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Apple (*Malus domestica* Borkh), a new habitat for *Typhlodromus* (Anthoseius) *hadii* Chaudhari (Phytoseiidae) from India

Vijay Singh, Usha Chauhan and VK Rana

Abstract
Species of the family Phytoseiidae includes some important natural enemies of spider mites and other arthropod pests. In the present investigation *Typhlodromus* (Anthoseius) *hadii* Chaudhari was recorded on apple. Apple is the new habitat for this predator ever reported from India. This phytoseiid was recorded from eight different localities of two major apple growing districts. This predator was observed in association with phytophagous mites population. The occurrence of this species on apple helps in determining the Phytoseiidae diversity and their distribution in the country.

Keywords: biological control, natural enemies, mites

Introduction
Introduction of high yielding varieties, modification in cultural practice to increase the crop yield and quality food production for good health, the use of pesticides in various agro-horticulture commodities is of main concern [1]. To overcome this problem, several measures have been adopted like organic farming and use of IPM practices to reduce the pesticide pressure on food commodities. One of the components among IPM practices is the conservation and application of biocontrol agents which are moreover present in the ecosystem or introduced to check the pests in different crops [2-4]. In biocontrol program, family Phytoseiidae includes various potential predatory species of spider mites and soft bodied arthropod pest [3, 5]. These phytoseiid are commonly found in the wild as well as on the cultivated crops. Their diversity and abundance is affected by climate conditions, habitat stability and food resources [5, 6]. Numerous species of family Phytoseiidae are able to stay alive and grow even during the prey scarcity due to their polyphagous diet [2, 4, 7]. Due to their varied feeding habits they mostly obtain interest worldwide as biological control agent against phytophagous mites and soft bodied arthropods [7, 9]. Worldwide as natural enemies they are gaining importance among growers that provide effective pest control under protective and open field conditions [7].
In India, their significance fascinated the awareness of workers to explore these organisms by adding new species. Separately from these points, effort has been conceded by Gupta and Karmakar [10] regarding their bio-ecology, predator–prey associations and effects of chemical pesticides on these mites. Various workers across the country reported the occurrence of phytoseiidae members inhabiting plants of diverse crops [7]. From Himachal Pradesh, there were different reports regarding the occurrence of phytoseiid mites on different crops [11-16]. However, crop protection is still necessary to ensure food quality and sufficiently high yield [1]. Several measures have been taken in several countries to limit the use of pesticides.

Material and Methods
During the study, apple leaves were collected from wild and commercial apple orchard from different areas of Himachal Pradesh from 2013-2015. Samples were collected in polythene bags which were tied with rubber bands and brought to the laboratory of biological control for further processing. To immobilize the phytoseiid mites, samples were stored in refrigerator overnight. Samples were observed under stereo zoom microscope (Olympus SZX9). Observed specimens were stored in the mixture of glycerin and alcohol (70%). For proper clearing and stretching, specimens were placed in Lactic acid at temperature of 40 ºC for 1-2 days. Specimens were individually mounted on microscopic slides in a drop of Hoyer's medium [17].

Slides were dried at 35-40 ^{0}C for 3-4 days and identified under phase contrast microscope by following the standards keys [18, 19]. All the measurements were taken in micrometers (µm).

Results

Different apple growing areas of Himachal Pradesh were investigated during the survey. Species, *Typhlodromus* (*Anthoseius*) *hadii* Chaudhri was collected from ten different localities of four apple growing districts *viz.* Shimla (Jubbal, Sheelghat, Nakaura, Kedi, Piontra, Hadsu), and Kullu (Patlikuhl, Hurla), Chamba (Sarol), Kinnaur (Sarboo) of Himachal Pradesh (Table 1). This species was recorded to be associated with population of European red mite and two spotted spider mites.

