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ARTICLE

Predatory mites fauna on medicinal and aromatic plants from Sundarban Biosphere Reserve, West Bengal, India

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ABSTRACT A regular survey was conducted in different places of Sundarban Biosphere Reserve (SBR) region of West Bengal on 32 different medicinal and aromatic plants. A total of 41 species of predatory mites belonging to 19 genera, 7 families, under 2 orders were observed during this study. Collection data, distribution and keys are given for all taxonomic categories. Many of the species and habitats reported here are new records. Ecological and behavioral remarks on all the predatory mite species reported from Sundarban Biosphere Reserve are also presented.
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INTRODUCTION

In India, Sundarban Biosphere Reserve (21°9497'N 89.11833'E) is one of the world heritage sites declared by UNESCO in 1997. It is in the Ganga-Bramhaputra delta of Bay of Bengal, and it is the largest single tract of mangrove systems covering 4100 km^2 of which 2/3rd falls under Bangladesh and 1/3rd portion lies under Indian territory. It is one of the richest biodiversity zones of India having luxuriant growth of mangrove plants, many of which are having medicinal values and are being used by local population in day–to-day healthcare system. In many fringe areas of Sundarban Biosphere Reserve, which are having habitation also possesses many non-mangrove plants such as, medicinal and aromatic plants (MAP). MAP possess a serious threat of being attacked by a number of herbivores among which insects and mites play significant role.

Among the major pests of MAPs in Sundarban, phytophagous mites are undoubtedly the worst, and their attack sometimes becomes so severe that the entire plant turns yellowish- brown to reddish, falling of leaves, and in some cases plant may die. The attack of phytophagous mites on these plants causes depletion and deterioration of their active ingredients and induce mild to hazardous damage to them. Damage to the plant may show adverse effect on the occurrence of predatory mites, which are present on the plant along with the phytophagous mite species. Most of the predatory mites considered as food generalists due to their feeding abilities on number of prey species along with plant exudates, pollen, and fungi (Tixier 2018). The predatory mites are natural enemies and can regulate the growth rate of phytophagous mite at low equilibrium densities and thus, can be utilized as biocontrol agents (McMurtry and Croft 1997; Gerson et al. 2003). Diversity of species, phylogenetic patterns and evolutionary processes play a pivotal role for identification of species which in turn is very significant for development of biological pest management strategy. Application of morphological taxonomic method would be advantageous for proper identification of mites. For proper implementation of biocontrol strategies against phytophagous mites, detailed knowledge of predatory mite biodiversity is essential and required (Tixier 2018). The information in all aspect are not available from our country specially from Sundarban Biosphere Reserve. So, the present study was designed to make a comprehensive list of predatory mites infesting MAPs along with a detailed taxonomic key, habitat, and distribution.

This information will be helpful for stakeholders to find out some predatory mites having great potentiality in utilizing as biological control for phytophagous mites infested MAPs.

Survey

A regular extensive survey of predatory mites was done in different, selected places of Sundarban Biosphere Reserve in the following localities: Sagar Island (21°7269'N 88°1096'E), Gosaba (22°1652'N 88°8070'E), Dhamakhali (22°3615'N 88°8645'E), Jeliakhali (22°3615'N 88°8645'E), Jharkhali (22°0306'N 88°7013'E), Balikhal (22°0307'N 88°7014'E), Sarberia (22°2675'N 88°4446'E), Hasnabad (22°5745'N 88°9174'E), Taki (22°5864'N 88°9097'E), during February 2017 to May 2018. During the surveys, various MAPs were investigated for the occurrence of predatory mites.

Collection

For collection of predatory mites, direct examination of leaves plucked from plants of our interest was done in the field with 20X hand lens, and after confirmation of mites, 25-30 leaves were taken in polythene zipper bags for proper examination in the laboratory under stereo-binocular microscope (MSZ-TR 70T0842). During the collection of plants, field observations were made regarding their association with phytophagous mites and the predatory importance of predatory mites, if any. All the measurements given in the text are in microns and entire collection was made by extensive survey by all the authors.

Preservation

The collected mites were preserved in 70% ethyl alcohol and subsequently, mounted in Hoyer's medium (Walter and Krantz 2009). Permanently mounted mites were identified under OLYMPUS CH-20i microscope. Identification was done consulting the updated literature. The keys of Gupta (2003), Moraes et al. (2004), and Chant and McMurtry (2007) were followed for the phytoseiid mite and Gupta (2002) was followed for identification and classification for other families. All the identified materials have been deposited in the Entomological Collection of Krishnagar Government College and those will be submitted to the National Collection Unit (Zoological Survey of India, Kolkata) in due course.

RESULTS

Taxonomic accounts

The identified collection of predatory mites belonged to 41 species of 19 genera, 7 families, under 2 orders from 32 species of medicinal and aromatic plants. The most dominating predatory mites associated with different species of phytophagous mite species were *Amblyseius largoensis, Amblyseius herbicolus*, *Euseius ovalis, Paraphytoseius bhadrakaliensis, Euseius coccinae, Euseius alstoniae, Euseius ovalis,* in the Phytoseiidae family and *Agistimus fleschneri* in the Stigmaidae family. The detailed taxonomic account with keys is given below.

Key to the superorders, orders and suborders of "Acari":

1. With 1-4 pairs of dorsolateral or ventrolateral stigmata posterior to coxa II, coxae of legs free usually movable, tarsi of leg II-IV with peripodomeric fissure associated with slit organs tarsus of leg I with dense dorsal cluster of solidiform setae subdistally ....**Superorder: Parasitiformes**

*Venter of subcapitulum with maximum of IV pairs of setae, triotosternum usually present with a distinctly base, 1-2 setuloselacini and valves of adult ------ or at most with 1 pair of setae, base of chelicerae enclosed by a sclerotised ring usually with epistome..... ..... **Order: Mesostigmata**

Idiosoma of adult female with 38 or fewer pairs of setae, dorsal shield with 23 or fewer pairs of setae including setae of r3 and R1; caudo-ventral area of female with 10 or fewer pairs of setae; corniculae slender, triotosternum well developed with two lacinae, chelicerae well developed with two digits, having variable dentition, interior margin of tectum smooth or minutely denticulate. .... Family: Phytoseiidae**

- Without visible stigmata posterior to coxae II, coxae of legs integrated with venter of podosoma and often forming coxi-sternum, tarsai of leg II-IV without peri-podomeric fissure and slit organ, tarsus of leg I with a pair of dorsal setae distally and subdistally..... .....**Superorder: Acariformes, 2**

