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An Overview of Occurrence, Diversity and Plant Association of Non-phytoseiid Predatory Mites in GKVK campus of UAS, Bangalore

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Abstract

The study aimed to record prostigmatid and mesostigmatid non-phytoseiid predatory mites and their association with plants (cultivated and wild) in GKVK campus from Feb. 2022 to Jan. 2023. Mite specimens collected belonged to 12 predatory families (six each from Mesostigmata and Prostigmata) under 26 genera and 39 species. The prostigmatid mite family, Stigmaeidae was more abundant with 54.90 per cent relative abundance and also collected frequently in 10 months period in one year. Among 26 genera recorded, *Agistemus* genus was more abundant (53.82% relative abundance) and was active almost throughout the year (except April & May). Among 39 species recorded, *Agistemus* sp. nr. *industani* was more abundant (32.29% relative abundance). Shannon-Weiner diversity index value for mite families, mite genera and mite species were 1.588, 1.854 and 2.412, respectively. Diversity of mites across 61 host plants of 38 botanical families revealed that family Fabaceae harboured maximum number of mites (174 specimens and 18.13% relative abundance), while family Moraceae harboured seven different mite families with the highest Shannon-Weiner diversity index value of 1.88. Ecological significance of occurrence of non-phytoseiid predatory mites in cropping cum natural forest ecosystem in GKVK is discussed.

Keywords : Occurrence and diversity of mites, Predatory mites, Mesostigmata, Prostigmata

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Mites belonging to class Arachnida of phylum Arthropoda are a diverse group of organisms of world wide distribution and inhabit all types of habitats. Globally, 55,000 species of mites under 5,500 genera and 540 families have been recorded (Krantz and Walter, 2009). From India, 2350 species of mites belonging to 725 genera under 190 families have been reported (Gupta and Gupta, 1999). This hyper-diverse group comprises of miniature predaceous, phytophagous, mycophagous, saprophagous, coprophagous, necrophagous, phoretic and parasitic mites. Of these, phytophagous mites are important as pests of crop plants and many of them are injurious, causing serious loss to farmers. Predatory mites on the contrary play an important role in agricultural ecosystem and are the natural biocontrol agents of mites as well as insect pests. Predatory mites of the order Mesostigmata and the suborder Prostigmata are regarded as natural enemies that exercise reasonable natural pest control on cultivated crops in field as well as in greenhouses. The predominant predatory families under Mesostigmata are Ascidae, Ameroseiidae, Blattisociidae Laelapidae and Sejidae, while Prostigmata includes predatory families such as, Anystidae, Bdellidae, Cheyletidae, Cunaxidae and Stigmaeidae. Predatory mites from these families are meagrely documented and are less-explored as natural control agents of pest mites and insects in the country. Indian monographs by Gupta (2002) and Gupta (2003)

have reviewed the literature on the taxonomy and bioecology of these groups of mites and since these publications, at least two decades have passed, hence there is an urgent need to update this information. GKVK campus in Bengaluru is reported to have diverse group of organisms like, 165 species of birds, 21 species of mushrooms (Sandhya *et al*., 2017), good no. of insects (Kimondiu *et al*., 2017), plants (Sumanth and Prasanna, 2022) and several species of snakes. As the campus is spread over the large area with diverse crops and wild plants, it is important to explore on the diversity of predatory mites, not attempted previously. The present paper thus records the fauna of predatory prostigmatid and non-phytoseiid mesostigmatid mites from the GKVK campus of University of Agricultural Sciences, Bangalore.

Material and Methods

The study was taken up at the Gandhi Krishi Vignana Kendra (GKVK) campus of the University of Agricultural Sciences, Bangalore located in the Latitude of 13° 05' North and Longitude of 77° 34' East and at an altitude of 924 m (above Mean Sea Level), which covers 1380 acres of greenest land area in the northern part of Bengaluru city. There are several cropping systems such as plantations (mango, guava, citrus, sapota, *etc.*), dry land farming systems, irrigated crops and agro-forestry crops. The rainfed crops such as cereal crops including millets, pulses, arid legumes, oilseed crops, horticultural crops such as flowering plants, fruit and vegetable crops (such as tomato, okra, chillies, *etc.*) are cultivated during different seasons. 'Mahatma Gandhi Botanical Garden' in GKVK spread over a land area of 167 ha in 14 pockets has been one of prominent Govt. of Karnataka notified biodiversity heritage sites in the country. This botanical garden is a repository of rare, endemic, threatened, medicinally and economically important plant species. The mean monthly maximum and minimum temperatures recorded during the study period (Feb. 2022 to Jan. 2023) ranged from 28.35 and 17.67 °C, respectively and total rainfall was 1605.80 mm. The present study intended to unravel the non-phytoseiid predatory mites' diversity in GKVK campus across different calendar months during 2022-23.

