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Cover: A gravid praying mantis just before she laid her ootheca—digital art on procreate. © Aakanksha Komanduri.



First record of the phoretic association between *Pediculaster* sp. (Pygmephoridae) mites and *Musca crassirostris* (Muscidae) flies in India

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The arthropods include many classes; one of them is Arachnida, which is great and assorted as it contains scorpions, spiders, ticks, and mites. It contains 1,14,275 species; among them merely Acari has 55,214 species of mites and ticks (Zhang 2013). In general, many small organisms exploit another larger organism for their movement from one place to another which is usually called phoresy. The word phoresy derives from the Greek phorein, which means ‘to carry’ (White et al. 2017). According to Farish & Axtell (1971), “Phoresy is a phenomenon in which one animal actively seeks out and attaches to the outer surface of another animal for a limited time during which the attached animal (termed the phoretic) ceases both feeding and ontogenesis, such attachment presumably resulting in dispersal from areas unsuited for further development, either of the individual or its progeny”. In simple words, we can say that phoresy is the short-term relation in which transportation takes the place of one animal by other animals. In mites, long-distance dispersal is chiefly determined by phoresy, aerial migration, and anemochory (dispersal by wind) (Szymkowiak et al. 2007).

The phenomenon of phoresy has been pragmatic in many organisms, be it flies & mites, flies & ticks, beetles & bees, nematodes & flies/slugs, and bugs & mantids

(White et al. 2017). An examination of a specific phoront on a carrion can authenticate the existence of its carrier even when the carrier is absent. Fast colonised mites have developed unique behaviours in which they have become phoront to flies for mobility and dispersal (Athias-Binche 1994; Siepel 1994). Upon reaching their preferred habitat, such as a corpse or other biological waste, the mites detach from the carrier and commence the process of maturing into their reproductive stage (Halliday 2000). Berlese (1918) was the first to report on phoretic mites found on carcasses. In this article, the description of a phoretic pygmephorid mite on a muscid fly in India marks its initial documentation. Pygmephorid mites fall under the order Prostigmata and the family Pygmephoridae.

Thirty-two mites were collected in July 2019 from Khajjiar town, which is located at 32.5558°N, 76.0656°E with 1,920 m elevation in the Chamba district of Himachal Pradesh, India. Collected mites were present on the muscid flies that were captured by a collection net from the bird corpse (*Acridotheres tristis*). Subsequently, collected flies along with mites were stored in the 70% alcohol. Mites were then detached from the flies with the help of forceps and cleared in lactophenol solution (for 48 hours). Slides of mites were mounted

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with Hoyer's medium. Afterward, photography was done with the help of the micro photographic unit (Leica, DM4000 B LED) in the Sophisticated Instrumentation Centre of Punjabi University, Patiala. Mites were identified with the help of keys given by Krantz & Walter (2009) and fly species by Emden (1965). Fly species were further confirmed with the help of molecular techniques by amplifying the mitochondrial DNA COI (Barcoding) region. The type material was deposited in the collection of the Department of Zoology and Environmental Sciences, Punjabi University, Patiala.

Mites were identified as species of the genus *Pediculaster* belonging to the family Pygmephoridae. Image 1 shows adults of *Pediculaster* sp. mites attached to the prothorax region of *Musca crassirostris* fly; Image 2 shows adults of *Pediculaster* sp.; Image 3 shows a close view of the gnathosoma part of the mite; and Image 4 shows a close view of the idiosoma part of the mite. The flies were recognized as *Musca crassirostris*, a member of the Muscidae family. Additionally, using LCO/HCO primers provided by Folmer et al. (1994), the mitochondrial COI gene (Folmer area) has been amplified to guarantee the identification of fly species. For sequencing purposes, amplified DNA was delivered to the Agrigenome labs. The species *Musca crassirostris* was validated by BLAST analysis of the sequence acquired after sequencing in the NCBI database. Upon submission of the sequence to the NCBI database, a distinct accession number, MH243421, was obtained (Table 1). It was the first instance of a phoretic connection between *Pediculaster* mites and *Musca crassirostris*.

Various muscid species were recognised as carriers for the *Pediculaster* mites. Kheradmand et al. (2006) recorded that *Pediculaster fletchmanni* mites used *Musca domestica* as a carrier. Camerik & Coetzee (1998) examined that *Pediculaster corpridis* mites attached to *Musca confisate* for their dispersal. Masan & Kristofik (1992) described that *Pediculaster mesembriane* mites used *Fannia manicata* flies for phoresy. *Cheyletus eruditus* & *Ereynetes* which are members of prostigmatic mites used Muscidae flies along with Lepidopteran as carriers.