2. Chelicera rarely chelate, fixed digit often regressed and movable digit often a hook-like needle or style-like structure, cheliceral bases sometimes face medially, palp simple or modified into a thumb-claw process, sometimes reduced, subcapitulum without rutella , ambulacra of at least legs II and III usually with 2 pair of lateral claws and with or rarely without a medium or empodium, may be pad-like or rayed and often sucker-like opisthsoma, lacking paired lateral glands , one pair of stigmata opens between base of chelicerae or on anterior prodorsum , usually present and sometimes associated with peretreme

dorsally on cheliceral bases or on the anterior margin of prodorsum.....**Order: Trombidiformes**
*Tracheal system with one pair of stigmata, opening between the bases of chelicerae or on anterior pro-dorsum usually present, usually with fixed digit sheath-like or completely regressed, coxal fields, contiguous or II-III separated.....**Suborder: Prostigmata**

Order: Mesostigmata

Family: Phytoseiidae

Phytoseiidae Baker and Wharton (1952) An Introduction to Acarology, The McMillan Co., USA, p. 87.

Key to the subfamilies of Phytoseiidae:

1. Setae z3 and S6 absent..... **Amblyseiinae**
- Either or both of setae z3 and S6 present..... 2

2. Setae Z1, S2, S4, and S5 absent .....**Phytoseiinae**
- At least one of setae Z1, S2, S4, S5 present .....
.....**Typhlodrominae**

Key to the tribes of subfamily Amblyseiinae:

1. Sternal shield with median posterior projection, deutosternal groove wider (>5 μm in width), some forward migration of preanal setae, JV2 and ZV2, preanal setae on male, preanal setae usually arranged in tangential row rather than a triangular pattern .....**Euseiini**
..... **Genus: *Euseius***
- Sternal shield without posterior projection, deutosternal groove narrower without forward migration of preanal setae on male usually arranged in a triangular pattern rather than in a tangential row 2

2. S4 absent.*
*Some dorsolateral setae thickened, serrate, arising from tubercles. Setae J2, S2 present, setae j6 short not longer than setae Z2 with 3 pairs of preanal setae.....
Kampidomini
.....**Genus: *Paraphytoseius***
- Seta S 4 present 3

3. Ratio of seta S4:Z1<3.0:1.0, setae S4, Z4, Z5 not greatly longer than other dorsal setae.....4
- Ratio of setae S4:Z1<3.1:1.0, setae S4, Z5, Z4 marked longer than other dorsal setae.....**Amblyseiini**
.....**Genus: *Amblyseius***

4. Genu II without and genu III rarely with a macrosetae, fixed digit of chelicerae with fewer than 6 teeth, rarely multidentate in structure..... **Genus: *Neoseiulus***
- Genu II and genu III rarely without macrosetae, fixed digit of chelicerae usually with more than 6 teeth.....
.....**Typhlodromipsini**
.....**Genus: *Scapulaseius***
..... ***Scapulaseius suknaensis***

Genus *Amblyseius* Berlese

Amblyseius Berlese (1914) Acari nuovi. Manipulus IX. Redia 10:113-150.

Key to the species groups of genus Amblyseius:

1. Cervix of spermatheca tubular or with various modifications.....2
- Cervix not tubular or with various modifications. 3

2. Cervix of spermatheca pocular and with parallel walls and nodular atrium. .....***obtusus* group**
.....***Amblyseius obtusus***
- Cervix elongated with fundibuliform wall and nodular atrium. .....***coffeae* group**
.....***Amblyseius coffeae***
- Cervix long, narrow, tubular, flared internally and atrium nodular type. ..... ***sundi* group**
..... ***Amblyseius paraaerialis***
- Cervix short or long, tubular and with a nodular atrium .....***aerialis* group**
.....***Amblyseius aerialis***
- Spermatheca with slightly corniform cervix. .....
.....***Amblyseius cucurbitae***
- Cervix long, slender, tubular with nodular, triangular or waforied atrium. .....***largoensis* group, 5**

3. Cervix of spermatheca saccular with various modifications.....4
- Cervix not saccular or not saccular with various modification.....***ipomeae* group**
.....***Amblyseius ipomeae***

4. Cervix of spermatheca long, saccular, swollen externally or distinctly flared internally and differentiated to slightly flared internally and differentiated to slightly nodular atrium.....***punctatus* group**
..... ***Amblyseius kulini***
- Cervix saccular with nodular or undifferentiated atrium. .....***orientalis* group**
.....***Amblyseius orientalis***

5. Spermatheca with tubular cervix.....
.....***Amblyseius largoensis***
- Spermatheca with fundibular cervix. 6

6. Z5 < 300 μm. 7
- Z5 approximately 300 μm or longer..... **8**
7. s4 approximately 100 μm, Z5 < 200 μm, ST4 75 μm... .....***Amblyseius herbicolus***
- s4 longer than 100 μm, Z5 longer than 250 μm, ST4 less than 70 μm. .....***Amblyseius adhatodae***

8. Z4 less than 100 μm.....***Amblyseius herbicoloides***
- Z4 longer than 100 μm.....***Amblyseius fletcheri***

Amblyseius aerealis (Muma)

Collection data: 2 females; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Datura metel*; Dt. 23.ix.2017.

Distribution: India (Karnataka, Bihar, West Bengal), Mexico, Brazil, USA, Jamaica

Remarks: The economic importance of the species is unknown in India though it has been reported to feed upon *Panonychus citri* on citrus (Gupta 2003). In the present study it was associated with *Brevipalpus rica* on *Datura metel.*

Amblyseius adhatodae Muma

Collection data: 1 female; India: West Bengal, Dist. North 24 Paraganas, Hasnabad on *Heliotropium indicum*; Dt. 5.xi.2017.

Distribution: India (Maharashtra, West Bengal), Pakistan.

Remarks: The economic importance is unknown.

Amblyseius coffeae De Leon

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Gosaba on *Cinnamomum tamala;* Dt. 4.vi.2017.

Distribution: Mexico, India (new record).

Remarks: This species as well as the habitat on which it was collected is a new record for India.

Amblyseius cucurbitae Rather

Collection data: 2 females; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Capparis zeylanica*; Dt. 16.iv.2017.

Distribution: India (Jammu and Kashmir, West Bengal).

Remarks: This species is the second report for India and the habitat is also new for the species.

Amblyseius fletcheri Schicha

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Dhamakhali on *Scuttelaria javanica*; Dt. 25.v.2017.