Diagnostic characters

Dorsal shield, 365 long, 205 wide. Measurement of setae: j_1-24, j_3-46, j4-8, j5-6, j6-15, z_2-12, z_3-57, z_4-22, z5-6, s4-54, r_3-32, R1-34, J_2-18, S2-57, S_4-41, S_5-38, Z_1-59, Z_4-48, Z_5-73, J_5-5 (Fig. a). Sternal shield, 71 long and 71-wide with 3 pair of setae (Fig. b). Genital shield 82 long and 79-wide with 1 pair of setae. Ventrianal shield, 131 long 75 wide with 4 pairs of preanal setae (Fig. c). Length of macrosetae, on genu 36, tibia-36 and basitarsus-37 (Fig. f). Fixed digit of chelicera with 3 teeth along with pilus dentilis whereas, 2 teeth present on movable digit (Fig. d).

Gupta [18] described this species on apricot from Uttar Pradesh and Jammu & Kashmir. Occurrence of this species was the first report on any crop from Himachal Pradesh whereas, it the first record on apple from India.

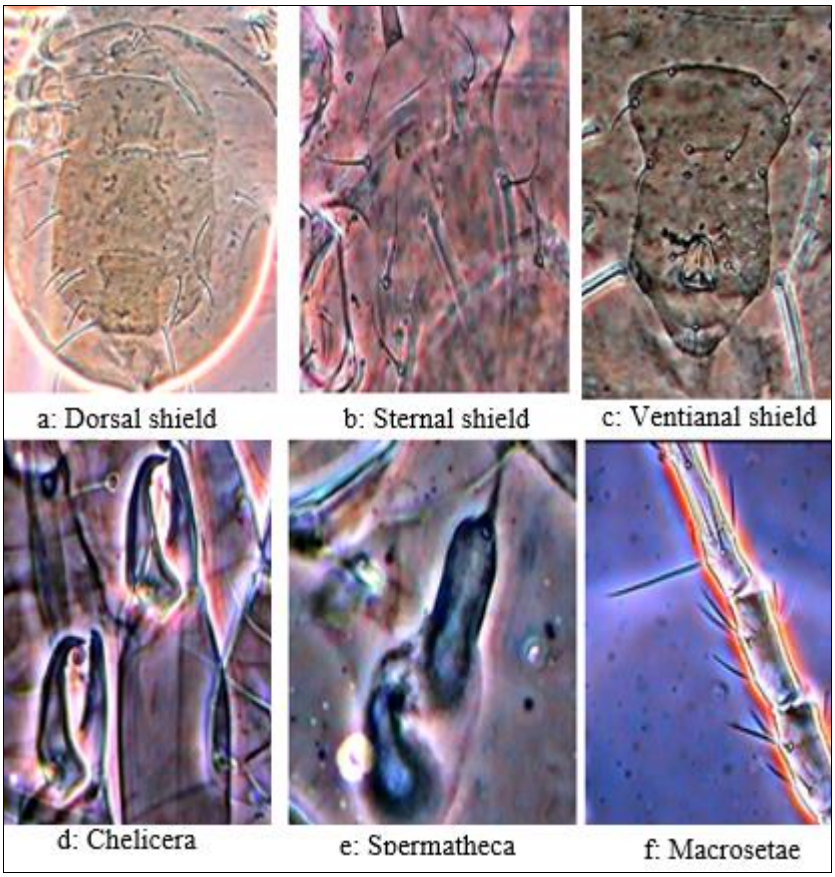
However, this species was reported from Jammu & Kashmir on mulberry and apple [18]. During the present study it was recorded that dorsal shield and setae were little larger than those specimens which were observed by Gupta [18] from *Prunus armeniaca* and fig. This difference could be due to different habitat and geographical variation of collected specimens.

Conclusion

During the present study this species was reported for the first time on apple from India and first report on any crop from Himachal Pradesh. This study explores new habitat as well as new area for this species and also the distribution of various member of Phytoseiidae in the country. In future this may be the new area for researcher to explore more diversity of these beneficial creatures which are more beneficial in bio-control of mite and soft bodied arthropod pests.

Table 1: Distribution of *Typhlodromus* (*Anthoseius*) *hadii* Chaudhri on apple in Himachal Pradesh

S. No.	Name of district	Name of locality
1.	Shimla	Jubbal, Sheelghat, Nakaura, Kedi, Piontra, Hadsu
2.	Kullu	Patlikuhl, Hurla
3.	Kinnaur	Sarol
4.	Chamba	Sarboo



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