Pakistan J. Zool., pp 1-10, 2025. **DOI**: https://dx.doi.org/10.17582/journal.pjz/20240816085733

Review Article

An Overview of Insect Mite Association

Allwin Loveson[1], Vaithiyanathan Radhakrishnan[2]*, S. Vijay[2], Varadharajan[2], Baskaran[3], Madhaiyan Ravi[4], Senjeriputhur Duraiyappan Sivakumar[2], Duraiyappan Periyar Ramasamy[5] and Muthuramalingam Ramasubramanian[6]

[1]*Agricultural College and Research Station, Killikulam-628252, India*
[2]*Institute of Agriculture, Tamil Nadu Agricultural University, Kumulur-621712, Trichy, India*
[3]*Department of Entomology, Tamil Nadu Agricultural University, Coimbatore-641003, India*
[4]*Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Sandhiyur-636203, India*
[5]*ICAR-Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Thiruvarur-614404, India*
[6]*Nammazhvar Organic Farming Research Centre, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India*

ABSTRACT

Mite comprises the largest group within the arthropodan of Class Arachnida, with over 45,000 described species in subclass Acari. The Arachnida is also represented by the spiders (Order: Araneae), harvestmen (Order: Opiliones) and pseudoscorpions (Order: Pseudoscorpionida). They exhibit greater diversity in their morphological, physiological, behavioral and ecological adaptations. These adaptations ensure their association with other arthropods and vertebrates. Acari-Insect association ranges from opportunistic, possible accidental to parasitic and predatory, in which one or more life stages of the mite occur and feed on the host. Special structures present in legs as well as gnathosoma leads to make the attachments easily.

Article Information
Received 22 October 2024
Revised 14 November 2024
Accepted 18 November 2024
Available online 22 January 2025
(early access)

Authors' Contribution
AL: Methodology, writing review and editing. RV: Conceptualization, writing review and editing. VS: Formal analysis, resources. BV: Formal analysis, resources. RM: Writing review and editing. SSD: Supervision. PD: Drafting and validation. RM: Supervision

Key words
Insects, Mites, Association, Phoresy, Attachments, Gnathosoma

INTRODUCTION

Insect-mite association is quite a long relationship, of which, it leads to phoretic, parasitic and predatory in nature. The placement of attachment may vary from insects to insects along with the associations. The overloading of mites in the insect body reduces the day today activity of host insects. These mites belong to orders Mesostigmata, Astigmata and Prostigmata. The detailed review on Acari-Insect association is summarized hereunder.

Order: Mesostigmata

More than 8,280 species have been described under Mesostigmata order in the world under 887 genera; 2 genera and 2 species in the fossil as reported by Lindquist (2005a). These groups are characterized by a single pair of breathing pores or stigmata, located laterally in the middle of the idiosoma between the second and third or third and fourth pair of legs. It also possesses two to three tined palpal claws and a tritosternum, for most mesostigmatid mites. It ranges from less than 0.2 mm to more than 4 mm in length and distributed globally. Mesostigmatid mites associated with economically important pests as well as biocontrol agents. It also found in quarantine inspections.

The principal host insect orders for the mesostigmatid mites are Coleoptera, Hymenoptera, Diptera and Lepidoptera. Almost 93 percent of the insect mites are associated with this particular mite order. Treat (1975) has narrated, comprehensive summary of mite-Lepidoptera association with 41 lepidopteran families. Even the association was also recorded from termite nests. Some of the mites are also having the characteristic features of predacious or parasitic in nature. The Phytoseiidae family are beneficial to humans as predators of the destructive spider mites.

Order: Astigmata

Lindquist (2005b) reported around 3,419 species of

* Corresponding author: drvradhakrishnan@tnau.ac.in
0030-9923/2025/0001-0001 $ 9.00/0

Astigmata in the world under 1096 genea; 2 genera and 3 species in the fossil. The mite super family Canestrinioidea attached as external commensals or parasites of most of the beetle families *viz*., Scarabaeidae, Chrysomelidae, Carabidae, Passalidae, Tenebrionidae and Lucanidae. Olynyk and Freitag (1979) stated that the mites are not site-specific on numerous insects especially carabids. The soil-dwelling bees and wasps are also attached with astigmatid mites which also establishing symbiotic relationships with both vertebrates and invertebrates.

Order: Prostigmata

More than 47 per cent are parasites or parasitoids of other arthropods and 7 percent of the species are free-living predators. The mite families *viz*., Pygmephoridae and Scutacaridaeare associated with social insects, whereas mite family Podapolipidae invade as parasites on beetles, grasshoppers and honey bees. A single mite genus i.e., *Leptus* spp. associated with extensive range of insect orders and it act as a parasitoid.

PHORESY

Phoresy means one animal (phorent) attaches another animal (carrier or host) for a limited time and period. At that time of migration, the phorent enters in to the quiescent stage and becomes active after its detachment. Soroker *et al*. (2003) narrated the steps of phoresy i.e., Initiation of phoretic behaviour, active host seeking, recognition of attractant behaviour and attachment to the host surface. The winged insects possess higher dispersal ability than the mites (Holte *et al*., 2001). Scutacarids are encountered as phoretic in behaviour (Baumann and Juli, 2024). *Parasitellus* species prefers as better host on *Bombus* sp. for its phoretic purpose (Kolster *et al*., 2024) and *Uroobovella* species attached on the thoracic region of grasshopper as phoretic relationship (Radhakrishnan *et al*., 2024a).