Distribution: New Caledonia, India (new record)

Remarks: The species has been unknown from India and hence is a new record. The habitat also forms a new record.

Amblyseius herbicoloides McMurtry

Collection data: 2 females, 1 male; India: West Bengal, Dist. South 24 Paraganas, Gosaba on *Cleome viscosa;* Dt. 26.iii.2017.

Distribution: Fiji, India.

Remarks: The occurrence of this species was casual, but *Cleome viscosa* is a new habitat record for this species. The presence of the species in India was reported earlier by Gupta and Karmakar (2015). The record of this species for West Bengal is made here for the first time.

Amblyseius herbicolus (Chant)

Collection data: 2 females, 1 male; India: West Bengal, Dist. South 24 Paraganas, Tangrakhali on *Cocos nucifera;* Dt. 6.xi.2017.

Distribution: India (West Bengal, Tripura, Mizoram, Sikkim, Tamil Nadu), USA, Brazil, Mexico, Australia, South Africa, Japan, Thailand.

Remarks: This is one of the commonest phytoseiid mites present on a wide range of plants (Gupta 2003). In our study, it was associated with the coconut perianth mite, *Acaria guerreronis* and fed on its eggs.

Amblyseius ipomeae Ghai and Menon

Collection data: 1 female, 1 nymph; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Ricinus communis;* Dt. 19.viii.2017.

Distribution: India (Maharastra).

Remarks: Its occurrence was casual and no economic importance has been observed, although, Ghai and Menon (1967) reported its occurrence in association with tetranychids mites.

Amblyseius largoensis (Muma)

Collection data: 5 females; India: West Bengal, Dist. South 24 Paraganas, Sagar Island on *Justicia adhatoda;* Dt. 25.ii.2017; 2 females; Jeliakhali on *Ixora coccinea*; Dt. 15.iv.2017; 1 male; Dhamakhali on *Ricinus communis*; Dt.16. iv.2017; 6 females and 2 males; Jharkhali on *Avicenia alba*; Dt. 23.ix.2017; 24.x.2017, 14.i.2018, 2 females; Dist. North 24 Paraganas, Hasnabad on *Occimum sanctum*; Dt. 5.xi.2017.

Distribution: India (Himachal Pradesh, Odisha, Gujarat, West Bengal, Andaman Nicobar Island, Karnataka, Manipur, Assam, Meghalaya, Nagaland, Kerala, Bihar), Brazil, Costa Rica, New Zealand, S. Africa, Japan, Angola, USA.

Remarks: This is another common phytoseiid mite species present on many plants feeding mostly in immature phytophagous mites. In the present study it was seen in the colony of *Oligonychus iseilemae* on *Avicenia alba* and in the colony of *Brevipalpus californicus* on *Justicia adhatoda* and in both cases its feeding was observed on the immature stages.

Amblyseius kulini Gupta

Collection data: 1 male, 2 females; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Cocos nucifera;* Dt. 23.ix.2017.

Remarks: In the recent study it was found feeding upon eriophyid mites on *Cocos nucifera*.

Amblyseius obtusus (Koch)

Collection Data: 1 female; India: West Bengal, Dist. North 24 Paraganas, Hasnabad on *Butea monosperma*; Dt. 23.xii.2017.

Distribution: Indonesia, Europe Australia, Canada, India (new record).

Remarks: The record of this species is made here for the first time.

Amblyseius orientalis Ehara

Collection data: 1 female; India: West Bengal, Dist. North 24 Paragana, Mini Sundarban on *Avicenia alba*; Dt. 12.v.2017.

Distribution: India (Assam, West Bengal), Japan

Remarks: The occurrence of this species has been reported as casual occurrence. Earlier studies reported this mite from Assam (Gupta 1978). Its feeding behavior was not observed.

Amblyseius paraaerialis Muma

Collection data: 2 females; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Vitex negundo;* Dt. 23.ix.2017.

Distribution: India (Arunachal Pradesh, Assam, Meghalaya, Sikkim, Kerala), Thailand.

Remarks: Although this species has been reported from India on a number of plants feeding upon phytophagous mite (Gupta 2003), it was recorded just only showing no predatory importance in the present study.

Genus *Euseius* Wainstein

Amblyseius (Amblyseius) section *Euseius* Wainstein (1962) Acarologia 4:15.

Euseius, Chant and McMurtry (2007) p.118.

Key to the species of genus Euseius:

1. All setae on dorsal shield minute except j1 and Z5.... **3**
- Besides j1 and Z5 some other setae also long..... **2**

2. S2-S5 equal.....***Euseius ovalis***
- S2-S5 unequal.....***Euseius rhododendronis***

3. j1, j3 either equal or j3 longer than j1..... **4**
- j1 longer than j3 ..... **5**

4. j3 longer than j1.....***Euseius alstoniae***
- j3 as long as j1 .....***Euseius coccinae***

5. Leg chaetotaxy on genu III 1 2 2 1; tibia III 1 2 2 1.
0 0 1 1.....
.....***Euseius prasadi***
- Genu III 1 1 1 1; tibia III 1 2 1 1
1 1 1 1..... ***Euseius finlandicus***

Euseius alstoniae Gupta

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Sagar Island on *Gmelina arborea;* Dt. 18.vi.2017.

Distribution: India (West Bengal, Odisha, Bihar, Uttar Pradesh, Punjab, Jammu and Kashmir)

Remarks: This species was in close association with *Oligonychus bihariensis* on *Gmelina arborea* and feeding upon its immature stages.

Euseius coccineae Gupta

Collection data: 2 females; India: West Bengal, Dist. South 24 Paragana, Sagar Island on *Justicia adhatoda*; Dt. 18.vi.2017

Distribution: India (Arunachal Pradesh, Meghalaya, Tripura, Gujrat, Odisha, West Bengal)

Remarks: This species was in close association with *Brevipalpus californicus* on *Justicia adhatoda* but both in field and laboratory examination its feeding was not noticed.

Euseius finlandicus Oudemans

Collection data: 1 male; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Heliotropium indicum;* Dt. 16.iv.2017.

Distribution: India (Karnataka, West Bengal, Bihar, Sikkim, Punjab, Jammu and Kashmir), Pakistan, Canada, Mexico, Russia, Europe, USA, Japan.

Remarks: This mite is known to be an important predator of tetranychids (Hoy 2011) but in the present study no such behavior was noticed.

Euseius ovalis (Evans)

Collection data: 2 females; India: West Bengal, Dist. South 24 Paraganas, Gosaba on *Murraya koenigii;* Dt. 23.viii.2017.

