Zoology and Ecology, 2025, Volume 35, Number 1
Online ISSN: 2165-8013
https://doi.org/10.35513/21658005.2025.1.3

OBSERVATIONS ON THE MOSQUITO *MANSONIA* (DIPTERA: CULICIDAE) PARASITIZED BY MITES IN WEST BENGAL, INDIA

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Datta Mudi, S., Paul, P., Ghosh, S., Barman, H., Saha, G.K., Aditya, G. 2025. Observations on the mosquito *Mansonia* (Diptera: Culicidae) parasitized by mites in West Bengal, India. *Zoology and Ecology* 35(1), 25–28.
https://doi.org/10.35513/21658005.2025.1.3

Article history
Received: 30 October 2024; accepted: 9 February 2025

Keywords:
Ectoparasite; *Arrenurus*; mosquito; biological control

Abstract. Ectoparasitic associations between adult mosquitoes and water mites are ecologically significant but poorly explored. During the survey of adult mosquitoes from cattle sheds in rural areas of West Bengal, India, we encountered *Mansonia uniformis* parasitized by the larval water mite *Arrenurus* sp. with an intensity of 2.45 and a prevalence of 7.75%. An extension to the earlier reports from West Bengal, India, on mite parasitizing mosquitoes is being made in the present study.

INTRODUCTION

The parasitic association between water mites and various freshwater insects (Böttger and Martin 2003; Abé et al. 2015), including multiple species of mosquitoes (Mullen 1975; Simpson and Hutchinson 2016), was reported from different parts of the world. The larval ectoparasitic stage (protonymph) and free-living predatory stage (deutonymph and adult) of water mites belong to the families Hydryphantidae and Arrenuridae (Mullen 1975). Recent studies reported 105 mosquito species under 12 genera (Simpson and Hutchinson 2016) and 111 mosquito species under 11 genera (Vasquez et al. 2020) that were parasitized by water mites. In various freshwater habitats like streams, ponds, rice fields, and associated water bodies, mosquito larvae and water mites commonly co-exist. Co-occurrence in such habitat allows larval water mites to attach to the larval and pupal stages of mosquitoes and ultimately to the adult stage after successful emergence (Smith and McIver 1984). In the adult form, mites form stylostomes through which they feed on the tissue fluids of the mosquito (Lanciani 1979). This parasitic association between water mites and host mosquitoes impairs several life history traits that directly influence the vectorial efficacy of mosquitoes (Rajendran and Prasad 1992) and provide a chance for biological vector control. Empirical studies have reported multiple vector mosquito species from Kolkata and the surrounding districts of Howrah, Hooghly, Burdwan, and 24 Parganas in West Bengal, India, where mosquito-borne diseases are prevalent (Pramanik and Raut 2000, 2002; Pramanik et al. 2006; Banerjee et al. 2015). Therefore, entomological monitoring of adult mosquitoes was carried out from Howrah and South 24 Parganas, West Bengal, as an extension of these studies. During the sampling of adult mosquitoes, an association between water mites and adult mosquitoes lead to the compilation of this note.

MATERIALS AND METHODS

Adult female mosquitoes were collected from rural areas of Kalyanpur (22.34067 N, 88.40295 E), South 24 Parganas, and Bagnan (22.53366 N, 87.90742 E), Howrah, West Bengal, India, using mechanical aspirators from randomly selected cattle sheds. From April 2022 to March 2024, 6 cattle sheds (3 from each location) were surveyed, and captured mosquitoes were brought to the laboratory. In the laboratory, during the identification of mosquitoes, mite-infested mosquitoes were encountered and photographed using a binocular stereoscope (SZ2-ILST, Olympus, Japan) fitted with a digital camera (DGI 510, Dewinter, India). Subsequently, the mite was prepared for scanning electron microscopic study (EVO 18 special edition, Zeiss, Germany). The number

of mite-infested adult mosquitoes and the position of mite infestation on the mosquito body were noted and recorded for further analysis. The identification of mites and adult mosquitoes was carried out using proper identifying keys (Mullen 1974; Reuben et al. 1994; Nagpal et al. 2005; Zawal 2008; WHO 2020).