The mesostigmatid mites and ectoparasitic larvae of the prostigmatid were attached with adult *Culicoides impunctatus* Goetghebuer (Wohltmann and Wendt, 1996). Whiteflies have strong phoretic potential with *Polyphagotarsonemus latus* (Banks) and the mites reduces the mobility and its biology to some extend (Palevsky *et al*., 2001). The phoretic relationships will be highly complex, but often are manipulative of the carrier's resources or progeny (Seeman and Walter, 2023). Dung beetles are possessing mesostigmatid mites on the ventral region of the head and it is purely phoretic in nature (Radhakrishnan *et al*., 2024b). Phoretic association with bumble bees were recorded no risk for their host (Revainera *et al*., 2020). Some of the phoretic mites associated with Diptera, Coleoptera, Hymenoptera, Hemiptera and Orthoptera have been summarized in Table I.

ACARI-SOCIAL INSECTS ASSOCIATION

Eickwort (1994) stated that mites are significant associate with the beneficial insects i.e., honeybees. Out of these association, a tracheal mite, *Acarapis woodi* is an obligate parasite of the honey bees *Apis mellifera* (L.) occurs many countries in the world (Matheson, 1993). The host insect termite had associated with *Histiostoma*, parasitic on the subfamilies *viz*., Otopheidominae, Treatiinae and Katydiseiinae (Zhang, 1995). Noel *et al*. (2020) stated that, the integrated pest management decreases the acaricide usages to control the *Varroa* mite in bees. The lists of very few mites associated with social insects are summarized in Table II.

BIOLOGICAL CONTROL AGENTS PARASITIC MITES

Podapolipidae (Acari: Tarsonemina) family were parasitized on various insect orders and the mite species was parasitic on the metanotum, metathoracic wing region, abdominal dorsal surface in carabid beetles (Husband and Kurosa, 2013) and four species from Australian carabid beetles (Seeman and Katlav, 2024).

The parasitic mites are divided into two groups based on their feeding sites.

Parasitic mites of insects (Ectoparasites)

The mite species *Pyemotes tritici* (Newp.) (Prostigmata: Pyemotidae), *Blattisicius tarsalis* (Berlese) (Mesostigmata: Ascidae), *Acarophenax mahundai* Steinkraus and Cross (Prostigmata: Acarophenacidae) are devoured as natural enemies of stored product insect pests (Faroni *et al*., 2001). Certain mite species are also act as egg parasites of various insects and their biology was not known (Goldarazena *et al*., 2001). Tenebrioniid beetles act as a parasitic host of canestriniid mite, *Bircericola bertrami* Haitlinger (Acari: Astigmata: Canestriniidae) (Haitlinger, 2000a). European butterfly adults are parasitized by bright red mite larvae of the family Trombidiidae (Southcott, 1986).

Endoparasitic mites of insects

Alfalfa weevil, *Hypera postica* Gyllenhall was parasitized by the larvae of *Trombidium newelli* Welbourn and Flessel (Acari: Trombidiidae) (Mohamed and Hogg, 1997). The insect order Orthoptera and Coleoptera were occupied the tracheae of *Podapolipus* and *Locus tacarus*. Sharma *et al*. (1983) stated that the mites pierce the cavity walls of the ear and destroy the ultrasonic sound.

Table I. Phoretic mites associated with different orders of insects.

Insect order and mite family	Mite name	Host insect name	Habit and habitat	References
Order: Diptera				
Arctoseiidae	*Iphidozercon* sp.	Psychodid flies	Mites are phoretic on the abdomen of the flies	Whitsel and Schoepphenr, 1973
Rhizoglyphidae	*Rhizoglyphus echinopus* (F.andR.)	*Narcissus* fly	Phoretic	Hussey *et al*., 1969
Uropodidae	*Fuscuropoda vegetans* De Geer	*Musca domestica*	Phoretic	Greenberg, 1961
Order: Coleoptera				
Canestriniidae	*Grandiella batocerae* (Vis.and Moh.)	*Hylastes* sp.	Mites found beneath the elytra	Vishnupriya and Mohanasundaram, 1988
Diplogyniidae	*Diplogynium oryctae* (Vis.and Moh.)	*Batocera rufomaculata* De Geer	Phoretic	Vishnupriya and Mohanasundaram, 1988
Eviphididae	*Alliphis serrochaetae* (Ram. and Moh.)	*Helicopris* sp.	Phoretic	Ramaraju and Mohanasundaram, 1996a
Macrochelidae	*Macrocheles scarabae* (Vis. and Moh.)	*Catharsius molossus* (L.)	Phoretic	Vishnupriya and Mohanasundaram, 1988
Macrochelidae	*Macrocheles sukabumiensis* Hartini and Takaku	*Cantharsius pithpcius* (F.)	Phoretic	Hartini and Takaku, 2003
Parasitidae	*Poecilochirus coimbatorensis* (Vis. and Moh.)	*Onthophagus* sp.	Phoretic	Vishnupriya and Mohanasundaram, 1988
Pachylaelapidae	*Pachylaelaps catharsiae* (Vis.and Moh.)	*Onitis philemon* (F.)	Phoretic	Vishnupriya and Mohanasundaram, 1988
Uropodidae	*Urobovella texana* (Wis and Hirsch.)	*Pholeomyia* sp.	Phoretic	Moser, 1976
Winterschmidtiidae	*Calvolia longireticulatae* (Ram. and Moh.)	Meloid beetle	Phoretic	Ramaraju and Mohanasundaram, 1999a
Uroactiniidae	*Centrouropoda almerodai*	*Rhynchophorus phoenicis*	Phoretic	Monzenga *et al*., 2021
Neopygmephoridae	*Allopygmephorus coelostomus*	Australian hydrophilid beetles	Phoretic	Hamid *et al*., 2022
Order: Hymenoptera				
Cheyletidae	*Cheletophyes xylocopae* (Ram. and Moh.)	*Xylocopa* sp.	Phoretic	Ramaraju and Mohanasundaram, 1999b
Chaetodactylidae	*Samsinakia carabae* (Ram. and Moh.)	Carabid beetle	Phoretic	Ramaraju and Mohanasundaram, 1999b
Chaetodactylidae	*Sennertia carpenteri* (Ram. and Moh.)	Carpenter bees	Phoretic	Ramaraju and Mohanasundaram, 2001
Laelapidae	*Blattisocius trigonae*	*Trigona iridipennis*	Phoretic	Radhakrishnan and Ramaraju, 2017a
Order: Hemiptera				
Tarsonemidae	*Polyphagotarsonemus latus* (Banks)	Whiteflies	Phoretic	Palevsky *et al*., 2001
Erythraeidae	*Erythraeus ankaraicus* (Saboori *et al*.,)	*Hyalopterus pruni* Geoffroy	Ectoparasite	Saboori *et al*., 2004
Order: Orthoptera				
Erythraeidae	*Leptus laviniacus* Haitlinger	*Catantops innotabilis* (Walk.)	Phoretic	Haitlinger, 2002
Erythraeidae	*Leptus astrubali* Haitlinger	*C. innotabilis*	Phoretic	Haitlinger, 2002
Scutacaridae	*Imparipes bengalensis*	*Labidura bengalensis*	Phoretic	Radhakrishnan and Ramaraju, 2017b