Distribution: India (Arunachal Pradesh, Assam, Sikkim, Mizoram, West Bengal, Gujarat, Punjab, Tamil Nadu, Kerala, Andaman & Nicobar Islands), Philippines, Taiwan, Hawaii, Mexico, Malaysia, Japan, New Zealand, Australia.

Remarks: This species is known to be a very important predator of a number of phytophagous mites (Gupta 2003). In the present study the species was found feeding upon the eggs of *Schizotetranychus cajani* on the leaf of *Murraya koenigii*. The infested leaf of *Murraya koenigii* infested with *Schizotetranychus cajani* when examined

under stereo-binocular microscope, the predator was found feeding upon eggs.

Euseius prasadi Gupta

Collection data: 2 females, 1 male; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Heritiera fomes*; Dt. 23.ix.2017. 1 male, 1 nymph; India: West Bengal, North 24 Paraganas, Taki on *Ocimum gratssiimum;* Dt. 14.iv.2018.

Distribution: India (West Bengal, Arunachal Pradesh, Assam, Meghalaya, Sikkim, Tripura Mizoram, Punjab, Himachal Pradesh, Jammu & Kashmir).

Remarks: This is a very common phytoseiid mite, known to be occurring on wide range of plants but its economic importance has not been observed in the field.

Euseius rhododendronis (Gupta)

Collection data:1 male, 1 female; India-West Bengal, Dist. South 24 Paraganas, Balikhal on *Acacia auriculiformis*; Dt. 23.x.2017.

Distribution: India (West Bengal, Tripura, Sikkim, Tamil Nadu, Karnataka), Thailand.

Remarks: This species has no known economic importance.

Genus *Neoseiulus* Hughes

Neoseiulus Hughes (1948) Min Agr Fish Lond, p. 141.

Neoseiulus longispinosus (Evans)

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Mangifera indica*; Dt. 16.iv.2017.

Distribution: India (West Bengal, Odisha, Bihar, Sikkim, Uttar Pradesh, Karnataka, Andaman and Nicobar Islands), Taiwan, Indonesia, Japan, Pakistan, Australia, Malaysia, Jamaica.

Remarks: This is one of the well-known and established predatory mites feeding upon phytophagous mites in India, and it is known to feed upon several tetranychid mites on a wide range of host plants. In the present study, this species was seen actively feeding upon *Oligonychus mangiferus* on mango.

Genus *Paraphytoseius* Swirski and Schechter

Paraphytoseius Swiriski and Schechter (1961) Israel J Agric Res 11:113.

Key to the species of genus Paraphytoseius:

1. Setae z2 and z4 serrate.....
.....***Paraphytoseius scleroticus***

- Setae z2 and z4 smooth .....
.....***Paraphytoseius bhdrakaliensis***

Paraphytoseius scleroticus Gupta and Ray

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Vitex negundo*; Dt. 16.iv.2017.

Distribution: India (West Bengal)

Remarks: This was earlier described from hilly area of North East India (Gupta and Ray 1981) and its presence in Gangetic plain of West Bengal in very interesting. Predatory behavior was not noticed.

Paraphytoseius bhadrakaliensis (Gupta)

Collection data: 1 male 2 female; India: West Bengal, Dist. South 24 Paragana, Gosaba on *Ficus racemose*; Dt. 26.iii.2017.

Distribution: India (West Bengal)

Remarks: This species was found associated with *Eotetranychus hirsti* on *Ficus racemosa*. It was seen attacking the immature stages of fig mite when the infested leaves were examined under stereo binocular microscope.

Tribe Typhlodromipsini

Genus *Scapulaseius* Karg and Oomen-Kalsbeck

Amblyseius (*Scapulaseius*) Karg and Oomen- Kalsbeck (1987) Zool Jahr Syst 114(1):131-140.

Scapulaseius suknaensis (Gupta)

Collection data: 4 females, 1 male; India: West Bengal, Dist. South 24 Paraganas, Kakdwip on *Uraria picta*; Dt. 14.i.2018.

Distribution: India (Arunachal Pradesh, Assam, Sikkim, Mizoram, Meghalaya, West Bengal, Odisha).

Remarks: The species is well distributed in various states of India and more so in the eastern and north eastern part of India. It has been recorded on a large number of plants often in association with phytophagous mite. In the present study, its feeding was observed on immature stages of *Tetranychus neocaledonicus* infesting *Rauvolfia sarpentina* and *Solanum melongena*. This appears to be a potential predator of phytophagous mites.

Subfamily Phytoseiinae

Genus *Phytoseius* Ribaga

Phytoseius Ribaga (1904) Gamasidi Planticoli Rivista Patalogia Vegetale, Italy 10:175-178.

Key to the species of subfamily Phytoseiinae

1. Setae R1 present ..... ***Phytoseius minutus***
- Setae R1 absent ..... ***Phytoseius swirskii***

Phytoseius minutus Narayanan, Kaur and Ghai

Collection data: 1 male; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Derris indica;* Dt. 24.ix.2017.

Distribution: India (Delhi, Punjab, Himachal Pradesh, Uttar Pradesh)

Remarks: Predatory importance not known.

Phytoseius swirskii Gupta

Collection data: 3 females; India: West Bengal, Dist. North 24 Paraganas, Hasnabad on *Ocimum gratssiimum*; Dt. 5.xi.2017.

Distribution: India (West Bengal, Karnataka).

Remarks: In present study this species was closely associated with larval stages of *Brevipalpus mitrofanovi* occurring on *Ocimum gratssiimum*.

Subfamily Typhlodrominae

Genus *Typhlodromus* Scheuten

Typhlodromus Scheuten (1857) Arch Nutur, Germany 23:104-112.

Typhlodromus fleshneri (Chant)

Collection data: 2 females; India: West Bengal, Dist. South 24 Paraganas, Sarberia on *Justicia adhatoda*; 3 females; Jharkhali, Sardar More on *Holarrhena pubescens*; Dt. 23.vii.2017.

Distribution: India (Assam, Meghalaya, West Bengal, Karnataka, Bihar).

Remarks: This species is well distributed in the eastern, north eastern and southern part of India associated with phytophagous mites. However, its predatory behavior was not reported neither in the present study nor in former studies.

