

Diversity of mites (Acari) on medicinal and aromatic plants in India*

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Abstract

Despite the diverse and frequent use of medicinal and aromatic plants throughout the world, they have received poor attention regarding the mites and insects that they harbor. Here we summarize the diversity of phytophagous and predatory mites recorded on medicinal and aromatic plants in India, including first-hand information obtained by the authors in regular observations of plants growing in different parts of India between 2002 and 2009 as well as information reported in previous works conducted in the country. In total, 267 mite species of 93 genera and 18 families were found or have been reported on these plants in India. Most of these species (208) belong to families constituted mostly by phytophages, but quite a large number of species (56) belong to families constituted predominantly by predators. Despite the wide array of phytophagous species, relatively few have behaved as major pests, which may be at least in part due to the effect of the predatory mites with which they have been found. We consider 17 species as major pests of medicinal and aromatic plants and 11 species as main predators. The search for prospective predatory mites and the study of the feasibility of their use for the control of mite pests on medicinal and aromatic plants is worthwhile, given that a considerable proportion of people interested on the use of medicinal plants are adverse to the ingestion of synthetic pesticides residues, which could be found on those plants if the pests were controlled with the use of those products.

Key words: Medicinal and aromatic plants, biodiversity, phytophagous mites, predatory mites.

Introduction

For a long time, man has made major use of medicinal and aromatic plants in different parts of the globe. A wide array of plants has been used for their presumed or known pharmaceutical and flavoring characteristics, either directly or as sources of products that contain those characteristics. According to the World Health Organization, 80% of the population of the developing world depends upon traditional and herbal medicines in their primary healthcare (Pramanik, 2004). The world transaction of medicinal and aromatic plants has exceeded 70 million US dollars and by 2050, could exceed 3 trillion US dollars (Pramanik, 2004; Gupta, 2005). Apart from being used as drugs, medicinal plants are also used for the production of different phytochemicals, toiletries, cosmetics, coloring and flavoring agents, nutraceuticals, food supplements, etc (Pramanik, 2004; Gupta, 2005). Considering the growing importance of these plants, the Indian government has provided incentives in cash and kinds for their intensive and extensive cultivation in the country.

Mites and insects are frequently found on medicinal and aromatic plants. Similarly to what has been observed on other plant groups, some of those arthropods are capable of producing serious damage, whereas others have the potential to protect the plants onto which they live by attacking the potentially harmful organisms.

With the increased cultivation of medicinal and aromatic plants, pest and disease problems are also increasing; some of the pests are mites of different groups (Gupta, 2005). Despite this, relatively little attention has been paid to the study of actual or potential pests and of the predatory mites associated with them, which could maintain them under adequate control. In India, some of

the most important works in this regard were reported by Lal & Mukherjee (1977), Ghosh & Gupta (2003), Ghosh (2004), Lahiri *et al.* (2004) and Gupta *et al.* (2005).

In this communication, we document the phytophagous and predatory mites on medicinal and aromatic plants in India, based on results of our own investigations and of investigations previously conducted by other authors.

Materials and Methods

Unpublished data provided in this paper were obtained through regular surveys conducted in different parts of India, giving more emphasis to the state of West Bengal, where a medicinal plant garden occupying an area of five acres and where over 380 species of medicinal and aromatic plants, including many threatened and endangered species, is maintained. Samples were collected between 2002 and 2009. Plants were inspected with a 20 x hand lens, and all mites found were collected with a brush and preserved in 70% alcohol. In the laboratory, they were mounted in Heinze's medium (Evans & Till, 1979) for later identification under a compound microscope.

Information regarding diversity of mites from medicinal and aromatic plants was also obtained by a search of the published literature. The following papers were consulted: Lal & Mukherjee (1977), Ghosh & Gupta (2003), Ghosh (2004), Lahiri *et al.* (2004), and Gupta *et al.* (2005). All together, about 300 plant species were considered in the surveys conducted in this study and in those corresponding to previous studies.

