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# OCCURRENCE OF FIVE SPECIES OF ERIOPHYOID MITES (ACARI: ERIOPHYOIDEA) AND THEIR NATURE OF INFESTATION ON TROPICAL PLANTS FROM NORTHERN DISTRICTS OF WEST BENGAL, INDIA

Sanjay Sarkar

*Entomology Research Unit, Department of Zoology, Serampore College, Serampore, Hooghly, W.B. 712201, India*

**ABSTRACT:** During the general surveys for eriophyoid mites in two districts namely Malda and Dakshin Dinajpur of West Bengal, India, five eriophyoid mites namely *Aceria ficus* (Cotte), *Aceria granati* (Canestrini & Massalongo), *Aceria mauritianae* Amrine & Stasny, *Aceria nerii* Channabasavanna, and *Aceria lalbaghi* Amrine & Stasny, were collected from four tropical plants. The host association, relationship with the host plants and their nature of damage, climatic condition of the study area, vegetative patterns of the study area and a taxonomic key to the species are provided in this article.

***Key words:*** Eriophyoid mite, host association, Taxonomic key, *Aceria*, damage, tropical plants, India.

## INTRODUCTION

The Acari comprising of ticks and mites, form one of the largest and biologically most diverse group of Arachnida. Some of them are potential pest of crop and other agricultural and forest plants, while some others like ticks are parasites on wide range of vertebrate hosts. Among the Acari, Eriophyoid mites are second largest group with regard to their economic importance as phytophagous pest throughout the world (Lindquist *et al.* 1996). These mites are drawing the attention of biologist all over the world for their morphological and biological specializations. Due to their obligatory phytophagous mode of nutrition, they exhibit marked host specificity. The great diversity of these tiny plant feeders is related to their extreme host specificity and intimate host relationships (Oldfield 2002). Their impact as specialized phytophagous mites is well known and strongly accented in each of their involvements as direct plant pests, plant pathogen vectors, agents of control of weeds, and food

*Author for correspondence: <montabhaloto@gmail.com>
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sources for predators. Eriophyoid mites, which are among the smallest plant feeders, are characterized by the intimate relationships they have with their hosts and the restricted range of plants upon which they can reproduce. They seek micro environments in which they live, feed and reproduce (Jeppson *et al.*1975). Many insert themselves into crevices, bud, scale, or at petiole bases on their host plants, and in that way, they receive shelter and food from their habitat. Since most of the eriophyoids are negatively phototropic, they are generally found in closed confined spaces of plant body such as sheath, erinea, galls etc. However, a large number of species are also found freely exposed on plant surface as vagrants on the under surface of leaves, twigs or are found either on leaf, lamina or in angles formed by the major vein. They are exclusively plant parasites in all stages of their development. During feeding, some species inject saliva to the plant tissues that affects plants in various ways. Due to their feeding habit many eriophyoid species are potentially harmful to crop plants and vegetables. In general, eriophyoids cause mechanical damage to plant tissue by their feeding. Several of them are directly responsible for developing various disease symptoms in plants viz. blisters, galls, formation of erinea, big bud, rusting fruits, spoiling blossoms, blasting buds, growth of felt like hairs on infested parts, outgrowth of closely packed papillae on leaf surface, distortion of flower buds, introduction of witches broom, rust and browning of leaves and fruits. Besides direct injury they are also known to transmit viruses to the plant body. Among all mites, eriophyoids are rather peculiar in several ways. They are not only microscopic in size but also show great reduction in body structure. Structurally, they possess a more or less elongate, averaging about 200 microns in length, vermiform, having only two pairs of legs in both adult and nymphs, body setation reduce to minimum and genitalia are proximal just behind the coxae. There are no definite ocelli on these mites, but little sub-triangular projections may be light receptors. Biologically also they are interesting because certain species exhibits two different forms of females, a primary form known as 'Protogyne' which reproduces in the same season in which it is formed, and other a secondary form known as 'Deutogyne', which is adapted for hibernation during unfavourable seasonal conditions and which does not normally reproduce in the season in which it is formed. (Lindquist, E.E. 1996 A further point of interest of these mites, potentially much more serious than direct losses to agriculture, is that a few species are known to be vectors of certain viral diseases of different crop plants (Slykhuis 1960). The transmission of 21 pathogens by 13 species of phytophagous