Superorder: Acariformes

Order: Trombidiformes

Suborder: Prostigmata

Key to the families of sub order Prostigmata

1. Without a palpal thumb-claw complex 2
- With a palpal thumb-claw complex 5

2. Rod-like solenidion on tarsus usually lying flush with tarsus in a specialized membranous depression; anteriorly the propodosoma with a tubercle, bearing 1 pair of setae .....**Eupodidae**
- Rod like solinidion on tarsus erect arising from a small circular membranous base 3

3. Cheliceral bases fused or if not fused, not capable of lateral scissors-like motion over gnathosoma Iolinidae
- Chelicerae free attached at base and free to move scissors-like laterally across gnathosoma 4

4. With two pairs of genital suckers, the relatively long palpi curved inwards, distal segment usually claw-like, free living.....**Cunaxidae**
- With 3 pairs of genital suckers, the relatively long palpi elbow like with distal setae, free living .....**Bdellidae**

5. Body dorsally densely covered with setae, larvae heteromorphic .....**Erythraeidae**
- Body setae relatively few, arranged in transverse row, larvae heteromorphic 6

6. Chelicera formed a stylophore, coxae II and III contiguous ..... **Raphignathidae**
- Chelicera generally independently movable but may be adnate or stylophore-like, in a few genera, coxae II and III not contiguous; leg I and II directed anteriorly and leg III and IV directed posteriorly ..... **Stigmaeidae**

Family Bdellidae

Key to the subfamilies of Bdellidae

1. Venter of hypostome with 6-7 pairs of strong setae and 2 pairs of small adornal setae, without well-developed genital tracheae 2
- Venter of hypostome with 2 pairs of strong setae and 2 pairs of small adornal setae with well-developed genital tracheae ..... **Spinibdellinae**
..... **Genus *Biscirus***
.....***Biscirus* sp.**

2. Trichoboth absent on tibia II, palpaltibio-tarsus expanded distally ..... **Bdellinae**
.....**Genus *Hexabdella***
.....***Hexabdella unusoculata***
- Trichoboth present on tibia II, palpaltibio-tarsus cylindrical or elongated ..... **Odontoscrirnae**
..... **Genus *Bdellodes***
.....***Bdellodes* sp.**

Genus *Biscirus* Thor

Biscirus Thor (1913) Zool Anzeig 42:28-30.

Biscirus sp.

Biscirus sp. Gupta (1992) In Contributions to Acarological Researchers in India, p.440.

Collection data: 1 male; India: West Bengal, Dist. South 24 Paraganas, Sarberia on *Cocos nucifera*; Dt. 14.xii.2017.

Distribution: India (Arunachal Pradesh, West Bengal)

Remarks: A damaged specimen was collected on *Cocos nucifera*.

Genus *Bdellodes*

Bdellodes Oudemans (1937) Kritsch Historisch Overzitchtder Acarologic 3(C):12-17.

Bdellodes sp.

Collection data: 1 female; India: West Bengal, Dist. North 24 Paraganas, Taki Mini Sundarban on *Justicia adhatoda*; Dt. 5.xi.2017.

Distribution: India (West Bengal, Haryana)

Remarks: An undetermined species of this genus was collected but species identification could not be ascertained due to the for damaged condition of the specimen.

Genus *Hexabdella*

Hexabdella van Den Schyff, Theron & Uckermann (2004) Afr Plant Protect 9(1):19-22.

Hexabdella unuscoluta van Der Schyff

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Dhamakhali on *Vitex negundo*; Dt. 15.iv.2017.

Distribution: South Africa, India (new record)

Remarks: Originally this species was described from Natal in South Africa from soil habitat and the occurrence of this species on *Vitex negundo* in Sundarban area is quite interesting providing a new distributional data.

Family Cunaxidae

Key to the genera and species of family Cunaxidae:

1. Palpal genu apically without elongate apophysis, tarsai I-IV long, slender and attenuate, without conspiqous lateral bilobed flanges terminally ..... ***Cunaxa*, 2**

- Palpal genu apically with elongate apophysis, tarsus I-IV long, stout and terminating in conspiqous bilobed lateral flanges ..... **Genus *Dactyloseiurus***
.....***Dactyloseiurus* sp.**

2. Propodosomal and hysterosomal shields smooth 3
- Propodosomal shield reticulate, smooth or striated and hysterosoma striated or with reticulate shield .....
.....***Cunaxa currasavica***

3. Palpal telofemur inner surface without flange or apophysis .....***Cunaxa evansi***
- Palpal telofemur inner surface with flange orapophysis
..... 4

4. Palpal telofemur inner surface with an uncinate or truncate apophysis .....***Cunaxa capriolus***
- Palpal telofemur inner surface with a distally rounded or sharply pointed apophysis or a rod like blunt finger like apophysis ..... ***Cunaxa terrula***

Genus *Cunaxa* von Heyden

Cunaxa von Heyden 1826, ISIS of Oken 18(6):609.

Cunaxa capreolus Berlese

Collection data: 2 females, India-West Bengal, Dist-South 24 Paraganas, Jharkhali on *Justicia adhatoda,* Dt.14.i.2018.

Distribution: India (Arunachal Pradesh, Meghalaya), cosmopolitan.

Remarks: Although it is a good predator of phytophagous mite (Smiley 1992) but in the present study its occurrence was scanty and therefore its predatory character was not observed.

Cunaxa currasavica Gupta

Collection data: 1 female; India: West Bengal, Dist. South 24 Paragana, Tangrakhali (Hasnabad) on *Abelmoschus esculentus*; Dt. 19.xi.2017.

Distribution: India (Arunachal Pradesh)

Remarks: This predator mite was described from north-east India. In this present case, its occurrence was casual.

Cunaxa evansi Smiley

Collection data:1 female; India: West Bengal, Dist. South 24 Paragana, Sagar Island on *Occimum sanctum*; Dt. 25.ii.2017.

Distribution: Mexico, Texas, India (new record)

Remarks: This species was earlier described from Mexico (Smiley 1992). It has been unknown from India. Its occurrence was casual on the undersurface of leaves. No predatory behavior was noticed.

Cunaxa terrula Den Heyer

Collection data: 1 male; India: West Bengal, Dist. South 24 Paraganas, Sagar Island on *Murraya koenigii*; Dt. 26.ii.2017

Distribution: South Africa, India (new record)

Remarks: This species has not been reported from India and hence the present is a new record.

Genus *Dactyloscirus* Berlese

Scirus (*Dactyloscirus*) Berlese, Redia 12(1):131.
Dactyloscirus Smiley (1975) Ann Ent Soc Amer 68(2):230.

Dactyloscirus sp.