The non-phytoseiid predatory mites were collected from the fresh green leaves of plants as well as leaf-litter of plants of different botanical families in different locations of GKVK campus from Feb. 2022 and Jan. 2023. Mites were extracted from the sampled plant material manually by picking them directly under stereo-binocular microscope. The plant samples were physically examined under a stereo-binocular microscope (10X - 40X) and the mites were picked individually using a fine needle moistened with MA 80 mixture, transferred and stored in labelled vials containing MA 80 mixture. Mites stored in MA 80 vials were processed within one or two days. The mites from leaf litter were extracted into vials using Berlese funnel technique and vials collecting the mites were taken out after two days (Macfadyen, 1953) for further processing. The mite specimens were directly mounted on microscopic glass slides in Hoyer's medium under a stereo-binocular microscope. The slide mounts were kept for drying in a hot air oven at 40 °C for 2-3 weeks. After drying, the edges of the cover slip were sealed properly with a sealant (or nail polish) using a slide turning disc. Slides were then stored in dry and cool place as permanent slides till further taxonomic examination. The specimens were then observed under Leica / Zeiss Phase Contrast (PH) and Differential Interference Contrast (DIC) microscope at 40X and 100X magnifications for further taxonomic identification using appropriate published literature (Strandtmann, 1971; Meyer & Ueckermann, 1987; Smiley, 1992; Gupta, 2002; Skvarla *et al.*, 2014; Fan *et al.*, 2016; Hernandes *et al.,* 2016 and Rehman *et al.*, 2018).

The number of predatory mites on plant or in litter samples was counted and recorded to compute the mite family-wise abundance. The predatory mite's association with host plants and other substrates like leaf-litter were analysed for the mite diversity. The Shannon-Weiner diversity index (Shannon, 1948) was computed for the mite data recorded and used as a relative measure of diversity at different levels like

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mite family, mite genera and mite species as detailed below.

1. Richness : Taxa richness (S) = Number of taxa observed
2. Abundance : Total number of each taxon was used to work out its per cent relative abundance using the following formula.

$$\text{Relative abundance (\%)} = \frac{\text{Number of specimens of particular taxa}}{\text{Total number of specimens of all taxa}} \times 100$$

3. Diversity : The Shannon-Weiner diversity index was used as a relative measure of species diversity for the macro-invertebrate data (Shannon, 1948).

$$\text{Species diversity (H')} = -\sum_{i=1}^{k} pi \ln pi$$

Results and Discussion

Mite Family-Wise Diversity

Data with respect to plant associated non-phytoseiid mesostigmatid and prostigmatid predatory mite diversity in GKVK campus as viewed from different levels are presented in Table 1, 2 & 3 with an illustration in Fig. 1 & 2. A total of 960 mite specimens collected during the study period of Feb. 2022-Jan. 2023, represented by six families each under order Mesostigmata (179 specimens) and suborder Prostigmata (781 specimens) revealed the dominance of prostigmatid predators compared to mesostigmatid predatory mites. The corresponding relative abundance of these groups of mites was 81.35 per cent and 18.65 per cent. Hence, non-phytoseiid predatory mite taxa richness in terms of number of

Table 1

Family-wise diversity of Mesostigmatid and Prostigmatid mites in GKVK campus

Higher Classification	Mite families	Total no. of mites recorded	Relative abundance (%)	Activity period (No. of months)
Super order : Parasitiformes	1. Ameroseiidae	19	1.98	1 (Mar.)
Order : Mesostigmata	2. Ascidae	89	9.27	1 (Mar.)
	3. Blattisociidae	31	3.23	1 (Mar.)
	4. Laelapidae	19	1.98	2 (Mar. & Oct.)
	5. Parholaspididae	8	0.83	2 (Mar. & Oct.)
	6. Sejidae	13	1.35	1 (Oct.)
Super order : Acariformes	1. Anystidae	1	0.10	1 (Dec.)
Order : Trombidiformes				
Suborder : Prostigmata	2. Bdellidae	13	1.35	6 (Feb., Mar., Jun., Jul., Aug. & Nov.,)
	3. Cheyletidae	53	5.52	3 (Mar., Jul. & Aug.)
	4. Cunaxidae	113	11.77	9 (except Apr., May, Sept.)
	5. Eupodidae	74	7.71	6 (Feb., Mar., Jun., Jul., Aug. & Nov.)
	6. Stigmaeidae	527	54.90	10 (except Apr. & May)
		960		
Taxa richness (no. of families): 12				
Shannon-Weiner Diversity Index for mite families (H): 1.5887				

TABLE 2
Genera-wise diversity of Mesostigmatid and Prostigmatid mites in GKVK campus