mites to at least 34 plants has been reported in the literature (Oldfield and Proeseler 1996; Seifers *et al.* 1996, 1998; Chagas *et al.* 2001; Childers *et al.* 2001; Stephan *et al.* 2008). Most mite species that are known to vector plant pathogens are in the Eriophyidae. At least 26 plant diseases are associated with eriophyid mites (Jones 1999). As a result of their tiny size and very short stylets, they feed only the epidermal cells of their plant hosts where they may acquire and transmit disease agents to these plant cells (Jones 1999). The location of these different viruses in epidermal cells of their plant host suggest that the mode of transmission by their mite vector should be of a non-persistent or semi-persistent type, but the data indicate that some may be of a persistent (circulative) type (Jones 1999). Eriophyoid mites can then disseminate phytovirus to non-affected areas if they are transported after the virus acquisition period.

Eriophyoids are highly host specific and this specificity is probably due to the chemical composition of host plant, leaf size, its texture etc. (Gupta 1985). Growth regulators are salivary chemicals possessed by some eriophyoids that when injected into plants either discolour leaves or change growth patterns of the affected cells. Composition of these growth regulators in mites is unknown, but these salivary chemicals are diverse. The longevity of the host plant does not influence host specificity of eriophyoid species, and that most species infesting either annual or perennial hosts are highly host specific (Anna Skoracka *et al.* 2010). Anna Skoracka *et al.* (2010) reported in an article that plant families of the greatest interest, i.e., those with the highest number of eriophyoid species (ES) recorded are: Rosaceae (300 ES), Fabaceae (250 ES), and Asteraceae (200 ES), as well as Aceraceae, Euphorbiaceae, Moraceae, Rubiaceae, Pinaceae, Salicaceae, Fagaceae, Poaceae (100 ES each). All of these plant families are large in terms of number of species and geographical range, and many are of economic importance.

The basic necessity for the proper control or eradication of any harmful organisms is to know its systematics as well as its degrees of damages inflicted on the host. In this regard, the eriophyoid mites are needed to understand in greater details particularly in India as the study of Indian eriophyoid is still at infant stage and mainly on taxonomy. Therefore, it requires exploring the eriophyoid fauna through faunistic surveys all over the country on zonal basis and subsequently the relevant biology, ecology etc. of the economically important species. They are distributed from tropics to beyond the Arctic Circle. Eriophyidae represent the second family economically important as crop pests after the

Tetranychidae (Lindquist and Amrine 1996). It is also the family with the highest number of taxa (about 3,700 species from 350 genera) (Amrine and De Lillo 2006)

The mounting media recommended here for study and preservation of eriophyooid mites are water media based primarily on chloral hydrate. This media besides helping to remove opaque soft tissue, soften, expands and platicizes exoskeletons of delicate eriophyoid mites. This expansion enlarges specimens and displays structural features. In addition, following points are required to be considered for better study of eriophyoid examples. these are ; 1) prepare well cleared and transparent specimens,; opaque inside tissue makes correct drawing impossible; 2) use of only well-formed examples of the mites with leg projecting ahead and diagonally down; 3) use particularly dissected mites for genitalia delineation; 4) since these mites show important characteristics by the presence or absence of microtubercles, do not leave the structures off of rings when they are actually present on the specimen being drawn; 5) carefully note presence or absence of all setae on the body and legs; show precise location of these setae; 6) follow body and leg form carefully, especially in depicting ridges, furrows and thickenings.

Since 1978, Chakrabarti and his associate workers took the first endeavor to study this group from north-east and eastern India i.e. West Bengal and eastern Bihar. The area of present work is the part of this endeavor and has been confined to the two districts of North Bengal viz. Malda and Dakshin Dinajpur of the state West Bengal where particularly no study on eriophyoid fauna has yet been made. The host association of these species, relation to the host plants, nature of infestation, have been provided in this paper.

