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A report on water mite associated with the freshwater mussel, *Lamellidens marginalis*. Gomti river, Lucknow, Uttar Pradesh.

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Abstract: - Freshwater mites belonging to the family Unionicolidae are commonly found in association with freshwater mussels and snails across lakes and streams worldwide, excluding Antarctica. Among the 265 known species of Unionicolidae, the majority are known to be associated with molluscs at least during one stage of their life cycle. This study presents a new host record from India: *Unionicola* (*Myanamaratax*) *savadiensis* was discovered on the host *Lamellidens corrianus*. Although *U. savadiensis* was also found with two other mussel species, *Lamellidens marginalis* and *Corbicula cashmiriensis*, DNA evidence confirms a parasite-host association specifically between *U. (M.) savadiensis* and *L. corrianus*, suggesting that its presence on the other mussel species may be considered as 'vagrant' associations. This report holds significance for two main reasons: firstly, it expands our understanding of mite-mussel associations by documenting new host and geographic associations, and secondly, it underscores the importance of interdisciplinary collaboration involving experts from acarology, malacology, and molecular biology to elucidate the nature of mite-mussel associations.

Keywords -Freshwater mites, Molluscs, *Lamellidens marginalis*, *Unionicola*, Gomti River.

Introduction-The vast majority of the 265 known unionicolid freshwater mites (Acari: Unionicolidae: *Unionicola*) are known to associate with molluscs during at least one stage of their life cycle. These mites have been documented to infest five out of the six families of freshwater mussels (Bivalvia: Unionoida) (Edwards and Vidrine 2013a, b). Mollusk-associated mites can be categorized into two main groups: mantle mites, which target the mantle and foot tissues of their hosts for oviposition, and gill mites, which utilize the gill tissues of their hosts for oviposition (Edwards and Vidrine 2006, 2013a, b, 2020). While it's not uncommon to find representatives of both mite groups in a single host individual in the Northern Hemisphere, these mites exhibit a high level of specificity not only in their choice of oviposition sites but also in their selection of host species. The water mite literature supporting these hypotheses regarding water mites has been summarized in various publications, including Edwards and Vidrine (2013a, b, 2021), Ernsting *et al* (2014), and more recently in Chapurina *et., al* (2021, 2022a, b). Notably, the discovery of species new to science and associations previously unknown is not uncommon. Each such discovery contributes significantly to qualifying significant

hypotheses in the evolutionary ecology of the complex 200-million-year history of mites and mollusc associations (Edwards and Vidrine 2020). The substantiation of this history with molecular evidence from a variety of sources, including both molluscan and acarine DNA sequences, is deemed essential.

In historical Indian collections, Karl Viets (1926) described two mites from a single host species in India. *Lamellidens marginalis* (Lamarck, 1819) was found to be infected by *Unionicola* (Prasadatax) diversipes Viets, 1926 (a gill mite) and *U*. (*Imamuratax*) *scutigera* Viets, 1926 (a mantle mite). Similarly, in Majumder's collections (Majumder and Pal 1987, 1988, 1990), U. *diversipes*, *U. scutigera*, and *Unionicola* sp. (= *U. (Majumderatax*) hankoi Szalay, 1927) (a mantle mite) were observed in the same host species. John and Inasu (2004) reported *U. diversipes* and *U*. (*Myanmaratax*) brandti Vidrine, 1985 from the same host species. It is plausible that the latter record might correspond to a mite belonging to one of the species described in the new subgenus in Chapurina et al. (2022a), but without supporting evidence, the record is considered doubtful. Chapurina *et al*. (2022a, b) reported several species from *Lamellidens* Simpson, 1900 as gill mites from Myanmar, including *U. diversipes*, *U. (Dimockatax) huangthayaensis* (Chapurina *et al.*, 2022b), *U. (Myanmaratax) generosa Chapurina*, Vidrine, Kondakov, Vikhrev & Bolotov, 2022 (in Chapurina *et al*., 2022a), and *U. (Myanmaratax) savadiensis* Chapurina, Vidrine, Kondakov, Vikhrev & Bolotov, 2022 (in Chapurina *et al.*, 2022a). The records of *U. (M.) savadiensis* in new host species, accompanied by molecular analyses, significantly contribute to our global understanding of the co-evolution of mussels and mites. Although a series of co-phylogenetic hypotheses is discussed elsewhere (Edwards and Vidrine 2013a), our focus here is specifically on the mites of the genus *Lamellidens* (Unionidae: Parreysiinae, Lamellidentini).