Family	Genera	Relative abundance (%)	Activity period (No. of months)
Mesostigmata			
Ameroseiidae	1. *Ameroseius* (8)	0.84	1 (Mar.)
	2. *Kleemannia* (10)	1.05	1 (Mar.)
Ascidae	3. *Asca* (13)	1.36	1 (Mar.)
	4. *Gamasellodes* (76)	7.96	1 (Mar.)
Blattisociidae	5. *Lasioseius* (31)	3.25	1 (Mar.)
Laelapidae	6. *Cosmolaelaps* (18)	1.88	2 (Mar. & Oct.)
	7. *Haemolaelaps* (1)	0.10	1 (Mar.)
Parholaspididae	8. *Krantzolaspina* (8)	0.84	2 (Mar. & Oct.)
Sejidae	9. *Epicroseius* (13)	1.36	1 (Oct.)
Prostigmata			
Anystidae	10. *Anystis* (1)	0.10	1 (Dec.)
Bdellidae	11. *Bdella* (2)	0.21	2 (Jul. & Nov.)
	12. *Odontoscirus* (8)	0.84	3 (Jun., Jul. & Aug.)
	13. *Spinibdella* (1)	0.10	1 (Feb.)
Cheyletidae	14. *Cheletomimus* (11)	1.15	2 (Mar. & Aug.)
	15. *Cheletomorpha* (11)	1.15	1 (Mar.)
	16. *Dubininiola* (3)	0.31	1 (Mar.)
	17. *Hypopicheyla* (1)	0.10	1 (Mar.)
	18. *Ker* (22)	2.30	1 (Mar.)
	19. *Oudemansicheyla* (3)	0.31	1 (Jul.)
	20. *Tutacheyla* (1)	0.10	1 (Jul.)
Cunaxidae	21. *Riscus* (25)	2.62	2 (Jul. & Aug.)
	22. *Rubroscirus* (87)	9.11	9 (except Apr., May & Sept.)
Eupodidae	23. *Eupodes* (74)	7.75	6 (Feb., Mar., Jun., Jul., Aug. & Nov.)
Stigmaeidae	24. *Agistemus* (514)	53.82	10 (Apr. & May)
	25. *Ledermuelleriopsis* (1)	0.10	1 (Mar.)
	26. *Zetzellia* (12)	1.26	4 (Feb., Mar., Jul. & Nov.)
Taxa richness (No. of genera): 26			
Shannon-Weiner Diversity Index for genera (H): 1.8545			

Figures in parentheses are the total number of mites collected in the respective mite genera

mite families in GKVK campus was 12 and the corresponding Shannon-Weiner diversity index (H) calculated for mite families collected was 1.5887 (Table 1).

Within suborder Prostigmata, 54.90 per cent of mite specimens belonged to family Stigmaeidae *i.e.,* 527 specimens, followed by next more abundant mite family of Cunaxidae with the relative abundance of 11.77 per cent from 113 mite specimens. The number of cheyletid and eupodid predatory mites collected was less than 100 (53 and 74 mites, respectively) and their corresponding relative abundance was 5.52 per

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TABLE 3
Species-wise diversity of Mesostigmatid and Prostigmatid mites in GKVK campus

Family	Genera / Species	Rel. abd. (%)	Activity period
Mesostigmata			
Ameroseiidae	*Kleemannia*		
	1. *K. kosi* (10)	1.08	1 (Mar.)
	Ameroseius		
	2. *Ameroseius* sp. (8)	0.86	1 (Mar.)
Ascidae	*Asca*		
	3. *Asca* sp. (13)	1.40	1 (Mar.)
	Gamasellodes		
	4. *G. bicolor* (76)	8.18	1 (Mar.)
Blattisociidae	*Lasioseius*		
	5. *L. reticulatus* (2)	0.22	1 (Mar.)
	6. *L. chaudhrii* (16)	1.72	1 (Mar.)
	7. *Lasioseius* sp. (13)	1.40	1 (Mar.)
Laelapidae	*Cosmolaelaps*		
	8. *Cosmolaelaps* sp. 1 (11)	1.18	2 (Mar. & Oct.)
	9. *Cosmolaelaps* sp. 2 (1)	0.11	1 (Mar.)
	10. *Cosmolaelaps* sp. 3 (4)	0.43	1 (Mar.)
	11. *Cosmolaelaps* sp. 4 (1)	0.11	1 (Oct.)
	Haemolaelaps		
	12. *Haemolaelaps* sp. (1)	0.11	1 (Mar.)
Parholaspididae	*Krantzolaspina*		
	13. *K. angustatus* (8)	0.86	2 (Mar. & Oct.)
Sejidae	*Epicroseius*		
	14. *Epicroseius* sp. (13)	1.40	1 (Oct.)
Prostigmata			
Anystidae	*Anystis*		
	15. *Anystis salicinus* (1)	0.11	1 (Dec.)
Bdellidae	*Odontoscirus*		
	16. *Odontoscirus koloseta* (6)	0.65	3 (Jun., Jul. & Aug.)
	Spinibdella		
	17. *Spinibdella* sp. (1)	0.11	1 (Feb.)
	Bdella		
	18. *B. maldahensis* (1)	0.11	1 (Jul.)
Cheyletidae	*Oudemanscheyla*		
	19. *O. denmarki* (3)	0.32	1 (Jul.)
	Cheletomimus		
	20. *C. bakeri* (1)	0.10	1 (Mar.)
	21. *C. congensis* (8)	0.86	1 (Aug.)

Table 3 Contd...