Results

In total, 267 mite species of 93 genera and 18 families were found by us or have been reported on medicinal and aromatic plants in India. Of those, 208 species of 66 genera belong to six principally phytophagous families, 56 species of 24 genera belong to 10 principally predatory families and two species of two genera belong to two principally fungivorous families. It may be mentioned that all of these species had been previously reported either by works of the senior author or by Lal & Mukherjee (1977).

Diversity

By far, most of the phytophagous species and genera on medicinal and aromatic plants in India belong to the Eriophyidae, followed by the Tetranychidae and the Tenuipalpidae (Table 1). Among the predatory mites, most species belong to the Phytoseiidae. The few fungivorous mites found, of two families.

In descending order, the most diverse genera of phytophagous mites were *Eotetranychus*, *Oligonychus*, *Tetranychus* and *Schizotetranychus* (Tetranychidae), *Tenuipalpus* and *Brevipalpus* (Tenuipalpidae), *Aceria*, *Calepitrimerus*, *Phytoptus*, *Aculus*, *Tegolophus*, *Aculops*, *Tetra* and *Calacarus* (Eriophyidae), each with five or more species (Table 2). Within the predatory mites, the most diverse genera were *Euseius*, *Amblyseius*, and *Typhlodromus* (*Anthoseius*) (Phytoseiidae) and *Agistemus* (Stigmaeidae), also each with five or more species.

Major pest species

Based on field observations of associated damage to plants made by the authors during the study, 17 phytophagous species were classified as "major pests" (Table 3) on medicinal and aromatic

TABLE 1. Mite diversity within each family on medicinal and aromatic plants in India, based on surveys conducted in this study and in previous studies conducted by different authors.

Family	Species	Genera
Phytophagous mites		
Eriophyidae	135	45
Tetranychidae	40	10
Tenuipalpidae	19	4
Tarsonemidae	1	1
Phytoptidae	2	2
Diptilomiopidae	7	4
Total	208	66
Predatory mites		
Phytoseiidae	33	11
Tydeidae	6	3
Stigmaeidae	5	1
Cunaxidae	4	2
Anystidae	2	2
Ascidae	2	1
Bdellidae	2	1
Cheyletidae	1	1
Erythraeidae	1	1
Eupodidae	1	1
Total	56	24
Fungivorous mites		
Acaridae	2	2
Glycyphagidae	1	1
Total	3	3

plants. Despite the higher diversity of the Eriophyidae, based on our experience and on the literature, most of the species known to be major pests of medicinal and aromatic plants are Tetranychidae. Eleven species of Tetranychidae, three of Tenuipalpidae, two of Eriophyidae and one of Tarsonemidae were considered major pests.

Main predatory mites

Also based on the abundance with which predatory mites were found and on frequent field evaluations, in which they were observed feeding on potential pest species, eight species of Phytoseiidae and one each of Cunaxidae, Stigmaeidae and Tydeidae were considered of main importance of medicinal and aromatic plants (Table 4).

Discussion

Although extensive information about mites found in India on medicinal and aromatic plants was available in the literature, the present study added a significant number of new records to what was already known. In addition, the present work allowed a panoramic view of all mite groups on those plants in India.

We found that a relatively large number of predatory mites are found on medicinal and aromatic plants in association with an array of phytophagous mite and insect species. Those predators need to be studied further in the field, to determine their natural role in the suppression of pest populations as well as the feasibility of using them in practical biocontrol activities. It is worth noting that despite the wide array of species belonging to groups composed just of phytophagous mites (Krantz & Walter, 2009), namely Diptilomiopidae, Eriophyidae, Phytoptidae, Tenuipalpidae

TABLE 2. Mite diversity within each genus on medicinal and aromatic plants in India, based on surveys conducted in this study and in previous studies conducted by different authors.