## MATERIAL AND METHODS

*Study area:* The present study area comprises of two districts of West Bengal viz. Malda and Dakshin Dinajpur where no study has so far been made on eriophyoid mites although the vegetation pattern and floral diversity are quite different from rest of the North Bengal districts. This present area of study is lying between 87°45' E to 88°58' E longitude and 24°40' N to 25°57' N latitudes. Topographically it shows both terrain as well as plain lands. Brief geographical features of the area are as follows: The area lies 347 kilometers north of Kolkata, the capital of the state of West Bengal. This area is surrounded by Murshidabad district in south,

North Dinajpur district in north, Bangladesh in east and part of Bihar state in the west. The area comprises a total 5895.66 km². Both the

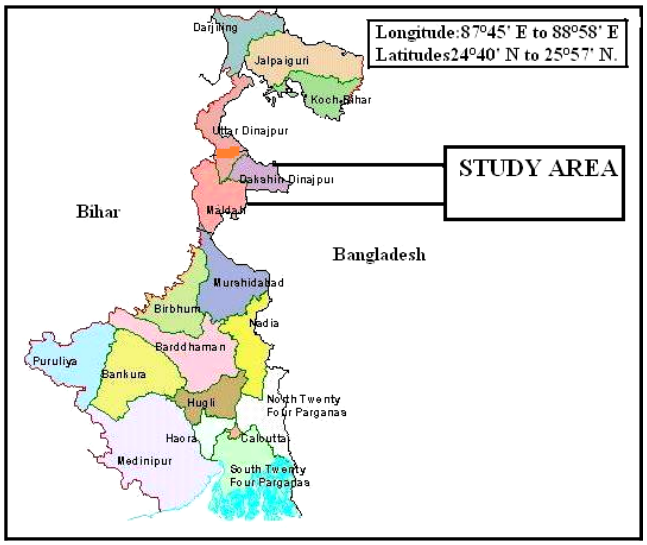


Fig.1 Map of West Bengal state of India showing the location of the present study.

districts are rural agricultural districts. Mulberry plantations and mango orchards occupy large areas of Malda district. Few important rivers viz. Mahananda, Kalindi, Atreye, Punarbhaba and Brahmani which can be mentioned flow in that area. The important and notable reserve forests of these area are Adina forest, Halna forest and among the protected forests Mazilkhan, Tilason, Pather Mahadeb bati. The State of West Bengal experiences Tropical Monsoon type of climate. The features of climate, however, vary between its different districts. Some of the important features of climate of the area of present study are described below.

*Rain fall:* Average rainfall of Dakshin Dinajpur and Malda measures about 4500- 5600mm and 6500-7000mm. respectively. Most of the precipitation are concentrated in June to September and those of July and August are recorded the highest.

*Temperature:* Here, temperature normally varies from 5°C in January to 35.5°C in June.

*Humidity:* Maximum relative humidity varies between 80-95%, seldom below 70% averaging maximum in June to September and minimum in December to February.

*Dew and fog:* From November to February, the nights are very cold with much dew. Otherwise fog and frost are absent but dew is normally deposited after April and continues up to June.

*Wind and storms:* The wind blows pleasantly from the foot hills area in September and October. During hot months from April to June, warm wind blows over this area from 11 AM to 3 PM and the air becomes dry with dust which is frequently interrupted by the storms. (Banerjee, 1993).

*Soil:* Soil of the districts is of mixed type. Red soil of old alluvial formation and stiff clay containing iron and lime is found and these are extremely hard during cold weather. The alluvium with deposit of sand and sandy clay is found along the course of rivers. There is ample ground water supply at a moderate depth and the upper soil may be porous and dry during summer and almost devoid of humus.

*Vegetation:* Vegetation of North Bengal can be divided in to 4 major formations (Banerjee, 1993) viz. a) Tropical wet semi-evergreen formation b) Tropical moist deciduous formation c) Riparian fringing formation d) Alluvial grassland and savannah woodland formation.