Material and Method-

Freshwater bivalves of the species *Lamellidens marginalis* were collected from different locations along the Gomti River in Lucknow, India. The Gomti River flows through the Lucknow district, positioned approximately between 26.914945° latitude and 80.888105° longitude. This study was carried out from January 2024 to April 2024 at multiple points along the course of the Gomti River.

Fig.1- Map of the site area.

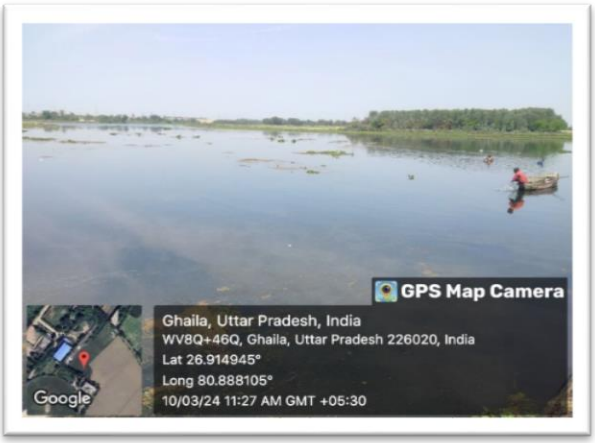

Fig.2- Image of the site area.

Fig.3- Collected animals

Fig. 4- Mite inside the animal

The mites obtained were collected by dissecting the animal *Lamellidens marginalis*. To prepare permanent mount, the water mites are stored in 10% formalin with distilled water for 24 hours. Then, they are dehydrated using various concentrations of alcohol (50%, 70%, 90%, 100%) and placed in xylene to achieve transparency. Dehydration continues until the mites become clear before mounting them in Canada balsam.

Result

Collected specimen identification occurred from Pennak (1989). In January two specimens of *Unionicola* collected from Mussels were successfully amplified from 30 animals. A collection of 30 *Lamellidens marginalis* was conducted in January 2024. Upon dissecting 10 *Lamellidens marginalis*, only one mite was obtained. Subsequently, upon dissecting 10 more *Lamellidens marginalis*, no mites were found. Repeated dissections of 10 additional *Lamellidens marginalis* yielded only one more mite. Due to low temperature in January month, there few mites available in animals. The collection of 30 *Lamellidens marginalis* was conducted in February 2024. Upon dissecting 10 *Lamellidens marginalis*, two mites were obtained. Subsequently, upon dissecting 10 more *Lamellidens marginalis*, three mites were found. Repeated dissections of 10 additional *Lamellidens marginalis* yielded only two more mites. In February frequency of mites were more than January because of temperature increase. And then the collection of 30 *Lamellidens marginalis* was conducted in March 2024. Upon dissecting 10 *Lamellidens marginalis*, four mites were obtained. Subsequently, upon dissecting 10 more *Lamellidens marginalis*, three mites were found. Repeated dissections of 10 additional *Lamellidens marginalis* yielded three more mites. Highest frequency of obtaining mites were found in march due to increasing temperature. The collection of 30 *Lamellidens marginalis* was conducted in March 2024. Upon dissecting 10 *Lamellidens marginalis*, six mites were obtained. Subsequently, upon dissecting 10 more *Lamellidens marginalis*, five mites were found. Repeated dissections of 10 additional *Lamellidens marginalis* yielded five more mites. In four months of studies, the highest number of mites found in April. Impact of temperature directly visible, in January a smaller number of mites present in comparison to April.