Family	Genera	No. of species	Family	Genera	No. of species
Phytophagous mites			Phytophagous mites		
Eriophyidae	<i>Aceria</i>	36	Tetranychidae	<i>Eotetranychus</i>	8
	<i>Calepitrimerus</i>	9		<i>Oligonychus</i>	8
	<i>Phytoptus</i>	8		<i>Tetranychus</i>	7
	<i>Aculus</i>	7		<i>Schizotetranychus</i>	6
	<i>Tegolophus</i>	7		<i>Aponychus</i>	3
	<i>Aculops</i>	6		<i>Eutetranychus</i>	2
	<i>Tetra</i>	6		<i>Panonychus</i>	2
	<i>Calacarus</i>	5		<i>Petrobia</i>	2
	<i>Anthocoptes</i>	4		<i>Bryobia</i>	1
	<i>Eriophyes</i>	4	Tenuipalpidae	<i>Porcupinychus</i>	1
	<i>Paratetra</i>	3		<i>Tenuipalpus</i>	9
	<i>Tegonotus</i>	3		<i>Brevipalpus</i>	8
	<i>Acaphyllisa</i>	2		<i>Dolichotetranychus</i>	1
	<i>Colopodacus</i>	2	Diptilomiopidae	<i>Raoiella</i>	1
	<i>Cosella</i>	2		<i>Diptilomiopus</i>	4
	<i>Epicecidophyes</i>	2		<i>Anchiphytioptus</i>	1
	<i>Phyllocoptes</i>	2		<i>Neodialox</i>	1
	<i>Abacarus</i>	1		<i>Rhombaculus</i>	1
	<i>Acarhynchus</i>	1	Phytoptidae	<i>Neophantacus</i>	1
	<i>Anchiphytioptus</i>	1		<i>Mackiella</i>	1
	<i>Bakeriella</i>	1	Tarsonemidae	<i>Polyphagotarsonemus</i>	1
	<i>Costacus</i>	1	Predatory mites		
	<i>Diptilomiopus</i>	1	Phytoseiidae	<i>Euseius</i>	8
	<i>Ectomerus</i>	1		<i>Amblyseius</i>	7
	<i>Indosetacus</i>	1		<i>Typhlodromus (Anthoseius)</i>	6
	<i>Keiferophyes</i>	1		<i>Gynaeseius</i>	2
	<i>Mackiella</i>	1		<i>Neoseiulus</i>	2
	<i>Metaculus</i>	1		<i>Proprioseiopsis</i>	2
	<i>Monotrimacus</i>	1		<i>Scapulaseius</i>	2
	<i>Neocosella</i>	1		<i>Paraphytoseius</i>	1
	<i>Neocupracarus</i>	1		<i>Transeius</i>	1
	<i>Neodialox</i>	1		<i>Typhlodromiops</i>	1
	<i>Neometaculus</i>	1		<i>Phytoseius</i>	1
	<i>Neophantacus</i>	1	Stigmaeidae	<i>Agistemus</i>	5
	<i>Neophytoptus</i>	1	Ascidae	<i>Lasioseius</i>	2
	<i>Neotegonotus</i>	1	Anystidae	<i>Tencateia</i>	1
	<i>Neodicrothrix</i>	1	Bdellidae	<i>Bdellodes</i>	2
	<i>Notocaphylla</i>	1	Cheyletidae	<i>Cheyletus</i>	1
	<i>Notostrix</i>	1	Cunaxidae	<i>Cunaxa</i>	3
	<i>Paraphytoptus</i>	1		<i>Dactyloscirus</i>	1
	<i>Phyllocoptruta</i>	1	Erythraeidae	<i>Sphaerolophus</i>	1
	<i>Rhyncaphytoptus</i>	1	Eupodidae	<i>Eupodes</i>	1
	<i>Rhombaculus</i>	1	Tydeidae	<i>Pronematus</i>	3
	<i>Vasates</i>	1		<i>Tydeus</i>	2
				<i>Parapronematus</i>	1
			Fungivorous mites		
			Acaridae	<i>Acarus</i>	1
				<i>Suidasia</i>	1
			Glycyphagidae	<i>Lepidoglyphus</i>	1

and Tetranychidae, relatively few species were observed to behave as major pests, which may be at least in part due to the effect of the predatory mites with which they have been found.