The present study area shows the combination of the above first two groups. a) Tropical wet semi-evergreen formation: The soil of the western region of the district is particularly suited to the growth of such vegetation. Plants in this area are mainly dominated by *Anthocephalus chinensis, Anisomelis indica, Adhotada vasica, Artocarpus utilis, Barringtonia acutangala, Citrus maxima, Calotropis procera, Clerodendrum viscosum, Croton oblongifolia, Dillenia indica, Dalbergia sisoo, Erisia levis, Ficus heterophyla, Ficus parasitica, Ficus bengalensis, Ficus carica, Ficus racemosa, Mangifera indica, Mallotus philippiensis, Murrya koengii, Nerium indicum, Sygigium cumini, Swetentia mahogini, Madhuca indica, Tiliacora racemosa, Terminalia arjuna, Terminalia crenulata,* and *Quisqualis indica.* Old river beds, ponds, marshy land and other watery regions have a copious vegetation of *Vallisnaria sp*. The areas which are subject to frequent inundation usually cover themselves with seedy grasses and in marshy parts *Rosainvolucrata sp.* is plentiful. b) Tropical moist deciduous formation: Climbers and shrubs are very common and luxuriant growth of herbaceous plants are found during monsoon. The dominant plants in this type of vegetation are *Azadirachta indica, Butea monospermia, Flacortia indica, Holarhena pubescence, Ichnocarpus frutescence, Lannea coromadilia, Mitragyna pervifolia, Punica granatum, Streblus asper, Spondias pinnata, Vangueria spinosa, Ventilago denticulate, Vitax negando* and *Zizyphus mauritiana*.

*General morphology of eriophyoid mites and characters of taxonomic importance:* Mites belonging to the super family Eriophyoidea can be distinguished from all other Acarina by their vermiform body having only two pairs of legs placed near the anterior end in adults as well as in the

immature stages. This is a unique feature separating them readily from all other Acarina. The body of these mites is distinctly divided into a short propodosoma covered dorsally and on the sides by the prodorsal shield, and a longer tapering opisthosoma with annulations which may or may not show any dorsoventral differentiation. An anterior projecting or down curved gnathosoma with needle like or lancet like chelicerae are present. Genital opening is transverse and located ventrally, more towards the anterior end of body just behind the coxae II. Body setation is characteristic and is reduced to minimum.

*Collection of specimens:* The shoots of plants were collected and placed in individual polythene bag. Care had been taken to avoid accumulation of moisture within the bags. These were finally stored in a refrigerator. The plant samples were examined under stereomicroscope within a short time to confirm whether there is infestation of mites or not. With the aid of a stereomicroscope the mites were picked up from the infested plant material with the help of a needle and placed onto a grooved slide containing Kono's medium. The slide was then placed on a hot plate having temperature of 50º C and cooked enough to clear the mites. The mites upon being cleared enough were mounted in Hoyer's medium after a bath in the same medium. The ingredients of Kono's mixture are cholral hydrate 100 gms, Glycerin 10 gms, water 50ml, concentrated HCI 1 ml. The mites were studied under a Letiz Dialux 20 microscope with provision for phase illumination. Camera lucida drawings were prepared using a built in draw tube type prism camera lucida attached to the microscope. The classification and terminology given by Amrine *et al.*, 2003 is followed here. Measurements were taken at (10 x 100X) magnification and strictly under phase contrast using an ocular micrometer. The following measurements were taken during this study: i) length of body: distance from the anterior tip of the prodorsal shield to the posterior end of the body, ii) width of body: maximum width just behind rear prodorsal shield margin, iii) length of shield: distance from the tip of anterior lobe to rear prodorsal shield margin, iv) width of prodorsal shield: maximum width along rear shield margin, v) length of gnathosoma: length from base of proximal segment to end point of terminal segment, vi) length of legs: distance from base of trochanter to the tip of tarsus, vii) length of epigynium: maximum width across mid transverse line, viii) length of seta: distance from the socket to its tip. Slides after being properly labeled with all relevant data were stored suitably. All slides bearing the type specimens were deposited in the Entomology Research Unit, Post

Graduate Department of Zoology, Serampore College, Hooghly, West Bengal, India.