Collection data: 1 male; India: West Bengal, Dist. South 24 Paraganas, Gosaba on *Ricinus communis*; Dt. 26.iii.2017.

Remarks: From India only 3 species of this genus is known. The chaetotaxy of palp and relative length of setae on dorsal surface did not match with any of the species from India or abroad. This is likely to be a new species and further studies are being made for confirmation.

Family Erythraeidae

Key to the subfamilies of Erythraeidae:

1. Two eyes on each side ..... **Erythraeinae**
..... **Genus *Erythraeus***
..... ***Erythraeus orientalis***
- One eye on each side ..... **Balustiinae**
..... **Genus *Balustium***
..... ***Balustium putmani***

Genus *Balustium*

Balustium von Heyden (1826) K.H.O.A 111P:309.

Balustium putmani Smiley

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Mangifera indica*; Dt. 16.iv.2017.

Distribution: Europe, USA, India (new record).

Remarks: This is a well-known predator of phytophagous mite. It was found feeding on immatures of *Oligonychus mangiferus.* The infested leaf when examined under stereo-binocular microscope revealed this. This mite has not earlier been reported from India.

Genus *Erythraeus*

Erythraeus orientalis (Khot)

Collection data: 1 female; India: West Bengal, Dist. South 24 Paragana, Jeliakhali on *Oxalis corniculate*; Dt. 16.iv.2017.

Distribution: India (Maharashtra, West Bengal, new record)

Remarks: This species was reported casually, and its predatory importance has not been noticed in the field.

Family Eupodidae

Genus *Eupodes*

Eupodes Koch (1842) Heft 1-40.

Eupodes sigmoidensis Strandmann & Goff

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Jeliakhali on *Bixa orellana*; Dt. 15.iv.2017.

Distribution: India (West Bengal, Mizoram, Lakshadweep Island, Sikkim)

Remarks: This mite is frequently encountered on different plants in India and has been observed in the field to jump as soon as disturbed. Its feeding habits could not be ascertained in the present study.

Family Iolinidae

Genus *Pronematus*

Pronematus Canestrini (1886), Att. 1st Veneto Ser. 6, 4:698.

Pronematus sextoni Baker

Collection data*:* 1 female; India: West Bengal, Dist. South 24 Paragana, Jharkhali, *Datura metel*; Dt. 14.i.2018.

Distribution: India (West Bengal, Delhi, Uttar Pradesh, Karnataka), Africa.

Remarks: This species was reported from various states of India (Gupta 1992) but it was not recorded on the plant found in the present study. During laboratory examination it was found that the species actively fed on eggs on of *P. latus* occurring on infested *Datura* leaves.

Family Raphignathidae

Genus *Raphignathus*

Raphignathus Duges (1834) Ann Sci Nat 29:1-46.

Raphignathus sp.

Collection data: 1 female; India: West Bengal, Dist. South 24 Paragana, Jeliakhali on *Acacia auriculifomes*; Dt. 16.iv.2017.

Remarks: The non-availability of concerned literature

made it unable to determine the identity of this specimen up to species level.

Family Stigmaeidae

Key to the genera of Stigmaeidae:

1. Dorsal setae la on median plate proper; this plate also carries setae a, b, c and lm .....**Genus *Agistemus*** .....***Agistemus fleschneri***
- Setae la distributed on small independent plates, median plate carries 4 pairs of setae or five pairs if intercalary plates are integrated with it.*
*13 pairs of dorsal setae, suranals included individuals of pair lm always brone on small independent plates. Three or more pairs of paragenital setae .....**Genus *Stigmaeus*** .....***Stigmaeus* sp.**

Genus *Agistemus*

Agistemus Summers (1960) Proc Ent Soc Wash 62:234.

Agistemus fleschneri Summers

Collection data: 2 females, 1 male; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Carica papaya*, *Solanum melangona*; Dt. 23.ix.2017.

Distribution: India (Arunachal Pradesh, Assam, Meghalaya, Sikkim, Tripura, West Bengal, Delhi, Punjab), USA, Chile, Mexico.

Remarks: This is a well-known predator of several phytophagous mites. In the present study this was found associated with eggplant infested with *Tetranychus urticae* as well as *Euyetranychus orientalis* on *Carica papaya*. However, field observations did not indicate any feeding on the respective phytophagous mites.

Genus *Stigmaeus*

Stigmaeus sp.

Collection data: 1 female; India: West Bengal, Dist. South 24 Paraganas, Jharkhali on *Citrus limon*; Dt. 20.vii.2017.

Distribution: India.

Remarks: This undetermined species of *Stigmaeus* was recorded on lemon tree for the first time. Due to damaged condition its specific identity could not be ascertained.

DISCUSSION

A very few attempts have been made earlier to document predatory mite fauna in Sunderban Biosphere Reserve. Gupta et al. (2004) provided a preliminary faunistic data on predatory mite fauna in some region of Sunderban. They found 28 species of predatory mites from Mangrove vegetation and agri-horticultural crops. Another study made by Kar and Karmakar (2021) reported 3 new species of phytoseiid mite from Sundarban. The present study on the predatory mites occurring on MAPs from Sundarban Biosphere Reserve revealed the occurrence of 41 species from 19 genera, 7 families and 2 orders. The diversity of predatory mites found in this study was high and this may be possible that such high diversity is a function of considerable diversity of plants sampled. A great diversity of plants leads to the great diversity of microhabitats that in turn allow a high number of mite species (Walter and O'Dowd 1995). The results of this study also suggest that the Sunderban Biosphere Reserve is an important reservoir of predatory mites, some of which may be helpful in controlling pest mites in different agro-ecosystem of Sunderbans. The occurrence of 7 species, 2, 3, 1 and 1, from *Cunaxa*, *Amblyseius*, *Balustium,* and *Hexabdella*, respectively, is new for India. This study also enlightens 25 plants that are acted as new habitats for some mites identified in this study (Table 1). Out of the 41 species, the occurrence of 12 species from West Bengal was hitherto unknown. Among these predatory mites *Amblyseius largoensis, Amblyseius herbicolus* and *Euseius ovalis* were active feeders of different stages of spider mites (Tetranychidae). The occurrence of other predatory mites was of causal nature. Some members of the genus *Stigmaeus*, *Dactyloscirus*, *Bdella*, and *Raphignathus* appear to be undescribed species and their taxonomic identities will be ascertained by further study. The data pertaining to the occurrence of predatory mites from Sundarban on MAPs is still fragmentary and thus, present paper will enrich the detailed taxonomic account of predatory mites from medicinal and aromatic plants of Sunderban Biosphere Reserve.