The major pests of these plants require the adoption of measures to control them. However, it is expected that a large number of people use medicinal plants exactly because they do not want to ingest residues of synthetically produced chemicals. Thus, the use of natural means of pest control, including biological control, to combat pest mites on these plants, is of major interest. The major pests determined in this study are also found on different crops (Gupta, 1985) and certain-

TABLE 3. Major pests of medicinal and aromatic plants in India.

Pest species	Host species
<i>Eutetranychus orientalis</i> (Klein)	21 hosts, mainly <i>Aegle marmelos</i> (L.) Corr. (Rutaceae), <i>Azadirachta indica</i> A. Juss. (Meliaceae), <i>Cassia angustifolia</i> Vahl. (Caesalpiniaceae), <i>Mentha piperata</i> L. (Lamiaceae), <i>Murraya koenigii</i> (L.) Spring (Rutaceae), <i>Rauwolfia serpentine</i> L. (Apocynaceae) and <i>Withania somnifera</i> (L.) Dunal (Solanaceae)
<i>Eotetranychus syzygii</i> Gupta & Gupta	12 hosts, mainly <i>Achyranthes aspera</i> L. (Amaranthaceae), <i>Calotropis gigantea</i> (L.) R.Br. ex Ait. (Asclepiadaceae), <i>Datura metel</i> L. (Solanaceae), <i>Sida rhombifolia</i> L. (Malvaceae) and <i>Wissadula periplocifolia</i> Presl. ex. Thor. (Malvaceae)
<i>Oligonychus mangiferus</i> (Rahman & Sapra)	6 hosts, mainly <i>Diospyros melanoxylon</i> Roxb. (Ebelaceae) and <i>Cassia fistula</i> L. (Caesalpiniaceae)
<i>Oligonychus oryzae</i> (Hirst)	4 hosts, mainly <i>Cymbopogon flexuosus</i> (Nees ex Steuden) (Poaceae), <i>Cymbopogon palmarosa</i> (Poaceae) and <i>Cymbopogon winterianus</i> Jawitt. (Poaceae)
<i>Petrobia harti</i> (Ewing)	<i>Oxalis corniculata</i> .L. (Oxalidaceae)
<i>Schizotetranychus baltazarae</i> Rimando	<i>Holarrhena tubescens</i> (Buch-Ham) Wall. ex G. Don (Apocynaceae) and <i>M. koenigii</i>
<i>Schizotetranychus hindustanicus</i> (Hirst)	5 hosts, mainly <i>Acorus calamus</i> L. (Araceae) and <i>A. indica</i>
<i>Tetranychus ludeni</i> Zacher	13 hosts, mainly <i>Clitoria ternatea</i> L. (Fabaceae), <i>Dolichos biflorus</i> L. (Fabaceae), <i>Pavonia odorata</i> Willd. (Malvaceae) and <i>Phyllanthus fraternus</i> Webster (Euphorbiaceae)
<i>Tetranychus macfarlanei</i> Baker & Pritchard	<i>Cajanus cajan</i> L. Millsp. (Fabaceae) and <i>W. somnifera</i>
<i>Tetranychus neocaledonicus</i> Andre	27 hosts, mainly <i>Abelmoschus moschatus</i> Medic. (Malvaceae), <i>D. biflorus</i> , <i>Mentha arvensis</i> L. (Lamiaceae), <i>Ocimum tenuiflorum</i> L. (Lamiaceae) and <i>Solanum surattense</i> Burm. (Solanaceae)
<i>Tetranychus urticae</i> Koch	44 hosts, mainly <i>Cannabis sativa</i> L. (Cannabaceae), <i>C. ternatea</i> , <i>Coriandrum sativum</i> L. (Apiaceae), <i>D. metel</i> , <i>Mentha piperita</i> , <i>O. tenuiflorum</i> , <i>Papaver somniferum</i> L. (Papaveraceae), <i>Piper nigrum</i> L. (Piperaceae) and <i>W. somnifera</i>
<i>Brevipalpus californicus</i> (Banks)	12 hosts, mainly <i>A. aspera</i> , <i>Artemisia nilagirica</i> C.B. (Clarke) Pamp. (Asteraceae) and <i>Saraca asoca</i> (Roxb.) de Wilde (Caesalpiniaceae)
<i>Brevipalpus obovatus</i> Donnadieu	15 hosts, mainly <i>Calotropis procera</i> (Ait.) R.Br. (Asclepiadaceae), <i>Ocimum grattissimum</i> L. (Lamiaceae) and <i>Wattakaka volubilis</i> (L.f.) Stapf. (Asclepiadaceae)
<i>Brevipalpus phoenicis</i> (Geijskes)	24 hosts, mainly <i>Bacopa monnieri</i> (L.) Wetts. (Scrophulariaceae), <i>Curcuma amada</i> Roxb. (Ziniberaceae), <i>Piper betel</i> L. (Piperaceae), <i>Vitex negundo</i> L. (Verbinaceae) and <i>W. somnifera</i>
<i>Polyphagotarsonemus latus</i> (Banks)	21 hosts, mainly <i>Capsicum</i> spp. (Solanaceae), <i>D. metel</i> , <i>M. arvensis</i> , <i>M. piperita</i> , <i>O. tenuiflorum</i> , <i>Tagetes erecta</i> L. (Asteraceae) and <i>W. somnifera</i>
<i>Aceria guerreronis</i> Keifer	<i>Cocos nucifera</i> L. (Arecaceae)
<i>Aceria tulipae</i> (Keifer)	<i>Allium sativum</i> L. (Liliaceae)