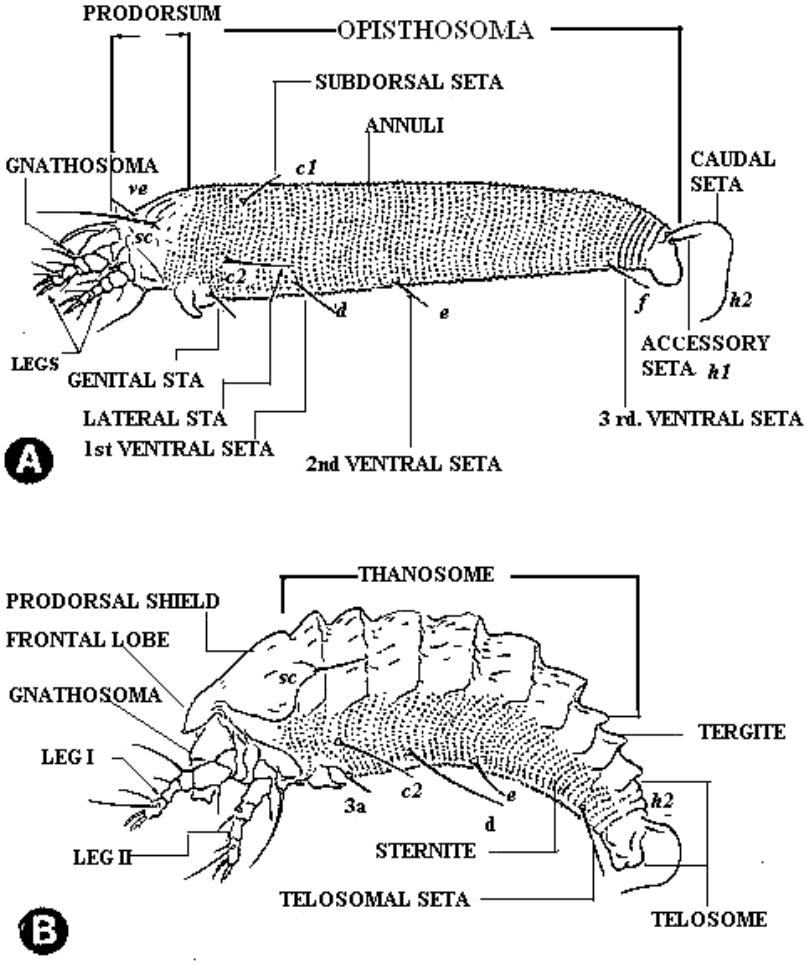


Fig. 2: Two major body forms of eriophyoid mites in lateral view. (Modified from Keifer, 1975). Setal notation cited in the text.

## RESULTS AND DISCUSSION

*Genus Aceria Keifer: Aceria* Keifer, 1944. *Bull. Calif. Dept. Agri., E.S.*- 14, 33: 18 Body worm like, circular in cross section. Gnathosoma usually small, when large chelicerae evenly curved. Prodorsal shield usually subtriangular almost without any frontal lobe over the base of gnathosoma . Prodorsal setiferous tubercles set on or near rear shield margin and setae always directed caudad. Legs with all usual setae; tarsal

empodium simple. Opisthosomal annuli subequal dorsoventrally and with all usual pairs of setae. Female genitalia a little behind the coxae II; epigynium either smooth or with scorings; anterior female apodeme of normal length in ventral view. Most species are able to form galls, erinium and other related plant abnormalities. A few species survive as vagrants within the hairy surface of the leaves of plants.