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Table 1. Location and habitat wise distribution list of predatory mites collected on medicinal and aromatic plants of Sundarbans area, West Bengal. Abbreviations: + denotes presence of mite species in that location, - denotes absence of mite species in that particular location.

No	Species	Location and habitat									Remarks
		Sagar Isl.	Gosaba	Dhamakali	Jelia Khali	Jharkhali	Bali Khal	Sar Beria	Hasnabad	Taki	
						Phytoseiidae					
1	*Amblyseius aerealis* (Muma)	-	-	-	-	+; *Datura metel*	-	-	-	-	Casual occurrence
2	*Amblyseius adhatodae* Muma	-	-	-	-	-	-	-	+; *Heliotropicum indicum*	-	New habitat record
3	*Amblyseius coffeae* De Leon	-	+; *Cinnamomum tamala*	-	-	-	-	-	-	-	New report in India
4	*Amblyseius cucurbitae* Rather	-	-	-	+; *Cappari zelyrica*	-	-	-	-	-	New habitat record
5	*Amblyseius fletcheri* Schicha	-	-	+; *Scuttelaria javanica*	-	-	-	-	-	-	New report from India
6	*Amblyseius herbicoloides* McMurtry	-	+; *Cleome viscosa*	-	-	-	-	-	-	-	New habitat record
7	*Amblyseius herbicolus* (Chant)	-	-	-	-	-	-	+; *Cocos nucifera*	-	-	Potential Predator
8	*Amblyseius ipomeae* Ghai and Menon	-	-	-	-	+; *Ricinus communis*	-	-	-	-	Casual occurrence
9	*Amblyseius kulini* Gupta	-	-	-	-	+; *Cocos nucifera*	-	-	-	-	Casual occurrence
10	*Amblyseius largoensis* (Muma)	*Justicia adhatodae*	-	*Ricinus communis*	*Ixora coccinea*	*Avicenia alba*	-	-	+; *Occimum sanctum*	-	Potent predator
11	*Amblyseius obtusus* (Koch)	-	-	-	-	-	-	-	+; *Butea monosperma*	-	New habitat record
12	*Amblyseius (Amblyseius) orientalis* Ehara	-	-	-	-	-	-	-	-	+; *Avicenia alba*	Casual occurrence
13	*Amblyseius paraaerialis* Muma	-	-	-	-	-	+; *Vitex nigundo*	-	-	-	Casual occurrence
14	*Euseius alstoniae* Gupta	+; *Gmelina arborea*	-	-	-	-	-	-	-	-	New habitat record
15	*Euseius coccineae* Gupta	+; *Justicia adhatodae*	-	-	-	-	-	-	-	-	Common predator
16	*Euseius finlandicus* Oudemans	-	-	-	+; *Heliotropium indicum*	-	-	-	-	-	Good predator of Tetranychids
17	*Euseius ovalis* (Evans)	-	+; *Murraya koenigii*	-	-	-	-	-	-	-	Important predator
18	*Euseius prasadi* Gupta	-	-	-	-	+; *Heritiera fomes*	-	-	-	+; *Ocimum gratssiimum*	Common and economically important predator
19	*Euseius rhododendronis* (Gupta)	-	-	-	-	-	+; *Acacia auriculiformis*	-	-	-	Casual occurrence
20	*Neoseiulus longispinosis* (Evans)	-	-	-	+; *Mangifera indica*	-	-	-	-	-	Well known predator
21	*Paraphytoseius bhadrakaliensis* (Gupta)	-	+; *Ficus racemosa*	-	-	-	-	-	-	-	Casual occurrence
22	*Paraphytoseius scleroticus* Gupta and Ray	-	-	-	+; *Vitex negundo*	-	-	-	-	-	Casual occurrence
23	*Scapulaseius suknaensis* (Gupta)	+; *Uraria picta*	-	-	-	-	-	-	-	-	New habitat record

Table 1. Continued.

No	Species	Location and habitat									Remarks
		Sagar Isl.	Gosaba	Dhamakali	Jelia Khali	Jharkhali	Bali Khal	Sar Beria	Hasnabad	Taki	
						Phytoseiidae					
24	*Phytoseius minutus* Narayanan, Kaur & Ghai	-	-	-	-	+; *Derris indica*	-	-	-	-	Predatory importance unknown
25	*Phytoseius swirskii* Gupta	-	-	-	-	-	-	-	+; *Ocimum gratsiimum*	-	Predatory importance unknown
26	*Typhlodromus fleshneri* Chant	-	-	-	-	-	-	+; *Justicia adhatoda*	-	-	New habitat record
						Bdellidae					
27	*Biscirus* sp.	-	-	-	-	-	-	+; *Cocos nucifera*	-	-	Casual occurrence
28	*Bdellodes* sp.	-	-	-	-	-	-	-	-	+; *Justicia adhatoda*	Predatory importance unknown
29	*Hexabdella unuscoluta* van Der Schyff	-	-	+; *Vitex negundo*	-	-	-	-	-	-	New record in India
						Cunaxidae					
30	*Cunaxa capreolus* Berlese	-	-	-	-	+; *Justicia adhatoda*	-	-	-	-	Good predator
31	*Cunaxa currasavica* Gupta	-	-	-	-	-	-	-	+; *Abelmoschus esculentus*		Casual occurrence
32	*Cunaxa evansi* Smiley	+; *Occimum sanctum*	-	-	-	-	-	-	-	-	New record in India
33	*Cunaxa terrula* Den Heyer	+; Murraya koenigii	-	-	-	-	-	-	-	-	New report from India
34	*Dactyloscirus* sp.	-	+; *Ricinus communis*	-	-	-	-	-	-	-	Casual occurrence
						Erythraeidae					
35	*Balustium putmani* Smiley	-	-	-	+; *Mangifera indica*	-	-	-	-	-	Potent predator
36	*Erythraeus orientalis* (Khot)	-	-	-	+; *Oxalis corniculata*	-	-	-	-	-	New habitat record
						Eupodidae					
37	*Eupodes sigmoidensis* Strandmann & Goff	-	-	-	+; *Bixa orellana*	-	-	-	-	-	Casual occurrence
						Iolenidae					
38	*Pronematus sextoni* Baker	-	-	-	-	+; *Datura metel*	-	-	-	-	Potential predator
						Raphignathidae					
39	*Raphignathus* sp.	-	-	+; *Acacia auriculifomes*	-	-	-	-	-	-	Casual occurrence
						Stigmaeidae					
40	*Agistemus fleschneri* Summers	-	-	-	-	+; *Carica papaya*	-	-	-	-	Important predator
41	*Stigmaeus* sp.	-	-	-	-	+; *Citrus limon*	-	-	-	-	Casual occurrence

REFERENCES

Baker EW, Wharton GW (1952) An Introduction to Acarology. The MacMillan Company, New York.