Family	Genera / Species	Rel. abd. (%)	Activity period
	22. *C. wellsi* (1)	0.11	1 (Aug.)
	Ker		
	23. *K. palmatus* (22)	2.37	1 (Mar.)
	Dubininiola		
	24. *D. boonkongae* (3)	0.32	1 (Mar.)
	Hypopicheyla		
	25. *H. elongata* (1)	0.11	1 (Mar.)
	Cheletomorpha		
	26. *C. lepidopterorum* (11)	1.18	1 (Mar.)
	Tutacheyla		
	27. *T. robusta* (1)	0.11	1 (Jul.)
Cunaxidae	*Rubroscirus*		
	28. *R. sinensis* (76)	8.18	8 (except Apr., May., Jul. & Sept.)
	29. *R.* sp. nov. (8)	0.86	4 (Feb., Jun., Jul. & Nov.)
	Riscus		
	30. *R. austroamericanus* (25)	2.69	2 (Jul. & Aug.)
Eupodidae	*Eupodes*		
	31. *E. garciai* (74)	7.97	6 (Feb., Mar., Jun., Jul., Aug. & Nov.)
Stigmaeidae	*Agistemus*		
	32. *A. gamblei* (24)	2.58	2 (Jul. & Oct.)
	33. *A.* sp. nr. *industani* (300)	32.29	8 (except Jan., Apr., May & Jul.,)
	34. *A. terminalis* (168)	18.08	8 (except Apr., May., Jun. & Sept.)
	35. *A. industani* (1)	0.11	1 (Aug.)
	36. *Agistemus* sp. 1 (4)	0.43	1 (Aug.)
	37. *Agistemus* sp. 2 (4)	0.43	2 (Aug. & Nov.)
	Ledermuelleriopsis		
	38. *L. spinosa* (1)	0.11	1 (Mar.)
	Zetzellia		
	39. *Z. languida* (7)	0.75	1 (Feb.)
Taxa richness (no. of species): 39			
Shannon-Weiner Diversity Index for mite species (H): 2.4108			

Figures in parentheses are the total number of respective mite species collected

cent and 7.71 per cent. Anystids and bdellids were recorded with lowest number of one and 13 mites, respectively with their relative abundance of less than 2 per cent.

From among the 179 non-phytoseiid mesostigmatids collected, the members of the family Ascidae were maximum, *i.e.,* 89 specimens and the relative abundance was also maximum *i.e.,* 9.27 per cent followed by the next higher no. of 31 from the family Blattisociidae. Two families Ameroseiidae and Laelapidae were represented by 19 mites each, while the other families such as Parholaspididae and

Sejidae represented by 8 and 13 mite specimens, respectively.

With regard to the activity of non-phytoseiid predatory mites in GKVK campus in different months of a calendar year, stigmaeids except in the months of April and May, were observed to be active almost all round the year. Cunaxids remained active for 9 months (except in April, May and September), while other prostigmatid mite families, Bdellidae, Cheyletidae and Eupodidae were abundantly collected in 3-6 months of a calendar year. Activity period of Parholaspididae and Laelapidae was spread over two months of March and October. Ameroseiidae (March), Anystidae (December), Ascidae (March), Blattisociidae (March) and Sejidae (October) were actively collected during one month only.

Mite Genera-Wise Diversity

Table 2 gives the details of different mite genera falling under two major predatory groups *viz.,* Mesostigmata and Prostigmata. Mite specimens represented 9 genera of Mesostigmata and 17 genera for Prostigmata. Non-phytoseiid predatory mite taxa richness in terms of number of genera collected during the study period (Feb. 22-Jan. 23) was 26 and the Shannon-Weiner diversity index was 1.8545. Among the prostigmatid mites, genus *Agistemus* was most abundant with 514 specimens, followed by mites from *Rubroscirus* (87), *Eupodes* (74), *Riscus* (25) and *Ker* (22) genera. The corresponding per cent relative abundance values were, 53.82 per cent, 9.11 per cent, 7.75 per cent, 2.62 per cent and 2.30 per cent. For few genera, only 1-3 specimens could be collected for some families like Anystidae (*Anystis*), Bdellidae (*Bdella* & *Spinibdella*), Cheyletidae (*Dubininiola, Hypopicheyla, Oudemansicheyla* and *Tutacheyla)* and Stigmaeidae (*Ledermuelleriopsis*). More abundant mesostigmatid genera were *Gamasellodes* (76 specimens), *Lasioseius* (31) and *Cosmolaelaps* (18 specimens) with the corresponding overall relative abundance of 7.96 per cent, 3.25 per cent and 1.88 per cent. With respect to activity period, genus *Agistemus* (except April and May) and *Rubroscirus* (except April, May and September) were collected during 10 and 9 month's time period, respectively. *Eupodes* and *Zetzellia* were collected during 6-4 months, respectively, while all other mite genera remained active for 1-3 months period only.

Mite Species-Wise Diversity

Details of species-wise relative abundance and activity period of different mite species collected from GKVK are shown in Table 3. Thirty-nine different mite species were recorded under 26 genera and 12 predatory mite families. Thus, Prostigmatid and Mesostigmatid non-phytoseiid predatory mite taxa richness in terms of number of species recorded from Feb. 22 to Jan. 23 period was 39 and the relevant Shannon-Weiner diversity index computed for mite species was 2.4108.