**Type species** : *Aceria tulipae (Keifer* 1938)

*Remarks:* The genus *Aceria* was erected by Keifer (1944) to separate worm like mites having scapular setae *sc* projecting posteriorly from tubercles of the rear shield margin. Newkirk and Keifer (1971) reviewed the genus Eriophyes von Siebold (1851) and provided a general description for it and stated that 'These structures are the same as were used in establishing *Aceria* as a genus'. Therefore, they considered *Aceria* as synonym of *Eriophyes* and placed the genus *Eriophyes* under the tribe Eriophyini. However, Shevtchenko (1957), Lindquist (1977) and other objected to this action and proposed to the International Commission on Zoological Nomenclature to retain the genus *Aceria*. The commission voted on the case in 1977 and the suggestions of Lindquist (1975) won the majority (ICZN 1979). Hence the generic name *Aceria* Keifer (1944) is used herein in the original sense as prior to Newkirk and Keifer (1971).

The genus *Aceria* is closely related to the genera *Cymoptus* Keifer (1946), *Acalitus* Keifer (1965a) and *Cenacea* Keifer (1972a) by its worm like body with almost complete annuli and evenly arched opisthosoma. But it remains distinct from all above genera in having paraxial tibial seta on tibia I. In addition, it also differs from *Acalitus* and *Cenacea* by the presence of basiventral femoral seta *bv* (absent in *Acalitus* and *Cenacea*) and from *Cymoptus* by simple opisthosomal annuli dorsally (in *Cymoptus,* opisthosomal annuli are sinuate or undulate dorsally)

*Host:* Euphorbiaceae, Acanthaceae, Amaranthaceae, Simarubaceae, Laminaceae, Moraceae, Poaceae, Berbaridaceae, Burseraceae, Tiliaceae, Fabaceae, Rutaceae, Ulmaceae, Oleaceae, Bignoniaceae, Sapindaceae, Lauraceae, Anacardiaceae, Sapotaceae, Apocynaceae, Boraginaceae, Leguminaceae, Lyrthaceae, Palmae, Malvaceae, Rosaceae, Rubiaceae, Aizoaceae, Sterculiaceae, Rhamnaceae.

Distribution: India, Australia, Mexico, South Africa, USA,China.

***Key To The Species:***

1.Tarsal empodium 7 rayed..... *ziziphi* (Mohanasundaram)

-Tarsal empodium less than 7 rays .....2

2.Tarsal empodium 6 rayed .....*lalbaghi* Amrine & Stasny,

Tarsal empodium less than 6 rays ..... 3

3. Tarsal empodium 5 rayed .....*ficus* (Cotte)

-Tarsal empodium less 4 rayed ..... 4

4. Coxae smooth .....*nerii* Channabasavanna

- Coxae strongly tuberculated .....*granati* (Canestrini & Massalongo)

***Aceria ficus* (Cotte, 1920)**

*Eriophyes ficus* Cotte,1920, *Bull. Soc. Path. Veget.*, 7:26= *Eriophyes fici* Essig & Smith, 1922*, Calif. Dept. Agri. Bull.*, 11: 143. *Aceria ficus* (Cotte) Keifer, 1952, *Bull. Calif. Insect Surv.*, 2(1): 28.[syn. Amrine & Stasny 1994:47]

*Material examined:* Many females, India: West Bengal: Malda, Amriti, 18 vi 2006 from *Ficus racemosa* L. (Moraceae), Coll. S. Sarkar. This species was originally collected and described by Cotte from California, USA. It is reported here for the first time from the present area of study.