RESULTS

During the survey, 911 adult female mosquitoes were collected, comprising 46 *Anopheles barbirostris*, 278 *An. hyrcanus*, 19 *An. subpictus*, 21 *Armigeres subalbatus*, 33 *Culex gelidus*, 9 *Cx. quinquefasciatus*, 363 *Cx. tritaeniorhynchus,* and 142 *Mansonia uniformis*. Out of the total *Ma. uniformis*, 11 were infested with the mite *Arrenurus* sp. with a prevalence of 7.75%. The number of *Arrenurus* mites on parasitized *Ma. uniformis* ranged from 1 – 6, and 27 mites were recovered from 11 mite-infested mosquitoes with an intensity of 2.45. In all the instances, mites were recovered from the abdominal region of the mosquitoes (Figure 1).

DISCUSSION

The larval water mite *Arrenurus* sp. infestation on *Ma. annulifera* and *Ma. indiana* has already been reported (Biswas et al. 2007). However, here we are reporting *Ma. uniformis* as a host of *Arrenurus* sp. Among different captured mosquito species, we only found *Ma. uniformis* was infected by *Arrenurus* sp. The prevalence and intensity of mite infestation on *Ma. uniformis* in our study was 7.75% and 2.45, respectively, similar to other studies (Smith and McIver 1984; Werblow et al. 2015). We observed that the mites were only attached to the abdomen, though other studies also observed the head and thorax as attachment sites of *Arrenurus* (Sharma and Prasad 1992; Biswas et al. 2007). The disparities in prevalence, infestation, and attachment sites of mites on the body of the mosquito may be due to the geographical and temporal variations, dissimilarities in environmental factors, and specific combination of parasite and host species (Karunaratne and Amerasinghe 1992; Milne et al. 2009).

Apart from the parasitic association, the phoretic association has also been observed between mosquitoes