Table II. Mites associated with social insects.

Insect order and mite family	Mite name	Host insect name	Habit and habitat	References
I. Ants				
Acaridae	*Tyrophagus formicetorum* (F and C)	Ant's nest	Phoretic	Fain and Chmielewski, 1987
Uropodidae	*Trichocylliba gibbata* (E.)	Army ants	Phoretic	Elzinga, 1995
Scutacaridae	*Scutacarus unicosimilis* Metwali	*Cataglyphus bicolor* (Lighton *et al*.,)	Large ant nest	Metwali, 1984
Macrodinychidae	*Macrodinychus multispinosus*	Ants	Ectoparasite	Lachaud *et al*., 2016
II. Honeybees				
Acaridae	*Acarus immobilis* (G.)	*Apis mellifera* (L.)	Facultative scavenger	DeJong *et al*., 1982
Acaridae	*Horstiella snellingi* (Och. and OCon.)	Neotropical *Epicharis* bees	Phoretic	Ochoa and OConnor, 2000
Laelapidae	*Androlaelaps bayoumi* (Bas. and Yous.)	*Trigona albipennis* Almedia	Found inside the nest	Basha and Yousef, 2001
Laelapidae	*Suracarus inusitatus* (Flech.)	*T. albipennis*	Found inside the nest	Flechtmann, 2005
Laelapidae	*Blattisocius trigonae*	*Trigona iridipennis*	Phoretic	Radhakrishnan and Ramaraju, 2017a
Tarsonemidae	*Acarapis woodi* (Re.)	*Euglossa* sp.	Parasite	Pettis and Wilson, 1996
Tydeidae	*Tydeus* sp. *Pronematus* sp.	*A. mellifera*	Found in bee hive	Malabanan and Corpuz Raros, 1998
Varroidae	*Varroa jacobsoni* (Oud.)	*A. cerana* *A. mellifera*	Found in bee hive	Malabanan and Corpuz Raros, 1998
III. Other bees				
Parasitidae	*Parasitus fimetorum* Berlese	*Nest of Ciconia ciconia* (L.)	Phoretic	Bloszyk *et al*., 2005
IV. Wasp				
Glycyphagidae	*Acaroglyphus robustus* (Del.)	Eumenine wasp	Mites isolated from the body	Baker and Baker,1976
V. Termite				
Otopheidomenidae	*Eickwortius termes* Zhang	*Macrotermesmichaelseni* Sjostedt	Phoretic	Zhang, 1995
Ascidae	*Proctolaelaps hypadari* (Oud.)	Termite	Parasitic on termite	Myles, 2002

Table III. Parasitic mites associated with different orders of insects.

Orders of insects and families of mites	Name of the mite	Host insect name	Habitat and nature of attack	References
Ectoparasitic mites				
Order: Orthoptera				
Erythraeidae	*Leptus oxyae* (Vis. and Moh.)	*Oxya nitidula* (Wal.)	Ectoparasite	Vishnupriya and Mohanasundaram, 1998
Erythraeidae	*Ramsayellar angitata* Zhang	Grasshopper	Ectoparasite	Zhang, 2000
Erythraeidae	*Charletonia keralicus* (Ram. and Moh.)	*Oxya* sp.	Parasite	Ramaraju and Mohanasundaram, 1998b

Table continued on next page.....