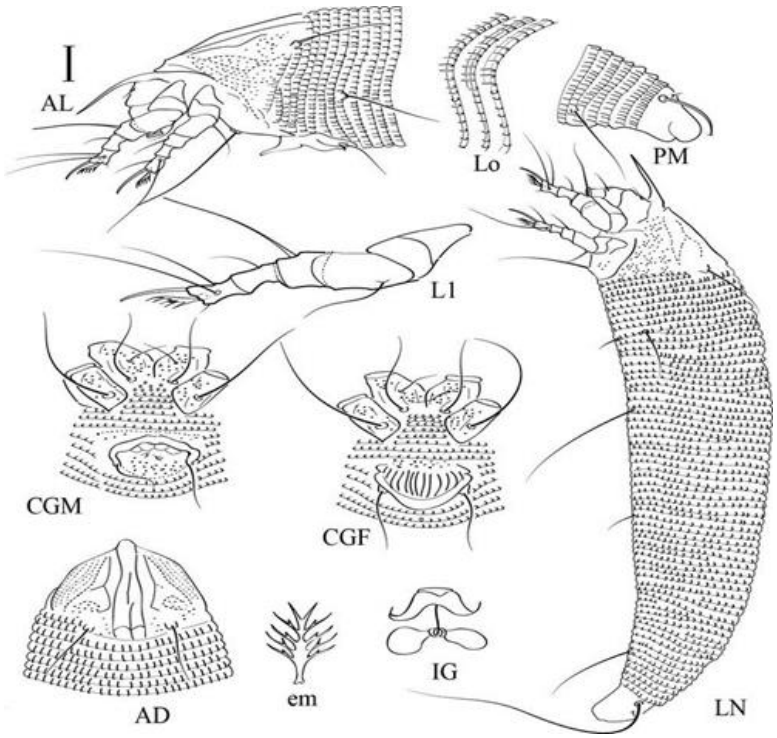


Fig. 3. Line drawings of *Aceria ficus* 9Cotté): AD, anterio-dorsal mite; CGF, coxigenital region of female; em, empodium; GM, male genitalia; IG, internal female genitalia; L1, Leg I; LN, lateral nymph; DL, dorsal larva; VL, ventral larva. Scale bars: 10µm for AD, CGF, GM, IG, LN, DL, VL; 5 µm for L1; 2.5µm for em. [This figure was uploaded by Ashraf Elhalawany]

*Relation to host:* Mites were found in buds, tender leaves and bases of fruits.

*Distribution:* India, Tamil Nadu, West Bengal, California (USA), Southern Europe (France); Egypt.

***Aceria granati* (Canestrini & Massalongo)**

*Aceria granati* Canestrini & Massalongo, 1894, Atti. Soc. Veneto-Trent. (2), 1 : 465. *Aceria granati* (Canestrini & Massalongo) Keifer, 1952, *Bull. Calif. Insect Surv.*, 2(1): 29 [syn. Amrine & Stasny 1994:50]

*Material examined:* Many females, India: West Bengal: Malda, English bazar, 09. x. 2021 from *Punica grabatum* L. (Puniaceae), Coll. S. Sarkar. This species was first collected and described by Canestrini & Massalongo from California. Mohanasundaram 1987 redescribed this species from Tamil Nadu, India. It is reported here for the first time from the present area of study.

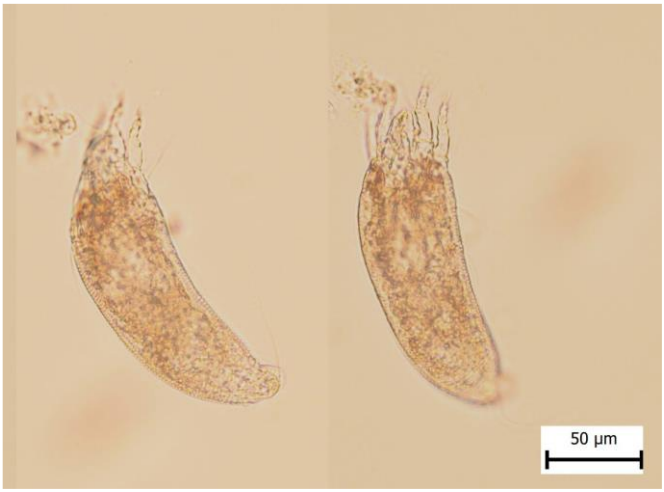


Fig. 2. Adult of the gall mite *Aceria granati* (This figure taken from https://doi.org/10.17221/141/2020-HORTSCI)

*Relation to host:* Mites causes rolling of margin and deformation of tender leaves.