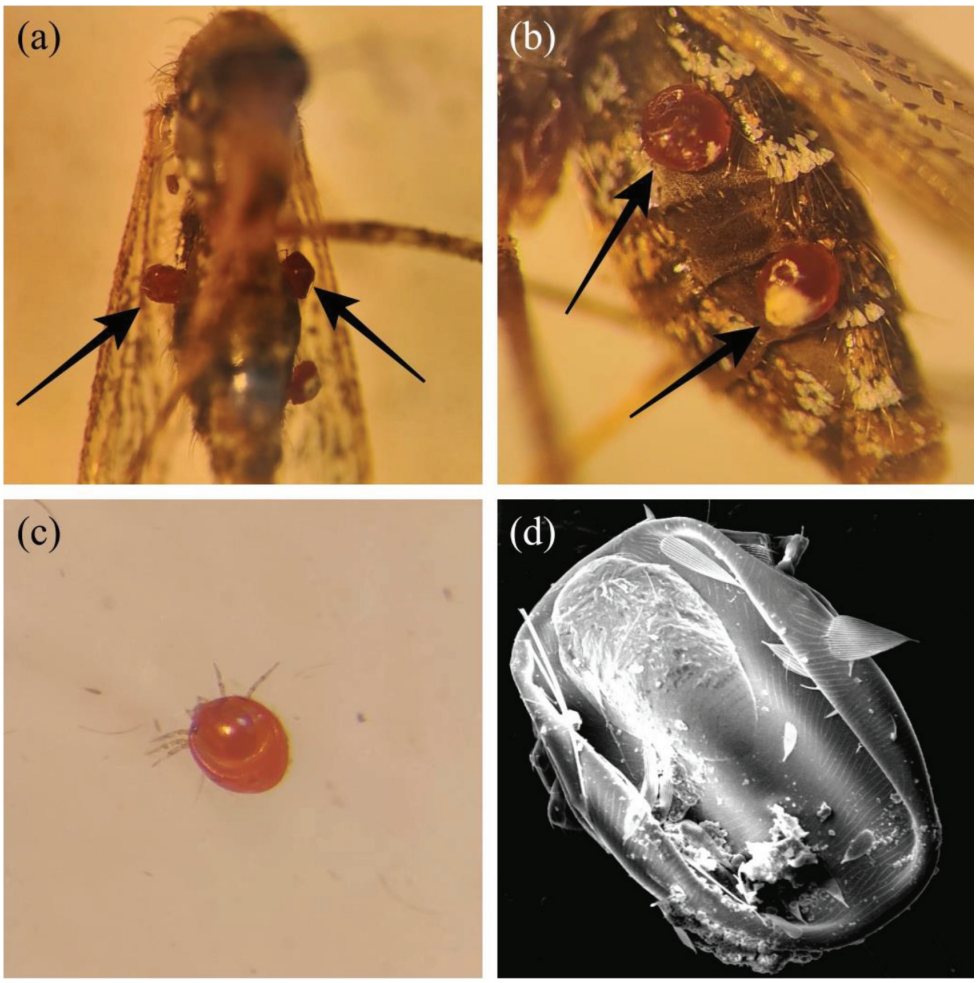

Figure 1. Ectoparasitic association between adult *Mansonia uniformis* mosquito and larval water mite *Arrenurus* sp.: (a) Water mites attached on both sides of the abdomen of the host mosquito body; (b) Mites attached to the lateral side of the mosquito abdomen were magnified; (c) Detached *Arrenurus* mite, and (d) SEM image of the mite.

and water mites (dos Santos et al. 2016). Mosquitoes infected with water mites were first reported in the late 18th century by DeGeer from an unidentified mosquito and thereafter reported by several studies from all over the world (Mullen 1975; Williams and Proctor 2002; Snell and Heath 2006; Kirkhoff et al. 2013; Manges et al. 2018), as well as from India (Rajendran and Prasad 1992; Biswas et al. 2007). This parasitic association was a possible indicator of the nulliparity of host mosquitoes, as *Arrenurus* mites are sporadically discovered in parous mosquitoes (Jalil and Mitchell 1972). The larval water mites are first attached to the immature stages of mosquitoes and subsequently to the adult mosquito body during ecdysis (Smith and McIver 1984). After attachment, mites form a tube-like structure in the mosquito body called stylostome, through which some toxic compounds may pass through the host's body (Lanciani 1979), which reduces the longevity of host mosquitoes such as *An. quadrimaculatus* and *An. crucians* (Lanciani and Boyt 1977; Lanciani 1979, 1986, 1987; Lanciani and Boyett 1980). Empirical studies also reported heavy *Arrenurus* mite infestation on mosquito bodies lowered egg production and reduced the flight capabilities of several species of mosquitoes (Lanciani and Boyt 1977; Smith and McIver 1984; Smith 1988). Rajendran and Prasad (1992) observed a heavy mite load on *Ma. uniformis* reduced the amount of blood meal ingestion, lowered the egg production rate, and increased the time of the gonotrophic cycle. Further, heavy mite infestations on vector mosquitoes reduce the probability of consuming another blood meal, which is essential for vector efficiency (Rajendran and Prasad 1992). These findings can aid in understanding the potential effects of parasitic mosquito control.

The efficiency of this parasitic association may depend on numerous ecological and environmental factors such as water quality, temperature, rainfall, and habitat structure. Moreover, host specificity by the larval mite *Arrenurus* and mite load on the host mosquito body determine their effect on regulating the vector mosquito population. Further research is needed to illuminate the ecological dynamics of this association and optimize its application in mosquito control.

ACKNOWLEDGMENTS

We thankfully acknowledge the constructive comments of the esteemed reviewer and Dr. Denis Copilas-Ciocianu, Editor-in-Chief, that enabled the enhancement of the manuscript to its present form. We are grateful to the Head, Department of Zoology, University of Calcutta, and the Director, CRNN, University of Calcutta, Kolkata, India, for the facilities provided, including DST-FIST and UGC DRS-SAP, Government of India.

Author contribution

Conceptualized by GA and GKS; Field collections and observations by SDM, PP, HB, SG, and GA; data presentation and photograph by SDM; SEM studies preparation by SDM and PP, draft preparation and final presentation by SDM and GA.

Financial support

SDM acknowledges UGC [Ref. No.: 685/(CSIR-UGC NET JUNE 2018) Roll-341095, dated 15/04/2019], PP acknowledges CSIR-HRDG [09/028(1115)/2019-EMR-1, dated 06/08/2019] and SG acknowledges CSIR-HRDG [09/0028(13457)/2022-EMR-1, dated 14/02/2022] for financial supports.

Conflict of interest statement

As authors of this article, we declare we do not have any conflict of interest.

Data availability statement

The data presented in the manuscript including the photographs can be provided upon authentic and reasonable request.

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