Astigmatic mite species are used as well as muscid flies for their dispersal. Flies belonging to family Histiotomatidae like *Copronomoia sphaerocerae*, *Histiostoma muscae*, *Myianoetus diadematus*, *Myianoetus ovatus*, *Myianoetus parvus*, *Myianoetus muscarum*, *Myianoetus longisetosus* (Masan & Kristofik 1992; Chinniah & Mohanasundaram 1995; Greenberg & Carpenter 1960; Greenberg 1961) and family Winterschmidtidae like *Vidia* sp. (Ho 1990) used muscid flies as a carrier for the disper-

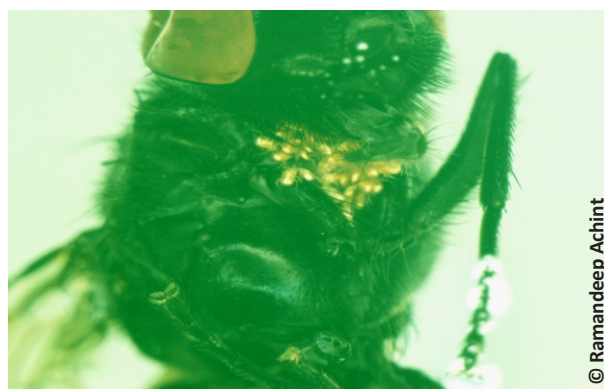


Image 1. Adults of *Pediculaster* sp. mites attached on the prothorax region of *Musca crassirostris* fly.



Image 2. Adult of mite *Pediculaster* sp.

sion. In company with Asitigmatic types mites, Mesostigmatic mites also used Muscid flies for phoresy as well. Numerous mites species belonging to Macrochelidae family like *Glyptolaspis confusa* used *Musca domestica* (Niogret et al. 2006); *Macrocheles bertrandi* used *Stomoxys calcitrans* (Niogret & Nicot 2008); *Macrocheles glaber* used *Hydrotaea dentipes* (Masan & Kristofik 1992); *Macrocheles muscaedomesticae* used *Musca domestica* (Pereira & Castro 1947) and *Musca sorbens* along with *Ophyra chalcogaster* (Ho 1990); *Macrocheles mykutowyczi* used many species of Muscid flies (Halliday 2000); *Macrocheles ovoidalis* used *Stomoxys calcitrans* (Niogret & Nicot 2008); *Macrocheles perglaber* used *Musca domestica* (Niogret et al. 2006); *Macrocheles robustulus* used *Musca domestica* (Axtell 1964); *Macrocheles subbadius* used *Stomoxys calcitrans*, *Musca domestica*, *Haematobia irritans* (Axtell 1964; Krantz & Whitaker 1988; Niogret et al. 2006) as a carrier. A few

Image 3. Close view of Gnathosoma part of *Pediculaster* mite.Image 4. Close view Idiosoma part of *Pediculaster* mite.Table 1. *Musca crassirostris* fly sequence submitted to the NCBI.

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>MH243421
TTTGGAGCATGATCTGGTATAGTAGGAACCTTCATTAAGAATTTAATTCGAGCCGAATTAGGACACCCTGGTGCTTAATTTGGTGACGATCAAATTTATAAT-
GTTATTGTAACAGCTCATGCTTTTATTATAATTTCTTTATAGTTATGCCTATTATAATTGGAGGATTGGAAATTGATTAGTTCCTTTAATGTTAGGAGCTCCT-
GATATAGCATTTCTCGAATAAATAATAAGTTTCTGACTTTTACCTCCTGCTCTTACTTTATTATTAGTTAGAAGTATAGTAGAAAAGGGGGCTGGGACAG-
GATGAACAGTTTATCCACCTTTATCTCAATTATTGCTCATGGAGGGGCTTCTGTTGATTAGCTATTTTTCTCTTCATTAGCCGGAATTTCTCAATTTAG-
GAGCAGTAAATTTATTACTACTGTAATTAATACGAGCTACTGGAATTACATTTGATCGAATACCTTTATTGATGATCAGTTGTAATTACTGCTTTATTACTTT-
TACTTTCTTTACCAGTTTATAGCCGGAGCTATTACTATACTATTAACAGATCGAAATTTAAATACTCTGTTCTTTGACCCAGCAGGAGGAGGTGA
```

mites belonging to the Parasitidae family which includes *Gamasodes spiniger* exploit *Hydrotaea* species as carriers. *Uroseius* sp. and *Halolaelaps* sp. species of families Trachytidae and Halolaelapidae employ *Musca domestica*, *Musca stabulans*, and *Hydrotaea dentipes* as dispersal carriers (Masan & Kristofik 1992; Perotti 1998).

The present study is the first of its kind in India but it needs to be done to a great extent directly to compile data about the species exactitude of mites and their habitat penchant. If knowledge about the carriers, life cycles, behaviour, and habitat particulars of mites is acquired then it will help in estimating the postmortem interval (PMI). Forensic acarology should formulate superior exploit of this and hastily expand into a helpful alternate input into forensic analysis.

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