Orders of insects and families of mites	Name of the mite	Host insect name	Habitat and nature of attack	References
Podapolipidae	*Podapolipoides mohanasundarami* (R. and S.)	*Oxya* sp.	Ectoparasite	Ramaraju and Suresh, 1999
Podapolipidae	*Podapolipoides cohni* (Hus. and Ma.)	Grasshopper	Ectoparasite	Husband and Martin, 2005
Podapolipidae	*Podapolipus sundarababui* (Ram. and Moh.)	*Attractomorpha*sp	Ectoparasite	Ramaraju and Mohanasundaram, 1996c
Eutrombidiidae	*Eutrombidium laosanum* Haitlinger	Undetermined Gryllidae	Ectoparasite	Haitlinger, 2006b
Order: Dictyoptera				
Podapolipidae	*Blaberpolipus cavernicola* (Hus. and OCon.)	*Blaberusparabolicus* (Wal.)	Ectoparasite	Husband and OConnor, 2003
Order: Hemiptera				
Trombidiidae	*Podothrombium gossypium* Zhang	Aphids	Ectoparasite	Zhang, 2001
Order: Diptera				
Trombidiidae	*Trombidium poriceps* (Oud.)	*Ochlerotatus notoscriptus* Skuse	Ectoparasite	Pugh *et al*., 1991
Order: Lepidoptera				
Pyemotidae	*Pyemotes* sp.	*Tribolium* sp. *Cryptolestes* sp.	Parasitize the immature stages	Pajni and Virk, 1982
Podapolipidae	*Regenpolipus madrasensis* (Hus. and Ram.)	*Anthia sexguttata* (Fab.)	Parasite	Husband and Ramaraju, 2006
Podapolipidae	*Tarsopolipus ramakrishnai* (Ram. and Moh.)	Scarab beetles	Parasite	Ramaraju and Mohanasundaram, 1996b
Podapolipidae	*Eutarsopolipus dastychi* (Hus. and Kha.)	*Calathus fuscipes*-Goeze	Parasite	Husband and Khaustov, 2004
Canestriniidae	*Haitlingeria longilobata* Baker and Schwarz	*Serrognathus platymelus* Motschulsky	Parasite	Kim *et al*., 2006
Order: Odonata				
Arrenuridae	*Arrenurus* sp.	*Trithemis pallidinervis*	Parasite	Radhakrishnan, Zawal and Ramaraju, 2010
Endoparasitic mites				
Order: Lepidoptera				
Otopheidonemidae	*Dicrocheles phalaenodectes* Treat	Noctuidae	Tympanum	Treat, 1975
Order: Coleoptera				
Podapolipidae	*Dorsipes auncinus* Husband and Weatherby	*Tefflus* sp.	Endoparasites of orthoptera, hymenoptera especially coleoptera	Husband and Weatherby, 2005

Five mite species were recorded from Laelapidae family as first time in Pakistan in the soil ecosystem (Khan et al., 2024). Bountiful species are reported under parasitic mite association. Few examples are mentioned in Table III.

Predatory mites of insects

Ferguson (2001) stated that predaceous mites are generally feeds on springtails whereas, the pyemotid mites devastated scales and flies (Bregetova and Koroleva, 1960). The eggs of Lepidoptera were fed by the deutonymph and adults of *Callidosoma metzi* Sharma, Drooz and Treat (Sharma *et al*., 1983). Some of the predatory mites associated with the various orders of insects are given in Tables IV.

Table IV. Predatory mites associated with different orders of insects.

Orders of insects and families of mites	Name of the mite	Host insect name	Habitat and nature of attack	References
Order: Orthoptera				
Trombidiidae	*Eutrombium trigonum* (Pes.)	*Heiroglyphus nigrorepletus* (Ph.)	Predator on immature stages	Peswani, 1960
Order: Thysanoptera				
Pyemotidae	*Adactylidium* sp.	*Thrips* sp.	Predaceous on eggs and thrips	EL Badry and Tawfik, 1966
Order: Hemiptera				
Hemisarcoptidae	*Hemisarcoptes malus* (Sh.)	*Aspidiotus nerii* (B.)	Predator	Beardsley and Gonzalez, 1975
Trombidiidae	*Allothrombium mitchelli* Davis	*Cryptococcus fagisuga* Lindinger	Predator	Wiggins *et al*., 2001
Order: Diptera				
Trombidiidae	*Allothrombium dipterae* (Ram. and Moh.)	*Musca domestica* (L.)	Predator	Ramaraju and Mohanasundaram, 1998a
Trombidiidae	*Allothrombium dipterae* (Ram. and Moh.)	Cicindellid beetle	Predator	Ramaraju and Mohanasundaram, 1998a
Order: Lepidoptera				
Ascidae	*Blattisocius tarsalis* Berlese	*Ephestia cautella* (Wal.)	Larvae and nymphs of mites feed eggs and host larvae	Graham, 1980
Pyemotidae	*Pyemotes ventricosus* (Newp.)	*Sitotroga cerealella* Olivier	Predatory on eggs	Navarro *et al*., 1987
Order: Coleoptera				
Pyemotidae	*Pyemotes tritici* (Newp.)	*Anthonomus grandis* Boheman	Attacks immature stages	Cross and Moser, 1975
Order: Hymenoptera				
Cheyletidae	*Cheyletus eruditus* Schrank	*Cephalonom iatarsalis* Ashmead	Biocontrol agent	Zdarkova*et al*., 2003

CONCLUSION

The studies on Insect-Mite relationship were very scanty. Since, the attachment of mite in different insect host was predatory, phoresy and parasitic in nature, it can be utilized in all the ways and means. Insect associated potential predatory mite will be exploited for the pest management studies and if possible, the mites will be multiplied on the same insect host. On the other hand, to minimize the insect pest incidence, the ecto and endoparasitic mite studies have to be strengthened and it will pave way to enlighten the pest management aspects.

DECLARATIONS

Acknowledgements

We acknowledge the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore for providing the lab facility to conduct the experiment.

Funding

No funding was provided /received for this experimental work.

IRB approval

The experimental work was carried out with the approval of Director of Research, TNAU, Coimbatore.

Ethical statement

All the applicable international, national or institutional guidelines for the care were followed.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Baker, M.D. and Baker, E.W., 1976. Notes on hypopi (Acarina) associated with bees and wasps (Hymenoptera). *J. N. Y. entomol. Soc*., **84**: 76-90.

Basha, A.A. and Yousef, A.T.A., 2001. New species of Laelapidae and Ascidae from Egypt: genera *Androlaelaps* and *Blasttisocius* (Acari: Gamasida). *Acaralogia*, **41**: 395-402.