TABLE 4. Main predatory mites on medicinal and aromatic plants in India.

Predator species	Number of plant substrates	Associated arthropod
<i>Amblyseius channabasavannai</i> Gupta & Daniel	2	<i>Raoiella indica</i> Hirst, <i>Aphis gossypii</i> Glover, <i>Myzus persicae</i> Sulzer
<i>Amblyseius herbicolus</i> (Chant)	2	<i>Eotetranychus syzygii</i> , <i>Tetranychus ludeni</i> , <i>Polyphagotarsonemus latus</i>
<i>Amblyseius largoensis</i> (Muma)	25	<i>Panonychus citri</i> , <i>Eutetranychus orientalis</i> , <i>Tetranychus neocaledonicus</i> , <i>P. latus</i> , <i>T. urticae</i>
<i>Euseius alstoniae</i> (Gupta)	18	<i>E. orientalis</i> , <i>Brevipalpus</i> spp.
<i>Euseius coccineae</i> (Gupta)	5	<i>P. citri</i>
<i>Euseius ovalis</i> (Evans)	10	<i>T. urticae</i>
<i>Neoseiulus longispinosus</i> (Evans)	5	<i>T. urticae</i> , <i>P. latus</i>
<i>Paraphytoseius multidentatus</i> Swirski & Shechter	14	<i>B. californicus</i> , <i>A. gossypii</i>
<i>Cunaxa setirostris</i> (Hermann)	3	<i>T. ludeni</i>
<i>Agistemus fleschneri</i> Summers	2	<i>M. persicae</i>
<i>Pronematus</i> spp.	5	<i>P. citri</i> , <i>T. neocaledonicus</i> , <i>B. phoenicis</i>

ly also on other vegetation in India. The search for prospective predatory mites on these other plants and the study of the feasibility of their use for the control of mite pests on medicinal and aromatic plants is worthwhile.

Most of the studies on mites of medicinal and aromatic plants in India was done in West Bengal, except for the work of Lal & Mukherjee (1977), that was conducted in Eastern Uttar Pradesh. Hence, a vast area of India, especially the southern part of India as well as Eastern and Western Himalayas, which harbor a rich heritage of medicinal and aromatic plants, needs exploration. Needless to say, such surveys will reveal many interesting mite species that may include important pests and predators.

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