Of the overall 929 mite individuals identified, the highest number of mite individuals (300) belonged to *Agistemus* sp. nr. *industani* with a relative abundance of 32.29 per cent followed by *A. terminalis* (168 individuals) with the relative abundance of 18.08 per cent. Seventy-six specimens each of *Rubroscirus sinensis* and *Gamasellodes bicolor* recorded a relative abundance of 8.18 per cent. *Eupodes garciai* with 74 individuals had a relative abundance of 7.97 per cent. The remaining 34 species were identified from less than 50 specimens, which recorded less than 5 per cent relative abundance.

With regard to occurrence and activity, *Agistemus* sp. nr. *industani*, *A. terminalis* and *Rubroscirus sinensis* were found active for 8 months period. *Eupodes garciai and Rubroscirus* sp. nov. were active for 4 to 6 months, while other 34 species were actively collected in 1-3 months period only (Table 3).

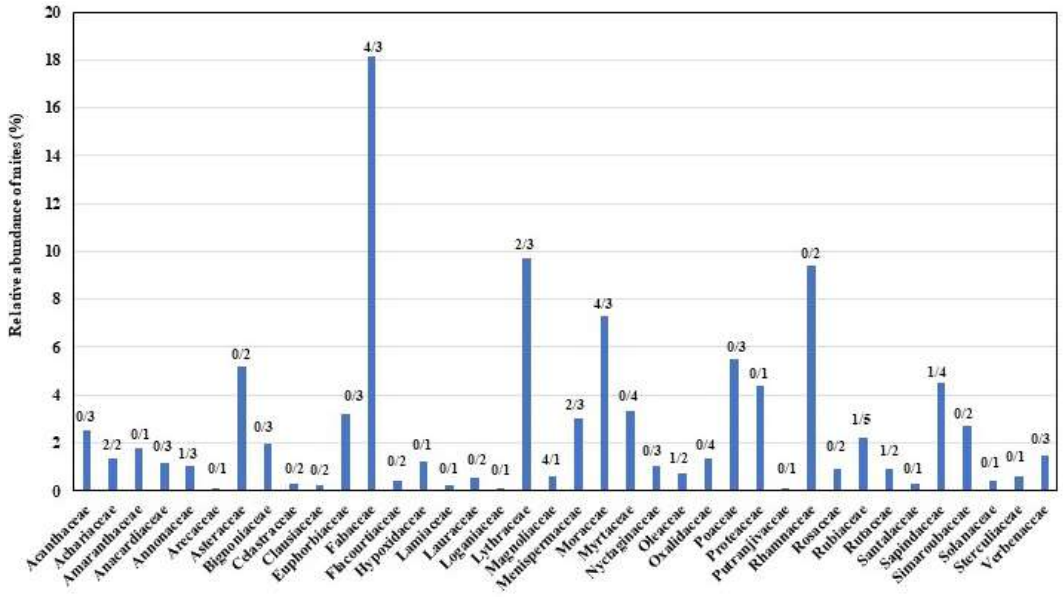
In GKVK campus prostigmatid predatory mites were more dominant over mesostigmatid predatory mites (excluding the members of Phytoseiidae family) as evidenced by the higher relative abundance of 81.4 per cent in respect of prostigmatid group of mites. However, both these mite groups were represented by six families each. Two predatory families, under Prostigmata *viz.,* Stigmaeidae and Cunaxidae were predominant both in terms of no. of mite specimens collected (527 & 113, respectively) as well as their

activity period of 9 (Cunaxidae) to 10 months (Stigmaeidae). Comparatively mesostigmatids though represented four major families, but were actively collected only for a period of two distinct months of March and October.

A roving faunal survey by Zeity (2011) reported Ascidae (2 species), Stigmaeidae (4) and Cunaxidae (2) from six plant species in GKVK campus. Our more systematic and year long study recorded 39 predatory species under 26 genera from 12 mite families collected from 61 species of host plants. Maximum no. of genera collected was seven from family Cheyletidae, followed by three each from Bdellidae and Stigmaeidae. Relatively, Cheyletidae, Stigmaeidae and Laelapidae recorded more no. of predatory species (9, 8 and 5, respectively) compared to Cunaxidae, Bdellidae and Blattisociidae with less no. of species *i.e.,* three species each. Other families were represented by either 1 to 2 genera/species only.