Baumann, J., 2024. An update on the knowledge about scutacarid mites as phoronts and inquilines. *Acarologia*, **64**: 3-17. https://doi.org/10.24349/sy16-8iqn

Beardsley, J.W. and Gonzalez, R.H., 1975. The biology and ecology of armored scales. *Annu. Rev. Ent*., **20**: 47-73. https://doi.org/10.1146/annurev.en.20.010175.000403

Bloszyk, J., Dariusz, J., Gwiazdowi, C.Z., Bajerlein, D. and Halliday, R.B., 2005. Nests of the white stork *Ciconia ciconia* (L.) as a habitat for mesostigmatic mites (Acari: Mesostigmata). *Acta Parasitol*., **50**: 171-175.

Bregetova, N.G. and Koroleva, E.V., 1960. The Macrochelid mites (Gamasoidae: Macrochelidae) in the USSR. Dept. separatae, parasitological collection. *Parasitology*, **18**: 132-154.

Cross, E.A. and Moser, J.C., 1975. A new dimorphic species of *Pyemotes* and a key to previously-described forms (Acarina: Tarsonemoidea). *Annls entomol. Soc. Am*., **68**: 123-132. https://doi.org/10.1093/aesa/68.4.723

DeJong, D., Roger, A. and Eickwort, G.C., 1982. Mite pests of Honeybees. *Annu. Rev. Ent*., **27**: 229-252. https://doi.org/10.1146/annurev.en.27.010182.001305

Eickwort, G.C., 1994. Evolution and life-history patterns of mites associated with bees. In: *Mites. Ecological and evolutionary analyses of life-history patterns* (eds. M.A. Houck). Chapman and Hall, New York. pp. 218-251. https://doi.org/10.1007/978-1-4615-2389-5_9

El-Badry, E.A. and Tawfik, M.S.F., 1966. Life cycle of the mite *Adactylidium* sp., Acarina: Pyemotidae), a predator of thrips eggs in the United Arab Republic. *Annls entomol. Soc. Am*., **59**: 458-461. https://doi.org/10.1093/aesa/59.3.458

Elzinga, R.J., 1995. Six new species of *Trichocylliba* (Acari: Uropodina) associated with Army ants. *Acarologia*, **36**: 107-115.

Fain, A. and Chmielewski, W., 1987. The phoretichypopi of two acarid mites described from ants nest; *Tyrophagus formicetorum* Volgin (1948) and *Lasioacarus nidicolus* Kadzhaja and Sevastianor (1967). *Acarologia*, **28**: 58.

Faroni, L.R.D'A., Guedes, R.N.C. and Matioli, A.L., 2001. Effect of temperature on development and population growth of *Acarophenax lacunatus* (Cross and Krantz) (Prostigmata: Acarophenacidae) on *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae). *Biocontr. Sci. Technol*., **11**: 5-12. https://doi.org/10.1080/09583150020029682

Ferguson, S.H., 2001. Changes in trophic abundance of soil arthropods along a grass-shrub-forest gradient. *Can. J. Zool*., **79**: 457-464. https://doi.org/10.1139/z01-002

Flechtmann, C.H.W., 2005. *Suracarus inusitatus* (Mesostigmata: Laelapidae) from the nest of a stingless bee from Brazil. *Int. J. Acarol*., **31**: 39-43. https://doi.org/10.1080/01647950508684414

Goldarazena, A., Ochoa, R., Jordana, R. and Oconnor, B.M., 2001. Revision of the genus *Adactylium* Cross (Acari: Heterostigmata: Acarophenacidae), mites associated with thrips (Thysanoptera). *Proc. Ent. Soc. Wash*., **103**: 473-516.

Graham, W.M., 1980. Warehouse ecology studies of bagged maize in Kenya. II. Ecological observations of an infestation by *Ephestia* (*Cadracautella*) (Walk.) (Lepidoptera: Phycitidae). *J. Stored Prod. Res*., **6**: 157-167. https://doi.org/10.1016/0022-474X(70)90004-4

Greenberg, B., 1961. Mite orientation and survival on flies. *Nature*, **190**: 107-107. https://doi.org/10.1038/190107a0

Haitlinger, R., 2000a. A new species of larval *Dasitrombium* Zhang, 1994 (Acari: Prostigmata: Neothrombiidae) parasitic on grass hoppers from Nicaragua. *Syst. Parasitol*., **47**: 65-67. https://doi.org/10.1023/A:1006469919082

Haitlinger, R., 2002. Two new species of *Leptus* Latrellie. 1796 and the first record of *Leptus astrubali* Haitlinger (Acari: Erythraeidae) from India and Sri Lanka. *Syst. appl. Acarol*., **7**: 177-184. https://doi.org/10.11158/saa.7.1.20

Haitlinger, R., 2006b. Two new species of *Eutrombidium* Verdun, 1909 (Acari: Prostigmata: Eutrombidiidae) from Asia and a new host record for this genus. *Syst. Parasitol*., **67**: 111-116. https://doi.org/10.1007/s11230-005-9025-3

Hartini, S. and Takaku, G., 2003. Japanese species of the mite genus *Macrocheles* (Arachnida: Acari: Gamasina: Macrochelidae). *Zool. Sci*., **20**: 1261-1272. https://doi.org/10.2108/zsj.20.1261

Holte, A.E., Houck, M.A. and Collie, N.C., 2001.

Potential role of parasitism in the evolution of mutualism in astigmatid mites: *Hemisarcoptes cooremani* as a model. *Exp. appl. Acarol.*, **25**: 97-107.