*Distribution:* California, Italy, India: Tamil Nadu, West Bengal

***Aceria lalbaghi* Amrine & Stasny, 1994**

*Aceria mitragynae* Mohanasundaram, 1988 *Journal of Acarology* , 12 (1&2): 54-55 (= *Aceria lalbaghi* Amrine & Stasny, 1994)

*Material examined:* Many females, India: West Bengal : Malda, Kendpukur, 15. vii. 2021 from *Mitragyna pevifolia* (Roxb.) Korth (Rubiaceae), Coll. S. Sarkar. Mohanasundaram (1987) described *Aceria mitragynae* from Lalbagh, Bangalore, Karnataka Tamil Nadu, India. Since

then the name was preoccupied with *Aceria mitragyneae* Farkas, 1969, a new name for this species was given by Amrine & Stasny (1994). It is reported here for the first time from the present area of study and also fist time from West Bengal.

*Relation to host:* mites were found in small erineal patches and cavity formed in the corners of leaf veins along the mid vein

*Distribution:* India: Karnataka, West Bengal.

***Aceria nerii Channabasavanna:***

*Aceria nerii* Channabasavanna,1966. *Univ. Agric. Sci. Hebbal*, *Bangalore*, pp 78-79.

*Material examined:* Many females, India: West Bengal: Malda, English bazar, 24. xii 2021 from *Nerium indicum* Mill. (Apocynaceae), Coll. S. Sarkar. This species was collected and described by Channabasavanna from Tamilnadu, Coimbatore, India. It is reported here for the first time from the present area of study.

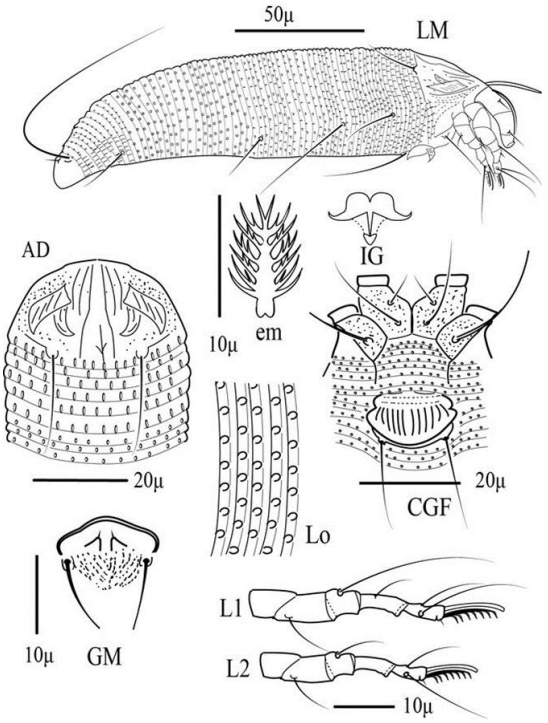


Fig. 3. *Aceria ziziphi* (Mohanasundaram, 1990)-LM, lateral view of mite; CGF, coxi-genital region of female; IG, internal genitalia of female; em, empidium; CGM, genital region of male; L1, L2, legs I,II; Lo lateral view of opisthosoma; AD, Anterior-dorsal view of mite. Relation to host-This species was found in the tender

apical shoots between hairs; causes no damage. (This Figure was taken from original author of the species)

*Relation to host:* Mites were found in buds and leaf axils.

*Distribution:* India, Tamil Nadu, West Bengal.

***Aceria mauritianae* Amrine & Stasny, 1994.**

*Aceria ziziphi* Mohanasundaram, 1987, *Journal of Acarology*, 12 (1&2): 76 [=*Aceria mauritianae* Amrine & Stasny, 1994]

*Material examined:* Many females, India: West Bengal: Malda, Kendpukur, 24. vi. 2021 from *Ziziphus mauritiana* Lamk. (Rhamnaceae), Coll. S. Sarkar. Mohanasundaram 1990 described this species from Tamil Nadu, India. It is reported here for the first time from the present area of study.

*Relation to host:* mites were found in the tender apical shoots among matted hairs.

*Distribution:* India: Tamil Nadu, West Bengal.

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