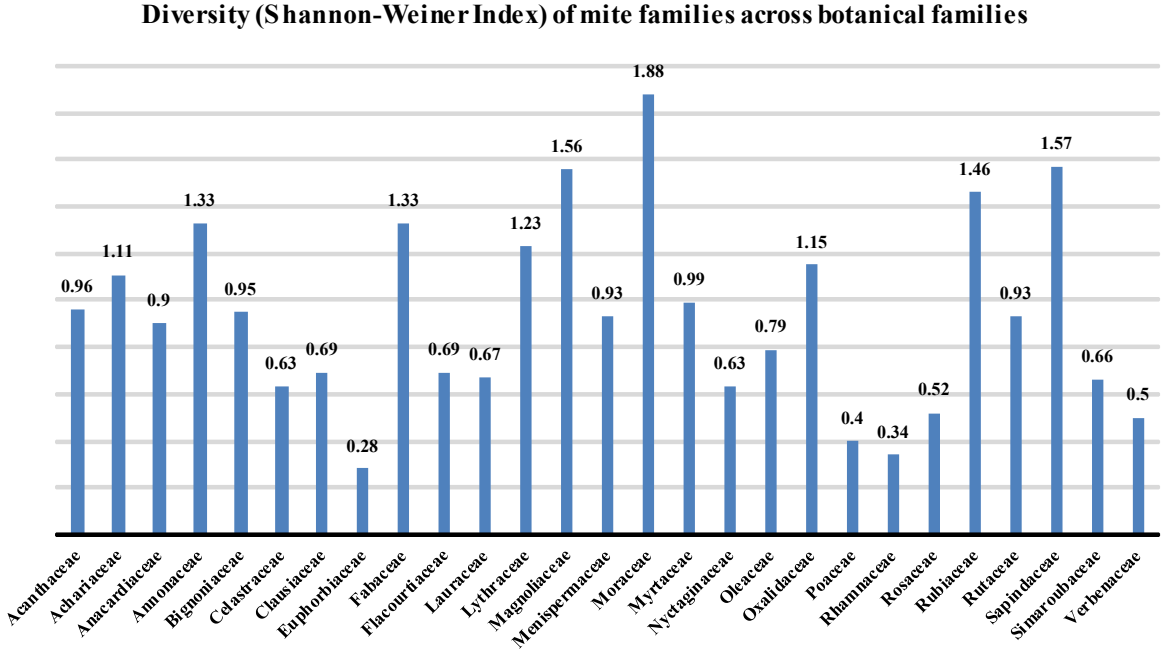
Plant Association of Non-Phytoseiid Predatory Mites

A total of 61 plants belonging to 38 botanical families sampled during the study, harboured 39 different species of mites belonging to 26 mite genera under 12 families (six each from Mesostigmata and Prostigmata). The plant family Fabaceae harboured highest number of mite individuals (174 individuals and 18.13% relative abundance) followed by Lythraceae (93 individuals and 9.69% relative abundance), Rhamnaceae (90 individuals and 9.38% relative abundance), Moraceae (70 individuals and 7.29% relative abundance), Poaceae (53 individuals and 5.52% relative abundance) and Asteraceae (50 individuals and 5.21% relative abundance). The other 32 botanical families harboured less than 50 mites and the relative mite abundance for each of them was less than 5 per cent (Fig. 1). The botanical family Moraceae harboured diverse groups of mites, which belonged to 7 different mite families and had the Shannon diversity index (H) of 1.88 followed by the botanical families such as Sapindaceae (H=1.57, 5 mite families), Magnoliaceae (H=1.56, 5 mite families), Rubiaceae (H=1.46, 6 mite families), Fabaceae (H=1.33, 5 mite families), Annonaceae (H=1.33, 4 mite families), Lythraceae (H=1.23, 5 mite families), Oxalidaceae (H=1.15, 4 mite families) and Achariaceae (H=1.11, 4 mite families). For the remaining 30 botanical families, the Shannon index was less than 1 and the botanical families namely, Amaranthaceae, Hypoxidaceae, Lamiaceae, Loganiaceae, Santalaceae, Solanaceae and Sterculiaceae harboured mites belonging to one mite family only (Fig. 2).



Numbers on each bar represent no. of mesostigmatid/prostigmatid mite families in each botanical family

Fig. 1 : Relative abundance of mesostigmatid and prostigmatid mite families across different botanical families in GKVK campus



*Botanical families with Shannon-Weiner Index value (H) <**0.1** are not represented*

Fig. 2 : Diversity of mesostigmatid and prostigmatid mite families across different botanical families in GKVK campus

Altogether 61 plant species belonging to 38 botanical families were recorded to harbour predatory mites from Prostigmata and Mesostigmata groups. Twenty-seven botanical families recorded only prostigmatid mites, while 11 botanical families recorded both prostigmatid and mesostigmatid groups of mites. Plants of Fabaceae and Moraceae family recorded predatory mites representing seven mite families, while Lythraceae harboured five of mite families. The corresponding predatory mite species-wise richness of these botanical families was 14, 13 and 6.

Ecological Significance of the Study

Prostigmatids and mesostigmatids are predatory mites well known as natural control agents of many insect and mite pests of cultivated crops and wild plants. Members of predominantly predatory mite family Phytoseiidae under suborder Mesostigmata are well documented and studied for their promising use in biocontrol programmes, mostly in greenhouses and protected cultivation systems. Chinnamade gowda (2009) while documenting the phytoseiid fauna from south interior Karnataka, reported the occurrence of atleast 20 species of phytoseiids from six species of wild plants in GKVK. Also, Zeity (2011) reported 14 species of plant associated phytoseiid mites from 19 cultivated and weed plants in GKVK, Bengaluru. Except for phytoseiids, predatory mites under Mesostigmata and Prostigmata groups are either meagrely documented or studied both in India and elsewhere. The present study focussed on reporting the occurrence and diversity of non-phytoseiid mesostigmatid and prostigmatid predatory mites in GKVK campus located in Eastern dry zone of southern Karnataka. Twelve predatory families recorded in the study included altogether 39 species, whose activity spread across 1-10 months in a calendar year. These predatory species were collected from 61 host plants under 38 plant families (Table 4), which form a diverse habitat of ornamental, fruits and wild shrubs. These plants might serve as a natural reservoir of predatory mites, which need to be conserved and sustained with minimal synthetic chemical control interventions.