Husband, R.W. and Kurosa, K., 2013. *Eutarsopolipus asiaticus* sp. nov., (Acari: Podapolipidae), subelytral parasite of *Chlaeniuscostiger chaudoir* (Coleoptera: Carabidae) from Japan. *Syst. appl. Acarol.*, **18**: 61–70. https://doi.org/10.11158/saa.18.1.7

Husband, R.W. and Khaustov, A.A., 2004. A new species of *Eutarsopolipus* (Acari: Podapolipidae) from *Calathus fuscipes* (Coleoptera: Carabidae) from Ukraine. *Int. J. Acarol.*, **30**: 329-333. https://doi.org/10.1080/01647950408684401

Husband, R.W. and OConnor, B.M., 2003. A new genus and species of mite (Acari: Tarsonemina: Podapolipidae) ectoparasite of the *Peruvian cockroach*, *Blaberus parabolicus* (Walker) and *Eublaberus distanti* (Kirby) (Blattoidea: Blaberidae). *Int. J. Acarol.*, **29**: 331-338. https://doi.org/10.1080/01647950308684349

Husband, R.W. and Weatherby, C.A., 2005. Description of the male *Auncinius* (Acari: Podapolipidae) from *Tefflus* sp., Coleoptera: Carabidae) in Kenya and comparision of adult and larval females of *Dorsipes auncinius* from democratic republic of the Congo and South East Kenya. *Int. J. Acarol.*, **31**: 245-248. https://doi.org/10.1080/01647950508684427

Husband, R.W. and Martin, J.M., 2005. A new species of Podapolipidae (Acari: Heterostigmata), parasite of *Aidemona azteca* (Orthoptera: Acrididae) in Honduras and redescription of the genus *Podapolipoides*. *Int. J. Acarol.*, **31**: 237-244. https://doi.org/10.1080/01647950508684426

Husband, R.W. and Ramaraju, K., 2006. A new species of *Regenpolipus* (Acari: Podapolipidae) from *Anthia sexguttata* (Coleoptera: Carabidae) from Southern India and a pictorial key to genera of world podapolipidae from Carabidae. *Int. J. Acarol.*, **32**: 153-161. https://doi.org/10.1080/01647950608684454

Hussey, N.W., Read, W.H. and Hesling, J.J., 1969. *The pests of protected cultivation*. Arnold, London. pp. 187.

Khadem-Safdarkhani, H., Hajiqanbar, H., Riegler, M., Seeman, O. and Katlav, A., 2022. Two new phoretic species of heterostigmatic mites (Acari: Prostigmata: Neopygmephoridae and Scutacaridae on Australian Hydrophilid beetles (Coleoptera: Hydrophilidae). *Insects*, **13**: 483. https://doi.org/10.3390/insects13050483

Khan, A.K., Bruce, H.R. and Muhammad, H.B., 2024. New records of soil mites from Pakistan with description of a new species (Acari: Laelapidae). *Persian J. Acarol.*, **13**: 51.

Kim, W., Lee, S., Choi, J., Sim, H., Kim, J., Choi, J. and Kim, K., 2006. A new canestriniid mite, *Haitlingeria longilobata* (Acari: Astigmata: Canestriniidae) parasitising *Serrognathus platymelus castauicolor* Motschulsky (Coleoptera: Lucanidae) from South Korea. *Syst. Parasitol.*, **65**: 13-18. https://doi.org/10.1007/s11230-006-9035-9

Kolster, J.M., Franziska, K., Heller, K., Mercado-Salas, N.F. and Husemann, M., 2024. Host range of the phoretic mite genus *Parasitellus* (Acariformes: Parasitidae) on wild bees (Hymenoptera: Apiformes), with specific notes on its morphological and genetic diversity in Northern Germany. *Integ. Syst. Stuttgart Contrib. Natl. Hist.*, **7**: 31-42. https://doi.org/10.18476/2024.396542

Lachaud, J.P., Hans, K. and Gabriela, P.L., 2016. *Macrodinychus* mites as parasitoids of invasive ants: An overlooked parasitic association. *Sci. Rep.*, **6**. https://doi.org/10.1038/srep29995

Lindquist, E.E., 2005a. *Synopsis of the described Mesostigmata of the world*. http://insects.tamu.edu.research/collection/hallan/acari/mesostigmata1.htm.

Lindquist, E.E., 2005b. *Synopsis of the described Astigmata of the world*. http://insects.tamu.edu.research/collection/hallan/acari/astigmata1.htm.

Malabanan, J.M. and Corpus-Raros, L.A., 1998. Mites associated with *Apis mellifera* Linnaeus and *Apis cerana* Fabricius in the southern Tagolog region, Phillippines. *Philipp. Ent.*, **12**: 123-135.

Matheson, A., 1993. World bee health report. *Bee World*, **74**: 176-212. https://doi.org/10.1080/0005772X.1993.11099183

Metwali, S.H., 1984. Survey on the family Scutacaridae (Acari) in Egypt. II. *Acarologia*, **25**: 241-248.

Mohamed, A.M.A. and Hogg, D.B., 1997. New ectoparasitic mite of alfalfa weevil in Wisconsin. *Midwest Biol. Contr. News*, **7**: 5.

Monzenga, L., Jean, C., Le, G., Guillaume, J., Keyisu, K. and Hannce, T., 2021. Phoretic mites associated with *Rhynchophorus phoenicis* Fabricius (1880) (Coleoptera: Curculionidae) in the Kisangani region, D.R. Congo. *Acarologia*, **61**: 291-296. https://doi.org/10.24349/acarologia/20214431

Moser, J.C., 1976. Surveying mites (Acarina) phoretic on the Southern pine beetle (Coleoptera: Scolytidae) with sticky traps. *Can. Entomol.*, **108**: 809-813. https://doi.org/10.4039/Ent108809-8

Myles, T.G., 2002. Observations on mite (Acari) associated with the Eastern Subterranean termite, *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). *Sociobiology*, **39**: 277-280.