Fig. 5- Water mite in gill of *Lamellidens marginalis*.

Fig. 6- Image of the water mite.

Discussion- The study findings suggest that the availability of mites more depends on the temperature. Some species of North American *Unionicola* mussel-mites are found across various host species, the majority are limited to just one or two specific hosts. Imply that if *Unionicola* spp. mussel-mites are found on multiple mussel species, they are likely closely related species within the same genus rather than belonging to different genera or families of hosts. These findings align with the conclusions drawn by Vidrine (1996b), who, albeit lacking quantitative evidence, proposed that most North American *Unionicola* species exhibit host specificity. This investigation's findings also corroborate studies exploring the dispersal capabilities and host recognition behaviors of *Unionicola* spp. mussel-mites. Mites with limited dispersal abilities and species-specific behaviors towards host mussels appear to be more specialized compared to those with better dispersal abilities and no clear behavioral patterns towards mussels. For instance, research by Downes (1989) showed that *U. abnormipes* did not exhibit a preference for chemical signals from host mussels, indicating a lack of specificity in its response. The majority of the 265 known unionicolid freshwater mites (Acari: Unionicolidae: *Unionicola*) are associated with mollusks at least during one stage of their life cycle. These mites are currently known to infest five of the six families of freshwater mussels (Bivalvia: Unionoida) (Edwards and Vidrine 2013a, b). The mollusk-associated mites can be divided into two groups: mantle mites, which use the mantle and foot tissue of their hosts as oviposition sites, and gill mites, which use the gill tissues of their hosts for oviposition (Edwards and Vidrine 2006, 2013a, b, 2020). In the Northern Hemisphere, it is not uncommon to find representatives of both groups of mites in a single host individual. However, the mites are highly specific not only in their choice of oviposition sites but also in their selection of host species. The literature on water mites supporting these hypotheses was summarized by Edwards and Vidrine (2013a, b, 2021), Ernsting *et al*. (2014), and more recently by Chapurina *et al*. (2021, 2022a, b). In historical Indian collections, Karl Viets (1926) described two mites from a single host species in India. *Lamellidens marginalis* (Lamarck, 1819) was infected by *Unionicola* (*Prasadatax*) *diversipes* Viets, 1926 (a gill mite) and *U.* (*Imamuratax*) *scutigera* Viets, 1926 (a mantle mite). Similarly, Downes (1989) observed that although *U. serrata* displayed negative phototaxis in water altered by mussels, this behavior wasn't specific to their natural habitat, as they exhibited it even in the presence of mussels they didn't naturally inhabit. Given that both *U. abnormipes* and *U. serrata* are adept swimmers (Downes, 1989), it's hypothesized that their good dispersal abilities enable them to locate and colonize a wide range of host species. On the other hand, two species of *Unionicola* from the subgenus *Parasitatax* (*U. formosa* and *U. foili*), characterized by limited swimming capabilities according to

observations by D. Edwards, display highly specialized behaviors towards host mussels, as demonstrated by research conducted by Edwards *et al*. (1998). An analysis of the genetic makeup of *U*. *formosa* across three host genera, as outlined by Edwards *et al.* (1998), unveiled that various populations associated with specific hosts exhibited significant genetic differences, forming reproductively isolated sibling species. Consequently, what was conventionally perceived as a single mite species existing in parasitic symbiosis with various mussels might actually signify the presence of two or more highly specialized, yet cryptic, *Unionicola* species. When comparing the host specificity between the two primary clades of mussel-mites, namely gill mites and mantle mites, it was observed that gill mites parasitized a narrower range of hosts in terms of taxonomy compared to mantle mites. This study further underscores the potential of a freshwater bivalve such as *Lamellidens marginalis* as a valuable laboratory model for investigation relationships between various parasitic animals and their impact on the environment.

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