Wild plants besides being a reservoir of predatory mites, also help in spatial and temporal movement of predatory mites into the cropping systems to enable

TABLE 4
Summary of different mite species and their plant hosts in GKVK campus

Mite species	Plant hosts with family
Agistemus gamblei	*Barleria cristata* (Acanthaceae), *Bougainvillea glabra* (Nyctaginaceae) & *Chromolaena odorata* (Asteraceae)
Agistemus industani	*Tecoma stans* (Bignoniaceae)
Agistemus sp. nr. *industani*	*Amaranthus viridis* (Amaranthaceae), *Bambusa* sp. (Poaceae), *Bauhinia acuminata* (Fabaceae), *Chromolaena odorata* (Asteraceae), *Curculigo orchioides* (Hypoxidaceae), *Grevillea robusta* (Proteaceae), *Lantana camara* (Verbenaceae), *Macroptilium artopurpureum* (Fabaceae), *Mallotus philippensis* (Euphorbiaceae), *Simarouba glauca* (Simaroubaceae), *Spathodea campanulata* (Bignoniaceae), *Stachytarpheta jamaicensis* (Verbenaceae), *Tectona grandis* (Lamiaceae), *Ziziphus mauritiana* (Rhamnaceae) & *Ziziphus oenopolia* (Rhamnaceae)
Agistemus sp. 1	*Solanum torvum (*Solanaceae)
Agistemus sp. 2	*Eriobotrya japonica* (Rosaceae) & *Ziziphus oenopolia* (Rhamnaceae)
Agistemus terminalis	*Acacia auriculiformis* (Fabaceae), *Artocarpus heterophyllus* (Moraceae), *Artocarpus hirsutus* (Moraceae), *Averrhoa carambola* L. (Oxalidaceae), *Bambusa* sp. (Poaceae), *Bauhinia purpurea* (Fabaceae), *Bougainvillea glabra* (Nyctaginaceae), *Caryota mitis* (Arecaceae), *Chromolaena odorata* (Asteraceae), *Codiaeum variegatum* (Euphorbiaceae), *Ficus pumila* (Moraceae), *Grevillea robusta* (Proteaceae), *Lagerstroemia speciosa (*Lythraceae), *Mangifera indica (*Anacardiaceae), *Milletia pinnata* (Fabaceae), *Polyalthia longifolia* (Annonaceae), *Santalum album* (Santalaceae), *Sapindus emarginatus* (Sapindaceae), *Simarouba glauca* (Simaroubaceae), *Syzygium cumini* (Myrtaceae), *Tecoma stans* (Bignoniaceae) & *Ziziphus mauritiana (*Rhamnaceae)
Ameroseiius sp.	*Artocarpus hirsutus* (Moraceae)
Anystis salicinus	*Jasminum sambac* (Oleaceae)
Asca sp.	*Acacia auriculiformis* (Fabaceae), *Anamirta cocculus* (Menispermaceae), *Artocarpus heterophyllus* (Moraceae), *Magnolia alba* (Magnoliaceae) & *Milletia pinnata* (Fabaceae)
Bdella maldahensis	*Coffea arabica* (Rubiaceae)
Cheletomimus bakeri	*Bambusa* sp. (Poaceae)
Cheletomimus congensis	*Tecoma stans* (Bignoniaceae)
Cheletomimus wellsi	*Lantana camara* (Verbenaceae)
Cheletomorpha lepidopterorum	*Ficus macrocarpa* (Moraceae), *Filicium decipiens* (Sapindaceae) & *Tamarindus indica* (Fabaceae)
Cosmolaelaps sp. 1	*Acacia auriculiformis* (Fabaceae), *Artocarpus hirsutus* (Moraceae) & *Lawsonia inermis* (Lythraceae)
Cosmolaelaps sp. 2	*Magnolia alba* (Magnoliaceae)
Cosmolaelaps sp. 3	*Artocarpus heterophyllus (*Moraceae)
Cosmolaelaps sp. 4	*Cassia fistula* (Fabaceae)

Table 4 Contd...