Navarro, R., Luna, C. and Juarej, R., 1987. Tests of different substrates for the mass multiplication of *Sitotroga cerealella*. *Agron. Trop*., **33**: 111-121.

Noël, A., Yves, L.C. and Fanny, M., 2020. *Varroa destructor*: How does it harm *Apis mellifera* honey bees and what can be done about it? *Emerg. Top. Life Sci*., **4**: 45-57. https://doi.org/10.1042/ETLS20190125

Ochoa, R. and OConnor, B.M., 2000. Revision of the genus *Horstiella* (Acari: Acaridae) mites associated with neotropical *Epicharis* bees (Hymenoptera: Apidae). *Annls entomol. Soc. Am*., **93**: 713-737. https://doi.org/10.1603/0013-8746(2000)093[0713:ROTGHA]2.0.CO;2

Olynyk, J.E. and Freitag, R., 1979. Some phoretic association of ground beetles (Coleoptera: Carabidae) and mites (Acarina). *Can. Entomol*., **3**: 333-335. https://doi.org/10.4039/Ent111333-3

Pajni, H.R. and Virk, N., 1982. Observations on some aspects of the biology of *Tribolium castaneum* Herbst., Coleoptera: Tenebrionidae). *Res. Bull. Punjab Univ. Sci*., **33**: 155-158.

Palevsky, E., Soroker, V., Weintraub, P., Mansour, F., Abo-Moch, F. and Gerson, U., 2001. How species-specific is the phoretic relationship between the broad mite, *Polyphagotarsonemus latus* (Acari: Tarsonemidae) and its insect hosts. *Exp. appl. Acarol*., **25**: 217-224. https://doi.org/10.1023/A:1010645315630

Peswani, K.M., 1960. *Eutrombidium trigonum* Herman., Trombidiidae: Acarina) a predatory red mite of *Heiroglyphus nigrorepletus* Bolivar., Phadka. *Indian J. Ent*., **28**: 411-412.

Pettis, J.S. and Wilson, W.T., 1996. Life history of the honey bee tracheal mite (Acari: Tarsonemidae). *Annls Ent. Soc. Am*., **89**: 368-374. https://doi.org/10.1093/aesa/89.3.368

Pugh, P.J.A., King, P.E. and Fordy, M.R., 1991. Larvae of *Trombidium (Trombidium) poriceps* (Oudemans) (Trombidiidae: Prostigmata: Acarina) parasitic on *Chersodromia speculifera* Walker (Empididae: Diptera: Hexapoda). *Acarologia*, **32**: 23-27.

Radhakrishnan, V. and Ramaraju, K., 2017a. New honeybee mite, *Blattisocius trigonae* sp. nov., Acari: Laelapidae), phoretic on *Trigona iridipennis* (Apidae: Hymenoptera) from Tamil Nadu, India. *J. Ent. Zool. Stud*., **5**: 841-844.

Radhakrishnan, V. and Ramaraju, K., 2017b. First record on *Imparipes bengalensis* sp. nov., Acari: Scutacaridae) on *Labidura bengalensis* Dohrn (Forficulidae: Dermaptera) from Tamil Nadu, India. *J. Ent. Zool. Stud*., **5**: 1606-1611.

Radhakrishnan, V., Vijay, S., Baskaran, V., Allwin, L., Ravi, M., Indiragandhi, P., Periyar Ramasamy, D., Ramaraju, K. and Sivakumar, S.D., 2024a. Description of *Uroobovella tripophinae* sp. Nov., Acarina: Uropodidae) phoretic association with grasshopper *Trilophidia turpis* Walker (Acrididae: Orthoptera) from Tamil Nadu, India. *Pakistan J. Zool*., pp. 1-4. https://dx.doi.org/10.17582/journal.pjz/20240307080135

Radhakrishnan, V., Zawal, A. and Ramaraju, K., 2010. First record of parasitized *Trithemis pallidinervis* (kirby) from Tamil Nadu, India by *Arrenurus* larvae, with a description of larval morphology (Anisoptera: Libellulidae; Acari: Hydrachnidia). *Odonatologica*, **39**: 243-252.

Radhakrishnan, V., Allwin, L., Vijay, S., Baskaran, V., Ravi, M., Sivakumar, S.D., Indiragandhi, P. and Ramaraju, K., 2024b. Description of *Gamasellus onitiae* sp. nov., Ologamasidae: Mesostigmata) from dung beetle, *Onitis philemon* (Scarabaeidae: Coleoptera) in India. *J. Ent. Sci*., **60**. https://doi.org/10.18474/JES24-21

Ramaraju, K. and Mohanasundaram, M., 1996a. A new species of *Alliphis* and *Eviphis* (Acari: Eviphididae) from Tamil Nadu, India. *Turk. Ent. Derg*., **20**: 163-173.

Ramaraju, K. and Mohanasundaram, M., 1996b. New species of *Podapolipus, Podapolipoides* and *Tarsopolipus* (Acari: Podapolipidae) from South India. *Int. J. Acarol*., 22(10): 33-41. https://doi.org/10.1080/01647959608684079

Ramaraju, K. and Mohanasundaram, M., 1996c. A new *Podapolipus* species (Acari: Podapolipidae) from Tamil Nadu, India. *Int. J. Acarol*., **25**: 189-194. https://doi.org/10.1080/01647959908684152

Ramaraju, K. and Mohanasundaramm M., 1998a. Two new predacious mite species of *Allothrombium* (Trombidiidae: Prostigmata) from Tamil Nadu. *J. Insect. Sci*., **11**: 110-113.

Ramaraju, K. and Mohanasundaram, M., 1998b. Two new species of *Charletonia* Oudemans (Acari: Erythraeidae) from Tamil Nadu, India. *J. Ent. Res*., **22**: 207-212.