Berlese A (1914) Acari nuovi. Manipulus IX. Redia 10:113-150.

Canestrini G (1886) Prospetto dell'acarofauna Italiana. Famiglia degli Eupodini. Atti del Reale Istituto Venrto de Scienze. Lettere ed Arti 4:693-734.

Chant DA, McMurtry JA (2007) Illustrated Keys and Diagnoses for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata). Indira Publishing House, West Bloomfield, USA.

Duges A (1834) Recherches sur l'ordre des Acariens en général et la famille des Trombides en particulier. Ann Sci Nat Zool S2 1:5-46.

Ghai S, Menon RMG (1967) Taxonomic studies on Indian mites of the family Phytoseiidae (Acarina). I. New species and new records of the genus *Amblyseius* Berlese from India (Acarina: Phytoseiidae) with a key to Indian species. Orient Insect 1:65-79.

Gerson U, Smiley RL, Ochoa T (2003) Mites (Acari) for Pest Control. Blackwell Science, Oxford, UK.

Gupta SK (1978) Studies on Indian Phytoseiidae (Acarina: Mesostigmata): some *Typhlodromus* mites from South India with descriptions of new species. Bull Zool Surv Ind 1:47-54.

Gupta SK, Ray S (1981) Species of the subgenera *Paraphytoseius* and *Asperoseius* from India with description of a new species of *Paraphytoseius*. *Bull Zool Surv India* 4:41-46.

Gupta SK (1992) Arachnida: Plant mites (Acari). State Fauna Series 3: Fauna of West Bengal. Vol. 3. Zoological Survey of India, Calcutta, pp. 61-211.

Gupta SK (1992a) Report on plant mite fauna of Arunachal Pradesh, India. Contr 10 Acarol Res India 433-445.

Gupta SK (2002) A monograph on plant inhabiting predatory mites of India Part I: Orders: Prostigmata, Astigmata and Cryotostigmata. Mem Zool Surv India 19:1-183.

Gupta SK (2003) A monograph on plant inhabiting predatory mites of India Part II: Order: Mesostigmata. Mem Zool Surv India 20:1-185.

Gupta SK, Ghoshal S, Choudhury A, Mukherjee B (2004) Phytophagous and predatory mite fauna of Sundarban Biosphere Reserve: II. Some Predatory mites occurring on mangrove vegetation and agrihorticultural crops. Rec Zool Surv India 103:33-45.

Gupta SK, Karmakar K (2015) An updated checklist of Indian Phytoseiid mites (Acari: Mesostigmata). Rec Zool Surv India 115:51-72.

Hoy MA (2011) Agricultural Acarology: Introduction to Integrated Mite Management. CRC Press, Boca, Raton, USA.

Hughes AM (1948) The Mites Associated with Stored Food Products. Ministry of Agriculture and Fisheries, London, UK.

Kar A, Karmakar K (2021) Description of three new species of phytoseiid mites (Acari: Mesostigmata) from Sundarban, West Bengal, India. Int J Acarol 47:51-60.

Karg W, Oomen-Kalsbeek F (1987) Neue Raubmilbenarten der Gattung Amblyseius Berlese (Acarina, Parasitiformes, Phytoseiidae). Antagonisten der unechten Spinnmilbe *Brevipalpus phoenicis* Geijskes. Zool Jahrbücher 114:131-140.

Koch CL (1842) Ubersicht des Arachnidensystems. JL Lotzberk, Nürnberg, 1-72.

de Moraes GJ, McMurtry JA, Denmark HA, Campos CB (2004) A revised catalog of the mite family Phytoseiidae. Zootaxa 434:1-494.

McMurtry JA, Croft BA (1997) Life-styles of phytoseiid mites and their roles in biological control. Annu Rev Entomol 42:291-321.

Oudemans AC (1937) Kritisch Historisch Overzicht der Acarologie III: 1805-1850: C: Leiden, Brill EJ, pp.1240-1253.

Ribaga C (1904) Gamasidi planticoli. Riv Patol Veget 10:175-178.

Scheuten A (1857) Einiges unber Milben. Arch F Naturgesch 23:104-112.

Smiley RL (1975) A generic revision of the mites of the family Cunaxidae (Acarina). Ann Entomol Soc Am 68:227-244.

Smiley RL (1992) The Predatory Mite Family Cunaxidae (Acari) of the World with a New Classification. Indira Publishing House, Michigan. pp 356.

Summers FM (1960) Several stigmaeid mites formerly included in *Mediolata* redescribed in *Zetzellia* Ouds, and *Agistemus*, new genus. Proc Ent Soc Wash 62:233-247.

Swirski E, Shechter R (1961) Some phytoseiid mites (Acarina: Phytoseiidae) of Hong Kong, with a description of a new genus and seven new species. Israel J Agric Res 11:97-117.

Tixier MS (2018) Predatory mites (Acari: Phytoseiidae) in agro-ecosystems and conservation biological control: A review and explorative approach for forecasting plant-predatory mite interactions and mite dispersal. Front Ecol Evol 6:192.

Thor S (1913) *Biscirus* genus novum. Eine neue Bdelliden-Gattung und zwei neue Untergattungen. Zoolog Anzeig 42:28-30.

Van der Schyff J, Theron PD, Ueckermann EA (2004) *Hexabdella*, a new mite genus of Bdellidae (Acari: Prostigmata) from southern Africa, with descriptions of five new species. Afr Plant Prot 9:19-22.

Von Heyden C (1826) Versuch einer systematischen Eintheilung der Acariden. Isis of Oken 18:608-613.

Wainstein BA (1962) Révision du genre *Typhlodromus* Scheuten, 1857 et systématique de la famille des Phytoseiidae (Berlese 1916) (Acarina: Parasitiformes). Acarologia 4:5-30.

Walter DE, O'Dowd DJ (1995) Life on the forest phylloplane:

hairs, little houses, and myriad mites. In Lowman MD, Nadkarni N, Eds., Forest Canopies. Academic Press, New York, 325-351.

Walter DE, Krantz GW (2009) Collecting, rearing and preparing specimens. A Manual of Acarology. Tech University Press, Texas 3:83-94.