Mite species	Plant hosts with family
Dubininiola boonkongae	*Acacia auriculiformis* (Fabaceae), *Artocarpus heterophyllus (*Moraceae) & *Magnolia alba* (Magnoliaceae)
Epicroseius sp.	*Clausena anisate* (Rutaceae), *Hydnocarpus pentandrus* (Achariaceae), *Lawsonia inermis* (Lythraceae) & Wild jasmine (Oleaceae)
Eupodes garciai	*Anacardium occidentale* (Anacardiaceae), *Anamirta cocculus* (Menispermaceae), *Averrhoa carambola* L. (Oxalidaceae), *Bougainvillea glabra* (Nyctaginaceae), *Coffea arabica* (Rubiaceae), *Filicium decipiens* (Sapindaceae), *Hydnocarpus pentandrus* (Achariaceae), *Lagerstroemia speciosa* (Lythraceae), *Polyalthia longifolia (*Annonaceae), *Sapindus emarginatus* (Sapindaceae), *Syzygium cumini* (Myrtaceae), *Tecoma stans* (Bignoniaceae) & *Thunbergia mysorensis* (Acanthaceae)
Gamasellodes bicolor	*Anamirta cocculus* (Menispermaceae), *Artocarpus hirsutus* (Moraceae) & *Milletia pinnata* (Fabaceae)
Haemolaelaps sp.	*Ixora brachiata* (Rubiaceae)
Hypopicheyla elongata	*Ficus macrocarpa* (Moraceae)
Ker palmatus	*Artocarpus hirsutus* (Moraceae), *Filicium decipiens* (Sapindaceae), *Ixora brachiata* (Rubiaceae), *Mallotus philippensis* (Euphorbiaceae) & *Tamarindus indica* (Fabaceae)
Kleemannia kosi	*Filiciumdecipiens* (Sapindaceae) & *Tamarindus indica (*Fabaceae)
Krantzolaspina angustatus	*Hydnocarpus pentandrus*(Achariaceae) & *Magnolia alba* (Magnoliaceae)
Lasioseius sp.	*Anamirta cocculus* (Menispermaceae), *Artocarpus hirsutus* (Moraceae) & *Milletia pinnata* (Fabaceae)
Lasioseius chaudhrii	*Acacia auriculiformis* (Fabaceae) & *Artocarpus heterophyllus* (Moraceae)
Lasioseius reticulatus	*Polyalthia longifolia* (Annonaceae)
Ledermuelleriopsis spinosa	*Anamirta cocculus* (Menispermaceae)
Odontoscirus koloseta	*Averrhoa carambola* (Oxalidaceae), *Cinnamomum verum* (Lauraceae) & *Hydnocarpus pentandrus* (Achariaceae)
Oudemanscheyla denmarki	*Barleria cristata* (Acanthaceae)
Riscus austroamericanus	*Averrhoa carambola* (Oxalidaceae), *Lagerstroemia speciosa* (Lythraceae), *Sapindus emarginatus* (Sapindaceae) & *Syzygium cumini* (Myrtaceae)
Rubroscirus sp. nov.	*Anacardium occidentale* (Anacardiaceae) *Catha edulis* (Celastraceae), *Flacourtia inermis* (Flacourtiaceae), *Jasminum sambac* (Oleaceae) & *Nephelium lappaceum* (Sapindaceae)
Rubroscirus sinensis	*Anacardium occidentale* (Anacardiaceae), *Anamirta cocculus* (Menispermaceae), *Anthocephalus cadamba* (Rubiaceae), *Artocarpus heterophyllus* (Moraceae), *Artocarpus hirsutus* (Moraceae), *Bambusa* sp. (Poaceae), *Clausena anisata* (Rutaceae), *Codiaeum variegatum* (Euphorbiaceae), *Eriobotrya japonica* (Rosaceae), *Ficus natalensis* (Moraceae), *Garcinia gummi-gutta* (Clausiaceae), *Lagerstroemia speciosa* (Lytraceae), *Macroptilium artopurpureum* (Fabaceae), *Milletia pinnata* (Fabaceae), *Polyalthia longifolia* (Annonaceae), *Sapindus emarginatus* (Sapindaceae), *Simarouba glauca* (Simaroubaceae), *Strychnos potatorum* (Loganiaceae), *Thunbergia mysorensis* (Acanthaceae) & *Ziziphus mauritiana* (Rhamnaceae)

Table 4 Contd...

Mite species	Plant hosts with family
Spinibdella sp.	*Ixora brachiata* (Rubiaceae)
Tutacheyla robusta	*Coffea arabica* (Rubiaceae)
Zetzellia languida	*Acacia auriculiformis* (Fabaceae) *Artocarpus heterophyllus* (Moraceae), *Ixora brachiata* (Rubiaceae) & *Milletia pinnata* (Fabaceae)

natural control of mites and other arthropod pests, particularly in the event of surge or resurge of pest species due to many obvious reasons of ecological disturbances. The present study on non-phytoseiid predatory mite faunal diversity is the first of its kind that would also serve as a baseline for further detailed studies. The study evidently reports the abundance and almost yearlong activity of predatory mite species such as*, Agistemus* sp. nr. *industani, Agistemus terminalis* and *Rubroscirus sinensis.* More regional and periodical surveys for longer period of time and extensive study area and more no. of plant families would certainly reveal a much greater abundance as well as occurrence of more no. of predatory mite species. Documentation of predatory mite-plant association has wider scope to appreciate, conserve and sustain the predatory mite fauna in different ecosystems.

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