Ramaraju, K. and Mohanasundaram, M., 1999a. A new hypopus of *Calvolia longireticulatae* (Acari: Winterschmidtiidae) from Tamil Nadu, India. *J. Ent. Res*., **23**: 47-49.

Ramaraju, K. and Mohanasundaram, M., 1999b. Two

new cheyletid mites (Acari: Cheyletidae) from Tamil Nadu, India. *Int. J. Acarol*., **25**: 121-127. https://doi.org/10.1080/01647959908683623

Ramaraju, K. and Mohanasundaram, M., 2001. New phoretic mites (Acari: Chaetodactylidae) on carpenter bees from Tamil Nadu, India. *Int. J. Acarol*., **27**: 107-112. https://doi.org/10.1080/01647950108684237

Ramaraju, K. and Suresh, S., 1999. A new species of *Podapolipoides* (Acari: Podapolipidae) from Tamil Nadu, India. *Int. J. Acarol*., **25**: 195-199. https://doi.org/10.1080/01647959908684153

Revainera, P.D., Silvina, Q., Gregorio, F.L., Facundo, M.A., Mariano, L., Alberto, H.A., Santiago, P., Martín, J.E. and Matías, D.M., 2020. Phoretic mites on South American bumblebees (*Bombus* spp.) as parasite carriers: A historical input. *Apidologie*, **51**: 455–464. https://doi.org/10.1007/s13592-020-00733-w

Saboori, A., Cakmak, I. and Gonbalani, G.N., 2004. A new species of larval *Erythraeus* (Zaracarus) (Acari: Erythraeidae) from Turkey. *Int. J. Acarol*., **30**: 131-136. https://doi.org/10.1080/01647950408684381

Seeman, O.D. and Katlav, A., 2024. Podapolipid mites (Acari: Heterostigmata): Key to genera, biogeographical history and description of four new Australian species of *Eutarsopolipus*. *Zootaxa*, **5448**: 301-347. https://doi.org/10.11646/zootaxa.5448.3.1

Seeman, O.D. and Walter, D.E., 2023. Phoresy and mites: More than just a free ride. *Annu. Rev. Ent*., **68**: 69–88. https://doi.org/10.1146/annurev-ento-120220-013329

Sharma, G.D., Drooz, A.T. and Treat, A.E., 1983. A new species of *Callidosoma* (Acari: Prostigmata: Erythraeidae) parasite on adults of *Anacamptodes vellivolata* (Lepidoptera: Geometridae) as a larva, and predator of eggs of Lepidoptera as deutonymph and adult. *Annls Ent. Soc. Am*., **76**: 120-129. https://doi.org/10.1093/aesa/76.1.120

Soroker, V., Nelson, D.R., Bahav, O., Reneh, S., Yablonski, S. and Palevsky, E., 2003. Whitefly wax as a cue for phoresy in the broad mite, *Polyphagotarsonemus latus* (Acari: Tarsonemidae), *Chemoecology*, **13**: 163-168. https://doi.org/10.1007/s00049-003-0243-3

Southcott, R.V., 1986. Studies on the taxonomy and biology of the subfamily Trombidinae (Acarina: Trombidiidae) with a critical revision of the genera. *Aust. J. Zool. Suppl. Ser*., **123**: 1-116. https://doi.org/10.1071/AJZS123

Treat, A.E., 1975. *Mites of moths and butterflies*. Cornell Univ. Press, Ithaca. pp. 362.

Vishnupriya, R. and Mohanasundaram, M., 1988. Mites associated with insects in Tamil Nadu, India. *Entomology*, **13**: 247-257.

Whitsel, R.H. and Schoepphenr, R.F., 1973. Mites associated with aquatic and semi-aquatic Diptera from sanmateo county, California. *Proc. Ent. Soc. Wash*., **75**: 71-77.

Wiggins, G.J., Grant, J.F. and Welbourn, W.C., 2001. *Allothrombium mitchelli* (Acari: Trombidiidae) in the Great Smoky Mountains National Park: Incidence, seasonality and predation on Beech scale (Homoptera: Eriococcidae). *Annls Ent. Soc. Am*., **94**: 896-901. https://doi.org/10.1603/0013-8746(2001)094[0896:AMATIT]2.0.CO;2

Wohltmann, A. and Wendt, F.E., 1996. Observations on the biology of two hygrobiotictrombidioid mites (Acari: Prostigmata: Parasitengonae), with special regard to host recognition and parasitism tactics. *Acarologia*, **37**: 31-44.

Zdarkova, E., Lukes, J. and Horak, P., 2003. Compatibility of *Cheyletus eruditus* (Schrank) (Acari: Cheyletidae) and *Cephalonomia tarsalis* (Ashmead) (Hymenoptera: Bethylidae) in biological control of stored grain pests. *Pl. Prot. Sci*., **39**: 29-34. https://doi.org/10.17221/3824-PPS

Zhang Z.Q., 1995. The genus *Neophanolophus* (Acari: Smaridídae) and description of a new species parasitic on an *Erythroneura* leaf hopper (Hemiptera: Cicadellidae) in India. *Orient. Insects*, **29**: 371-379. https://doi.org/10.1080/00305316.1995.10433746

Zhang Z.Q., 2000. *Ramsayella*, new genus of Erythraeinae (Acari: Erythraeidae) parasitic on grasshoppers in New Zealand. *Int. J. Acarol*., **26**: 33-40. https://doi.org/10.1080/01647950008683633

Zhang Z.Q., 2001. Description of *Podothrombium gossypium* from cotton in Jiangxi, China, (Acari: Trombidiidae). *Acta Zoot. Sin*., **26**: 172-178.