise) 2023-24	Total no. of host examined	No. of host infected with gregarines	% prevalence
Summer	February- 2023	86	66	76.74
	March- 2023	91	64	70.32
	April- 2023	77	51	66.23
	May- 2023	83	56	67.46
	Total	**337**	**237**	**70.32**
Monsoon	June- 2023	95	68	71.57
	July- 2023	70	55	78.57
	August- 2023	104	76	73.07
	September- 2023	131	119	90.83
	Total	**400**	**318**	**79.50**
Winter	October- 2023	118	102	86.44
	November- 2023	142	117	82.39
	December- 2023	91	76	83.51
	January- 2024	98	79	80.61
	Total	449	374	83.29

Fig. 1 Photo plate: Different species of gregarines found in tenebrionid insects (*Gonocephalum simplex*)

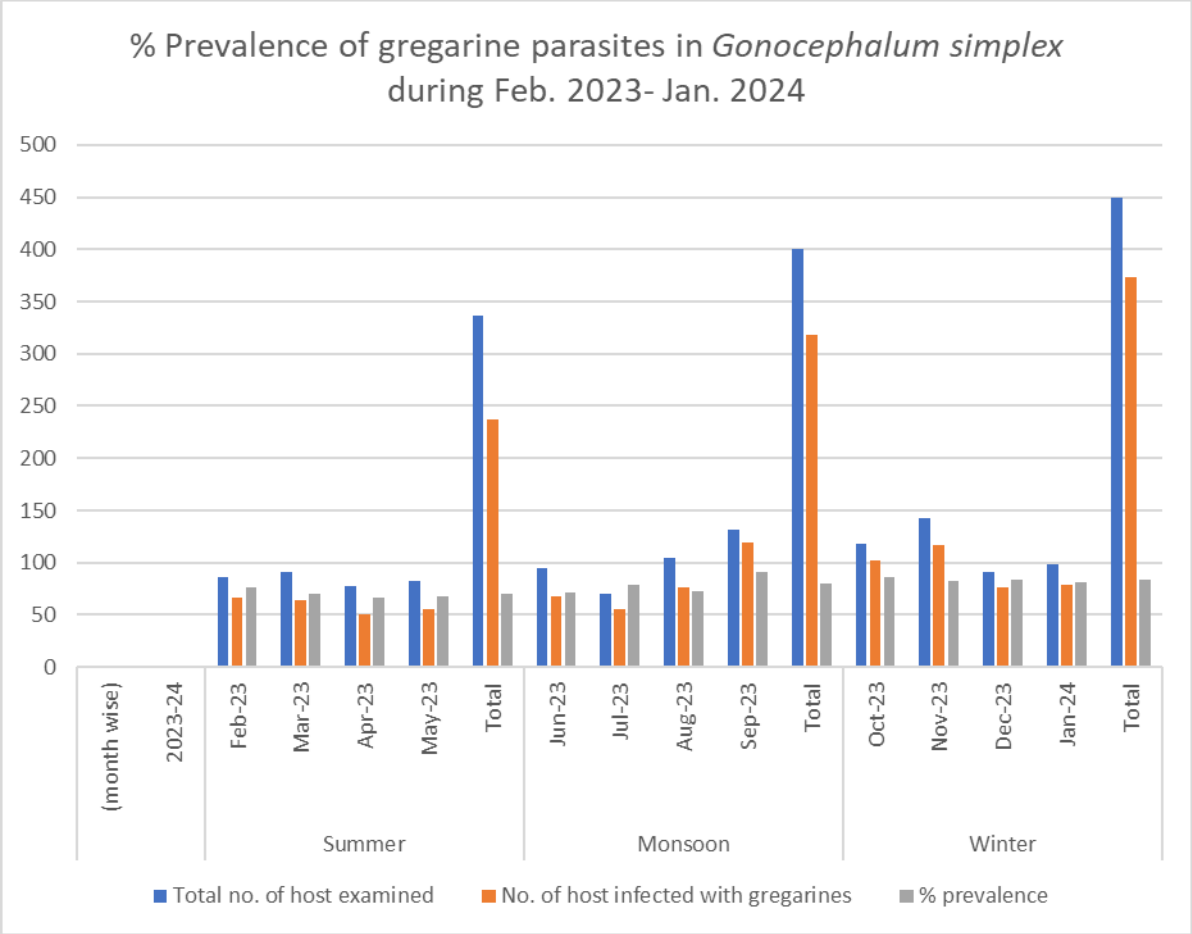

Fig. Showing the month wise prevalence of gregarine parasites (from Feb. 2023 to Jan. 2024)

CONCLUSION

The study on the prevalence of gregarine parasites in *Gonocephalum simplex* over a period of one-year underscores notable variations in infection rates on a seasonal basis.

Throughout the study period, infection rates displayed distinct seasonal patterns, indicating potential environmental and climatic influences on gregarine parasite prevalence. The peak infection rates were observed during the colder months, with November recording the highest rate at 86.55%.

In contrast, the warmer months showed relatively lower infection rates, with May having the minimum prevalence at 53.19%. These findings are also supported by analysis of Kanse (2014) The studies on some Apicomplexan parasites from invertebrates.
These findings strongly suggest that seasonal fluctuations, possibly influenced by temperature, humidity, or other environmental factors, significantly impact the prevalence of gregarine parasites in *Gonocephalum simplex*. According to Wadaskar and Patil (2016) understanding these seasonal variations is crucial for developing targeted management strategies and interventions to control and mitigate gregarine infections in economically important insects. Further research focusing on the seasonal dynamics of parasite-host interactions could provide valuable insights into the ecology and epidemiology of these parasites.

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